Basic Medical Techniques and Patient Care in

IMAGING TECHNOLOGY



Lillian S. Torres

FIFTH EDITION

Lippincott

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FIFTH EDITION

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5th Edition

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To Joseph

Preface

Radiologic technology has become a dynamic health care profession. When the first edition of this textbook was written and published in 1979, the authors and consultants for the text had no concept of the degree of change that was to take place in this discipline. Although each edition of this textbook has changed and grown to meet the growing professional accountability of the radiologic technologist, the fifth edition differs greatly from previous editions as the expanded scope of practice has dictated. Contributing authors have been added. Two radiologic technology educators who are experts in basic and specialty areas and who are respected members of the profession were invited to write Chapter 1 and were advisors on other areas of the text.

The radiologic technology student (to be called radiographer) must understand the responsibilities of membership in a profession. To meet this end, the educational requirements, the necessity of belonging to one's professional organizations, and the inter-relationship of the radiographer to other members of the health care team are emphasized in this edition. The potential of the radiologic technologist for professional growth is discussed, and the specialty areas in the profession are presented.

The subjects of professional ethics and the legal aspects of radiologic technology have been enlarged to enhance the understanding of the radiographer's obligation to his profession and to the law. Responsibility to the patient in his or her care is also emphasized.

The most important aspect of professional growth in any field is the ability to think in a critical manner. This ability leads to reliable judgment when problem-solving. This subject was discussed superficially in previous editions of this textbook but becomes a major focus in this edition. Each chapter has critical thinking problems included for student practice in areas where they will need to make sound professional judgments.

Infection control in health care continues to be a major concern. The re-emergence of tuberculosis, the continuing threat of HIV and the hepatitis viruses, and the techniques of infection control necessary to protect oneself and the patient from acquiring these diseases are dealt with in detail, as is the use of Universal Blood and Body Fluid Precautions in all patient care.

Professional communication, interviewing techniques, therapeutic communication, and sensitive patient care are issues of grave concern in radiologic technology and have been reinforced. Other aspects of safe patient care are expanded, including use of acceptable immobilization and transfer techniques, and the special needs of the geriatric and pediatric patient. The sequence of subject matter has been rearranged at the suggestion of colleagues across the country.

Knowledge of pharmacology and safety in drug administration is now a requirement in radiography. A new section has been added that instructs the radiography student in the fundamentals of pharmacology and presents a detailed description of all methods of drug administration. Special emphasis is placed on intravenous administration of contrast agents, as this is currently within the radiographer's scope of practice in many states in the United States.

Patient care in special procedures has also been expanded. It is the hope of the author that this will lend insight into the needs of persons who are receiving special procedures, since the radiographer is a prominent member of the health care team during these procedures.

The format of this edition has been altered only by adding critical thinking problems at the end of each chapter. It is my hope that the enlarged body of this text will assist the radiography student to be a safe practitioner in every aspect of patient care.

Lilian S. Torres, RN, BS, MS, MEd, CNS, NP

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Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Define the criteria for a profession and explain how the field of radiologic technology has evolved to meet these criteria.
2. List the members of the health care team with whom the radiographer frequently interacts and briefly describe the role of each.
3. Discuss the purpose of professional organizations and list the reasons for the radiographer to join those in his field.
4. Define *ethics* and discuss ethics as it applies to radiologic technology.
5. Explain the legal obligations the radiographer has toward his patients, his peers, and other members of the health care team.
6. Define *patient rights* and describe the role of the radiologic technologist in protecting these rights.
7. List the responsibilities of the patient as he seeks health care.
8. Discuss the legal implications of the use of immobilization techniques, unusual occurrence reports, Good Samaritan laws, informed consent, and malpractice insurance.
9. Explain the need for accurate and complete medical records and documentation in health care and the obligations of the radiographer in this aspect of patient care.
10. Discuss legal issues for the radiographer related to computer technology.

Glossary

Adhere: to stay fixed or firm
Bias: an inclination or temperament based on personal judgment; prejudice
Common law: decisions and opinions of courts that are based on local customs and habits of an area within a particular country or state
Continuum: continuous whole whose parts cannot be separated
Diagnostic imaging: modern term for radiography, encompassing all specialties devoted to producing a picture of a body part
Euthanasia: deliberately bringing about the death of a person suffering from an incurable disease or condition
Grieving process: an emotional state one must go through when a loss is experienced to maintain sound emotional health
Holistic: the view that an organic or integrated whole has a reality independent of and greater than the sum of its parts
Liability: something one is obligated to do or an obligation required to be fulfilled by law; usually an obligation of financial nature
Litigation: lawsuit
Malpractice: professional negligence that is the cause of injury or harm to a patient
Mentor: a teacher, coach, or advisor
Preceptor: a teacher; directs action or conduct of another individual
Profession: a calling that requires specialized knowledge and intensive academic preparation
Statutory law: established law that is enacted by a legislative body and punishable by law
Terminal illness: a disease with no known cure that results in death
Therapeutic: healing
Unethical: not conforming to the standards of conduct of a particular profession or group

Radiologic technology has evolved to meet the criteria of a profession. As in all professions, it is expected that the conduct and behavior of radiographers will adhere to the particular ethical and legal standards of the field. Any person who does not adhere to this code is subject to loss of his license and the privileges of that profession.

The radiographer does not work alone in caring for the patient. He works and interacts with members of a health care team toward the goal of improving or restoring the patient to good health. The health care team consists of physicians, nurses, therapists, and social workers, all of whom work within their scope of practice and are accountable for the performance of their professional duties.

The student who has made the decision to enter the profession of radiologic technology must realize that he is committed to accepting the code of ethics of this profession and must work within that scope of practice. The student must also understand that he is accountable for his work and may be held legally liable for any errors made while caring for patients.

Radiologic technology is a profession oriented toward the diagnosis and treatment of trauma and disease. This means that the radiologic technologist (called the radiographer in this text) works in intimate contact with people on a daily basis. He must be prepared to work with people of all races, religions, and economic backgrounds and to relate to them in an unbiased, nonjudgmental manner.

The student contemplating a career in radiologic technology must examine the reasons why he has chosen this profession. It would be helpful if he asked himself the following questions before proceeding:

Am I prepared to accept and practice the profession of radiologic technology and support the ethics of this profession?

Am I prepared to avoid violations of the law in practicing this profession?

Will I be willing and able to learn to relate to my patients in a professional and nonjudgmental manner at all times?

Any student who cannot answer these questions positively should reconsider his career choice.

The Criteria for a Profession

A profession is defined as a vocation or occupation that requires extended training and education of its members based on a liberal foundation. It has a theoretical body of knowledge leading to strictly defined skills, abilities, and principles of action. A profession provides a specific service and members of that profession are given the autonomy to make decisions within the scope of their practice. All professions have a code of ethics and professional organizations that control the educational and practice requirements of its members. The two organizations that assume these roles for radiographers are the American Society of Radiologic Technologists (ASRT) and the American Registry of Radiologic Technologists (ARRT). The professional radiographer is registered by the ARRT and by state licensure if applicable.

Radiologic technology fulfills the basic requirements of a profession and is striving to become in-

creasingly autonomous in professional practice. With the status of a profession comes responsibility and educational requirements that the person formerly known as an "x-ray technician" did not have.

In 1995, the ASRT House of Delegates adopted a resolution stating that "the ASRT represents those professionals who, upon the order of a physician, perform diagnostic medical imaging procedures and/or administer various forms of ionizing and nonionizing radiation to human beings for the performance of diagnostic and therapeutic procedures. As such, the ASRT is concerned with the quality of patient care, control of radiation and the quality of education standards of technologists" (ASRT, 1995).

The preparatory education for the radiographer has evolved from a hospital-based preceptor program. There are now prolonged hospital-based programs as well as college- or university-based programs of study. At the 75th conference of the ASRT House of Delegates that met in 1995 (ASRT Second Century Conference), a resolution was adopted concerning the requirements for education in radiologic technology that includes the following educational levels for the registered technologist:

1. *Certificate or associate degree:* the basic entry level into practice
2. *Baccalaureate degree:* a requirement for professional level of practice
3. *Graduate degree:* a requirement in many states for those who teach in the profession

A position statement was formulated at this conference establishing that, "The ASRT recognizes the baccalaureate degree as the professional level of radiologic sciences education." It was confirmed that the radiographer of 2005 will be either a technical or a professional practitioner. The scope of practice for the technical versus the professional radiographer was outlined as follows.

The technical radiographer will possess the skills and ability to perform the following functions:

1. Apply modern principles of radiation exposure, radiation physics, radiation protection, and radiobiology to produce diagnostic images
2. Utilize knowledge of medical terminology, pathology, cross-sectional anatomy, topographic anatomy, anatomy and physiology, and positioning procedures to produce diagnostic images
3. Provide direct patient care such as ECG, contrast media, and other drug administration
4. Evaluate recognized equipment malfunctions
5. Evaluate radiographic images
6. Achieve a level of computer literacy
7. Teach educational courses at the technical level
8. Communicate with other members of the health care team
9. Provide patient and family education
10. Participate in community affairs

The technical radiographer will possess the following qualities: an ability to think in a critical manner; a willingness to participate in lifelong learning, including becoming an active member of professional organizations; ethical behavior; an appreciation for the implications that rising health care costs have for patient care; a holistic caregiver perspective; a broad computer knowledge base; problem-solving skills; and the ability to communicate effectively orally and in writing.

The professional radiographer will: possess all of the qualities and technical abilities listed above as well as demonstrate the following:

1. The ability to supervise, evaluate, and counsel staff, as well as provide professional development and perform lead technologist's duties
2. Advanced knowledge in areas of supervision, in-service education, and regulatory compliance
3. Superior decision-making skills
4. Patient advocacy.
5. Knowledge of trauma radiography
6. The ability to perform fluoroscopic procedures
7. The ability to utilize the team concept of administrative philosophy
8. Potential as a resource person to technical-level practitioners in geriatric/gerontological examinations
9. Skills as a mentor

10. Multicompetency in a range of specialties such as CT, MRI, and special procedures

The changes in education that will be needed by the radiographer in order to be able to meet the requirements listed above were considered. The need for courses to promote critical thinking, scientific inquiry skills, and decision-making abilities has yet to be resolved.

Continuing education, which had been voluntary for radiographers, became a mandate in 1995 for all who are licensed by the ARRT. Now, radiographers are required to take 24 continuing education units. These credits, which must be accepted by the ARRT, are to be taken every 2 years and must be verified by the licensing body prior to renewal of license. These credits may be in the form of seminars, conferences, lectures, departmental in-service education, directed reading, home study, and college courses pertaining to the field of radiologic technology. If the radiographer prefers, he may take an advanced examination, which he must pass, to receive a renewed license to practice radiologic technology. This is a minimal education requirement, and the radiographer who is committed to high standards of patient care will seek a great deal more continuing education.

THE EVOLUTION OF PROFESSIONAL ORGANIZATIONS IN RADIOLOGIC TECHNOLOGY

Participation in professional organizations is the responsibility of all practicing professionals, regardless of their field. Membership in professional organizations provides a pathway to successful professional life for several reasons. It provides members the opportunity to remain current in a constantly changing technological field. It provides opportunities for technical growth and development of leadership skills, as well as an arena for professional interaction and problem solving. Many programs and services are offered by professional organizations, including continuing education, publications, scholarships, and collective legislative power. Ultimately, membership in professional organizations enables the radiographer to continue providing quality health care and to maintain the standards of his profession.

There are various levels of professional organizations in radiologic technology. Internationally, there is the International Society of Radiographers and Radiologic Technologists. In the United States, the ASRT is the national organization for radiologic technology. It has affiliated societies at state levels, and the state societies have district affiliates. A chronology of the events that stimulated the ASRT to evolve into the strong professional organization that it is today is interesting to review (see Display 1–1).

The Health Care Team

The radiographer will interact on a daily basis with peers in radiographic imaging and with other members of the health care team. Recognition of the roles that the other members of the team play in patient care is helpful to the student radiographer. What follows are brief descriptions of the roles of the various health care team members with whom the radiographer will interact on a daily basis.

THE PHYSICIAN

The physician is considered the leader of the health care team in many instances. It is the physician's role to order treatments, medications, and consultant care as necessary to return the patient to a state of health. A baccalaureate degree is required, followed by 4 years of education at an accredited medical school where the degree of Medical Doctor is attained. The physician then chooses an area of specialization in which to practice. Family practice, pediatrics, orthopedics, radiology, obstetrics/gynecology, internal medicine, and surgery are just some of the areas in which medical doctors can specialize. Each of these areas of specialty have official educational programs that require from 2 to 8 years of theoretical and clinical work. Many of the medical specialties have subspecialties that require further study.

THE NURSE

Nursing care is provided for the hospitalized patient 24 hours a day. The nurse's role has many facets, including that of caregiver, case manager, patient and family educator, and patient advocate. Nurses administer medications and treatments as ordered by the physician, monitor the patient's health status, and coordinate and facilitate all patient care.

Nursing education may be obtained in several ways. The nurse may attend a university program and obtain a baccalaureate degree in nursing. Following graduation, the nurse must take and satisfactorily pass a licensing examination that is given at the state or national level. When this is complete, the title of registered nurse (RN) is given. There are master's and doctoral programs in nurs-

DISPLAY 1–1 Chronology of Events in the History of the Radiologic Technology Profession

1895 Wilhelm Conrad Roentgen discovered x-rays in Wurzburg, Germany.

1920 The American Association of Radiological Technicians, the first society for the profession, was created by a group of technologists in Chicago, Illinois. The society was dedicated to the advancement of radiologic technology.

1921 The Society's first annual meeting was held. Membership totaled 47.

1923 The American Registry of Radiological Technicians originated.

1930s–1940s Radiographer education was primarily by apprenticeship.

1932 The name of the American Association of Radiological Technicians was formally changed to the American Society of X-ray Technicians (ASXT).

1936 The Society was authorized to make appointment to the Registry Board of Trustees.

1952 The Society provided a basic minimum curriculum for training schools.

1955 The Society created a new membership category—Fellow of the ASXT—recognizing individual members having made significant contributions to the profession.

1959 The Society membership reached 8600 members.

1960 Registry applicants were required to have at least 2 years of training or experience.

1963 The American Registry of Radiological Technicians changed its name to the American Registry of Radiologic Technologists.

1964 The ASXT changed its name to the American Society of Radiologic Technologists.

1966 Registry applicants were required to be graduates of training programs approved by the American Medical Association's Council on Medical Education.

1967 The Association of University Radiologic Technologists was established to stimulate an interest in radiologic technology through the academic environment.

1968 The Society membership reached 14,000.

1970 Registry Certificate No. 1 was awarded to Sister Mary Beatrice by the Registry.

1984 The Association of University Radiologic Technologists changed its name to The Association of Educators in Radiological Sciences (AERS). Currently membership is around 1000 educators from the United States and other countries.

1988 The Summit on Radiologic Sciences and Sonography met in Chicago to develop strategies to alleviate the personnel shortage in the profession.

1995 The American Registry of Radiologic Technologists announced that, beginning in 1995, x-ray technologists would henceforth be obligated to obtain 12 continuing education units per year to maintain their licenses.

1996 The Society membership reached 47,000 members.

ing and specialty areas of education that may be pursued following completion of a baccalaureate program.

There are also Associate Degree in Nursing programs and a few remaining diploma schools in nursing. Graduates of these programs receive 2 to 3 years of nursing education, take the state licensing examination, and are awarded the title of RN. They are then able to pursue the baccalaureate degree in nursing as their time permits.

There are vocational programs that require approximately three semesters of nursing education to complete. The graduates of these programs must also pass a state licensing examination before they may practice. The vocational nurse (LVN) works with patients under the supervision of an RN.

OCCUPATIONAL AND PHYSICAL THERAPY

The members of these separate professions are the health care workers who play a significant role in rehabilitating the patient following illness or injury. The educational programs for these specialties are university-based and require a baccalaureate degree plus one year of internship. The therapist evaluates the patient's rehabilitation needs and designs a program to help the patient achieve mobility or perform activities of daily living (ADLs) independently. ADLs range from wash-

ing, dressing, and feeding to re-learning to shop, obtaining necessary transportation, and successfully returning to the outside world following physical or emotional illness or injury.

THE PHARMACIST

The pharmacist is the health care worker who prepares and dispenses medications and, in a hospital-based pharmacy, oversees the patient's drug therapy. This specialty requires a baccalaureate degree and an internship of 1 to 2 years.

THE RESPIRATORY THERAPIST

The respiratory therapist is responsible for maintaining the patient's respiratory status. This service is ordered by the physician for the patient whose respiratory status is threatened due to illness or injury. Respiratory therapists administer various forms of respiratory therapy, monitor ventilatory equipment, and administer drugs that must be given by inhalation. The respiratory therapist may attend a college-based program and obtain a certificate of completion that takes from four to five college semesters to obtain. Upon completion of the program, the graduate must take and satisfactorily pass a licensing examination.

OTHER SERVICES

There are a number of medical professionals and paraprofessionals with whom the radiographer will work with from time to time; however, this text is not large enough to outline each of them. Each performs a valuable service and the radiographer will learn about them as he works in the profession.

SPECIALTY AREAS IN RADIOGRAPHY

Radiography has made dramatic progress since its inception in 1895. At present, this profession has a scope of practice that reflects the increasing responsibilities of the radiographer (Display 1–2). In addition to radiographic imaging, the radiographer may enhance his professional growth by specializing in diagnostic and therapeutic treatment areas that have evolved from the field of basic radiography. Some of the areas for professional advancement include computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), mammography, ultrasound, nuclear medicine, and radiation therapy. These and other areas of specialization will be discussed in detail in Chapter 13. The completion of the basic radiologic technology program can be the end of one's educational career or merely the beginning.

Professional Ethics

Ethics may be defined as a set of moral principles that govern one's course of action. *Moral principles* are a set of standards that establish what is right or good. All individuals have a personal code of ethics that evolves based on their cultural and environmental background. This same background has taught us to place *values* on behaviors, as well as on objects in our environment; that is, to assign a judgment of either good or bad to an action. As the student can quickly see, these terms are closely linked and may be used interchangeably from time to time.

The student entering the profession of radiologic technology brings with him his personal code of ethics, his moral principles, and his personal set of values. All professionals also have a set of ethical principles or a *code of ethics* that governs professional behavior. This is true of radiologic technology (Display 1–3; adopted in 1993). The ARRT also has developed *Principles of Professional Conduct*, which address the issue of professional ethics (Display 1–4). Together, these documents represent the application of moral principles and moral values to the practice of the profession. They are concerned with the duties and responsibilities the radiographer has toward himself, his patients, and his professional peers and associates. The radiographer's responsibilities deal with rights and correlated responsibilities and will be discussed in the following section of this chapter.

Unfortunately, as the world of health care becomes increasingly complex and the ability to prolong life expands, there are more difficult choices to be made. This leads to a growing number of ethical conflicts and dilemmas. The radiographer will not be immune to these as he performs his professional duties. He must adhere to his professional code of ethics at all times, even though doing so will, at times, present difficult problems to be resolved.

A set of ethical principles has been derived from two basic ethical philosophies. These are utilitarianism and deontology.

Utilitarianism is often called *consequentialism* and advocates that actions are morally correct or right when the largest number of persons are benefited by the decision made. This is an acceptable philosophy if one is not in the minority that does not benefit from the decision.

DISPLAY 1–2 The Scope of Practice

Radiographer—RT(R)(ARRT)

1. Completion of a formal program of study accredited by the Committee on Allied Health Education and Accreditation of the American Medical Association in collaboration with the American Society of Radiologic Technologists and the American College of Radiology, which sponsor the Joint Review Committee on Education in Radiologic Technology.
   OR
   Completion of didactic and clinical experience acceptable to the American Registry of Radiologic Technologists.
   AND
2. Certification by the American Registry of Radiologic Technologists.

The art and science of radiography requires that the radiographers achieve a specific level of knowledge and skill. The radiographer must possess and demonstrate knowledge of and competency in, but not limited to, the following areas:

Human Structure and Function—including general anatomy, cross-sectional anatomy and anatomical relationships, organ and organ system functions and relationships in order to perform accurate radiographic examinations.

Medical Ethics—including ethical and legal considerations that impact upon practice.

Medical Terminology—including knowledge of disease and abnormalities to allow the radiographer to effectively communicate in the performance of radiographic procedures.

Pathology—including knowledge of disease and abnormalities that influence performance of radiographic procedures.

Patient Care—including attention and concern for the physical and psychological needs of the patient. Additionally, the technologist identifies the accurate assessment of life-threatening conditions and exercises independent judgment to implement basic life support procedures.

Positioning—including proper beam-part-image receptor alignment with respect to source of radiation, selected imaging modality, and area to be examined.

Principles of Radiographic Exposure—including appropriate selection of all technical factors and equipment to produce a quality diagnostic radiograph.

Quality Assurance—including darkroom chemistry and processing procedures, sensitometry characteristics, preventive maintenance, and knowledge of equipment.

Radiation Physics—including atomic structure, beam quality, radiation interactions, and the functions and operations of various generator components.

Radiation Protection—including the use of beam restrictive devices, patient shielding techniques, proper screen–film combinations, accurate assessment, and implementation of appropriate exposure factors as well as a working understanding of applicable governmental regulations. The primary utilization of this knowledge is to minimize radiation to the patient, the practitioner, and others.

Radiobiology—including understanding of beam formation and radiation interaction with matter as it relates to genetic and somatic effects. The necessity for this knowledge and its application is to reduce possible genetic damage to future generations resulting from unnecessary radiation exposure.

Special Techniques—including all vascular and neurological radiographic procedures, computed tomography, magnetic resonance, mammography, and interventional radiography.

The practice of radiography is stated as the performance, for compensation or personal profit, of service including, but not limited to:

- Radiographic examinations, upon the order of a physician, of all body parts for diagnostic interpretation by a physician.
- Optimal patient care utilizing established and accepted techniques.
- Supervision of other practitioners where applicable.
- Supervision and instruction of students where applicable.
- Evaluation of the above functions and recommendations for improvement.

Source: The American Society of Radiologic Technologists

Deontology upholds the philosophy that the rules are to be followed at all times by all individuals. This philosophy advocates the principles of autonomy, nonmaleficence, beneficence, and justice. These principles have been widely used in health care and are explained in the following section.

ETHICAL PRINCIPLES

In order to resolve ethical dilemmas, the radiographer may apply this established set of principles to decision making. They are as follows:

1. *Autonomy:* Refers to the right of all persons to make rational decisions free from external

DISPLAY 1–3 Code of Ethics

This Code shall serve as a guide by which Radiologic Technologists may evaluate their professional conduct as it relates to patients, colleagues, other members of the medical care team, health care consumers, and employers. The Code is intended to assist radiologic technologists in maintaining a high level of ethical conduct.

1. The Radiologic Technologist conducts himself/herself in a professional manner, responds to patient needs and supports colleagues and associates in providing quality patient care.
2. The Radiologic Technologist acts to advance the principal objective of the professional—to provide services to humanity with full respect for the dignity of mankind.
3. The Radiologic Technologist delivers patient care and service unrestricted by the concerns of personal attributes or the nature of the disease or illness, and without discrimination regardless of sex, race, creed, religion, or socioeconomic status.
4. The Radiologic Technologist practices technology founded upon theoretical knowledge and concepts, utilizes equipment and accessories consistent with the purposes for which they have been designed, and employs procedures and techniques appropriately.
5. The Radiologic Technologist assesses situations, exercises care, discretion and judgment, assumes responsibility for professional decisions, and acts in the best interest of the patient.
6. The Radiologic Technologist acts as an agent through observation and communication to obtain pertinent information for the physician to aid in the diagnosis and treatment management of the patient, and recognizes that interpretation and diagnosis are outside the scope of practice for the profession.
7. The Radiologic Technologist utilizes equipment and accessories, employs techniques and procedures, performs services in accordance with an accepted standard of practice, and demonstrates expertise in limiting the radiation exposure to the patient, self, and other members of the health care team.
8. The Radiologic Technologist practices ethical conduct appropriate to the profession, and protects the patient's right to quality radiologic technology care.
9. The Radiologic Technologist respects confidences entrusted in the course of professional practice, respects the patient's right to privacy, and reveals confidential information only as required by law or to protect the welfare of the individual or the community.
10. The Radiologic Technologist continually strives to improve knowledge and skills by participating in educational and professional activities, sharing knowledge with colleagues and investigating new and innovative aspects of professional practice. One means available to improve knowledge and skill is through professional continuing education.

pressures. Patients have the right to make decisions concerning their lives and the radiographer must respect those decisions.

2. *Beneficence:* All acts must be meant to attain a good result or be beneficial. The radiographer must always plan patient care to assure safe outcomes and avoid harmful consequences.
3. *Confidentiality:* Refers to the concept of privacy. All patients have the right to have the information obtained about their state of health or other personal information kept in confidence unless it will benefit him or there is a direct threat to society if not disclosed.
4. *Double effect:* Refers to the fact that some actions may produce both a good and a bad effect. Four criteria must be fulfilled before this type of action is ethically permissible:
   a. The act is good or morally neutral.
   b. The intent is good, not evil, although a bad result may be foreseen.
   c. The good effect is not achieved by means of the evil effect.
   d. There is a favorable balance between good over bad. Radiation exposure may be harmful; however, the diagnosis obtained by the exposure will aid in restoring the patient to health.
5. *Fidelity:* Refers to the duty to fulfill one's commitments and applies to keeping promises both stated and implied. The radiographer must not promise patients results that he cannot achieve.
6. *Justice:* Refers to all persons being treated equally or receiving equal benefits according to need. The radiographer does not favor one patient over another or treat one patient differently from another, regardless of personal feelings.
7. *Nonmaleficence:* Refers to the duty to abstain from inflicting harm and also to prevent harm. The radiographer is obligated to practice in a safe manner at all times.
8. *Paternalism:* Refers to the attitude that sometimes prompts health care workers to make decisions regarding a person's care without

DISPLAY 1–4 Principles of Professional Conduct for Radiologic Technologists

Principle 1:

Radiologic Technologists shall conduct themselves in a manner compatible with the dignity and professional standards of their profession.

Principle 2:

Radiologic Technologists shall provide services with consideration of human dignity and the needs of the patient, unrestricted by consideration of age, sex, race, creed, social or economic status, handicap, personal attributes, or the nature of the health problem.

Principle 3:

Radiologic Technologists shall make every effort to protect all patients from unnecessary radiation.

Principle 4:

Radiologic Technologists should exercise and accept responsibility for independent discretion and judgment in the performance of their professional services.

Principle 5:

Radiologic Technologists shall judiciously protect the patient's right to privacy and shall maintain all patient information in the strictest confidence.

Principle 6:

Radiologic Technologists shall apply only methods of technology founded upon a scientific basis and not employ those methods that violate this principle.

Principle 7:

Radiologic Technologists shall not diagnose, but in recognition of their responsibility to the patient, they shall provide the physician with all information they have relative to radiologic diagnosis or patient management.

Principle 8:

Radiologic Technologists shall be responsible for reporting unethical conduct and illegal professional activities to the appropriate authorities.

Principle 9:

Radiologic Technologists shall continually strive to improve their knowledge and skills by participating in educational and professional activities and sharing the benefits of their attainments with their colleagues.

Principle 10:

Radiologic Technologists shall protect the public from misinformation and misrepresentation.

These Principles are intended to serve as a guide by which radiologic technologists may evaluate their professional conduct as it relates to patients, colleagues, other members of the medical care team, health-care consumers, and employers and to assist radiologic technologists in maintaining a high level of ethical conduct.

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consulting the person affected. If a radiographer is tempted to make such a unilateral decision, he must consider whether the action is justifiable based on potential outcomes. The radiographer is justified in taking action when not acting would do more harm than the lack of patient input into the decision.

9. *Sanctity of life:* Refers to the belief that life is the highest good and nobody has the right to judge that another person's quality of life is so poor that his life is not of value and should be terminated. The radiographer cannot make life-and-death decisions for his patients based on his personal values.
10. *Truthfulness:* Refers to honesty in all aspects of one's professional life. The radiographer must be honest with his patients, his coworkers, and himself.
11. *Respect for property:* Refers to keeping the belongings of patients safe and taking care not to be careless with or intentionally damage or waste equipment or supplies with which one works.

ETHICAL ISSUES IN RADIOGRAPHY

The radiographer is expected to conduct himself in a professional manner. He must be reliable; that is, he is expected to report for work on time and complete his assigned share of the workload in a timely and efficient manner. He is also expected to work as a cooperative member of the health care team. He must be articulate and his speech must be free from vulgarisms or inappropriate slang. He must treat all patients as persons with dignity and

worth and there can be no demonstration of preference for one patient over another.

In spite of impeccable behavior on the part of the student radiographer, he will observe behaviors and patient care problems that may be seen as ethical concerns as he performs his clinical laboratory practice in health care institutions. Some of the problems that might be encountered are defensive shielding of professional colleagues who are violating the code of professional ethics; unequal medical resource allocation based on the patient's age or socioeconomic status; lack of respect for the patient; breaches of privacy and confidentiality; and over- or under-treatment of patients. The student will observe that what is taught in the classroom often does not match what is seen in the clinical area.

In such cases, the student would do well to observe the issues that he believes to be violations of the ethical code and to discuss them with his colleagues and his instructor in private conference. These issues can become learning experiences for the student as he and his colleagues contemplate as a group how they should be resolved.

As the scope of practice and the professional responsibilities of radiologic technology grow, so do the ethical responsibilities of radiographers. Often, an ethical decision involves a choice between two unsatisfactory solutions to a problem. This is often the case with health care. If the radiographer conscientiously follows his professional code of ethics and the ethical principles listed above to make difficult decisions as they arise, he will be able to resolve ethical dilemmas in a manner that allows him peace of mind. This approach must be combined with critical thinking and the problem-solving process that will be discussed in Chapter 2 of this text.

For ethical dilemmas of some magnitude, most health care institutions have ethics committees that meet on a regular basis to solve problems and formulate policies that provide guidelines to facilitate decision making. If the radiographer encounters an ethical dilemma in his workplace that cannot be readily resolved by following his professional code of ethics, he is obliged to present the problem to such a body.

Legal Issues in Radiologic Technology

The New World Webster's dictionary defines *law* as all rules of conduct established and enforced by the authority, legislation, or custom of a given community or group. The group in the case of the radiographer includes the ARRT and the ASRT. The rules of conduct refer to the *Scope of Practice of the Radiologic Technologist* (see Display 1–2), which provides guidelines for safe performance and standards of care.

PATIENT RIGHTS

All patients who present themselves for care in a health care facility are protected by the *Patient's Bill of Rights* (Display 1–5). This bill delineates the rights that the patient has as a consumer of health care. Because all health care workers are required to adhere to the provisions of this bill, they must be familiar with it. The radiographer must also be aware of the areas of practice in which they may possibly infringe upon the patient's rights and be held legally liable. Some examples of these are as follows:

- Acting in the role of a radiologist and providing patients with results, impressions, or diagnoses of radiographic examinations
- Failing to obtain appropriate consent from women of childbearing age prior to performing a radiographic procedure
- Failing to obtain a complete history from a patient prior to administering an iodinated contrast agent
- Failing to correctly identify a patient before performing an examination
- Failing to explain a radiographic procedure to a patient prior to the examination
- Failing to document technical factors used to facilitate dose calculations for a procedure
- Failing to maintain a patient's physical privacy during an examination
- Failing to maintain the highest quality of radiographs with lowest possible radiation dose for the patient

PATIENT RESPONSIBILITIES

Just as the radiographer has to abide by the *Patient Bill of Rights* and other professional standards, the patient has responsibilities when he presents himself for health care. These responsibilities are as follows (Grieco, 1996):

1. The patient has the responsibility to provide, to the best of his knowledge, an accurate and complete health history.
2. The patient is responsible for keeping ap-

DISPLAY 1–5 The Patient's Bill of Rights

The American Hospital Association presents a Patient's Bill of Rights with the expectation that observance of these rights will contribute to more effective patient care and greater satisfaction for the patient, his physician, and the hospital organization. Further, the Association presents these rights in the expectation that they will be supported by the hospital on behalf of its patients, as an integral part of the healing process. It is recognized that a personal relationship between the physician and the patient is essential for the provision of proper medical care. The traditional physician–patient relationship takes on a new dimension when care is rendered within an organizational structure. Legal precedent has established that the institution itself also has a responsibility to the patient. It is in recognition of these factors that these rights are affirmed.

1. The patient has the right to considerate and respectful care.
2. The patient has the right to obtain from his physician complete current information concerning his diagnosis, treatment, and prognosis in terms the patient can be reasonably expected to understand. When it is not medically advisable to give such information to the patient, the information should be made available to an appropriate person in his behalf. He has the right to know by name the physician responsible for coordinating his care.
3. The patient has the right to receive from his physician information necessary to give informed consent prior to the start of any procedure and/or treatment. Except in emergencies, such information for informed consent should include but not necessarily be limited to the specific procedure and/or treatment, the medically significant risks involved, and the probable duration of incapacitation. Where medically significant alternatives for care or treatment exist, or when the patient requests information concerning medical alternatives, the patient has the right to such information. The patient also has the right to know the name of the person responsible for the procedure and/or treatment.
4. The patient has the right to refuse treatment to the extent permitted by law, and to be informed of the medical consequences of his action.
5. The patient has the right to every consideration of his privacy concerning his own medical care program. Case discussion, consultation, examination, and treatment are confidential and should be conducted discreetly. Those not directly involved in his care must have the permission of the patient to be present.
6. The patient has the right to expect that all communications and records pertaining to his care should be treated as confidential.
7. The patient has the right to expect that within its capacity a hospital must make reasonable response to the request of a patient for services. The hospital must provide evaluation, service, and/or referral as indicated by the urgency of the case. When medically permissible, a patient may be transferred to another facility only after he has received complete information and explanation concerning the needs for and alternatives to such a transfer. The institution to which the patient is to be transferred must first have accepted the patient for transfer.
8. The patient has the right to obtain information as to any relationship of his hospital to other health-care and educational institutions insofar as his care is concerned. The patient has the right to obtain information as to the existence of any professional relationships among individuals, by name, who are treating him.
9. The patient has the right to be advised if the hospital proposes to engage in or perform human experimentation affecting his care or treatment. The patient has the right to refuse to participate in such research projects.
10. The patient has the right to expect reasonable continuity of care. He has the right to know in advance what appointment times and physicians are available and where. The patient has the right to expect that the hospital will provide a mechanism whereby he is informed by his physician or a delegate of the physician of the patient's continuing health-care requirements following discharge.
11. The patient has the right to examine and receive an explanation of his bill regardless of source of payment.
12. The patient has the right to know what hospital rules and regulations apply to his conduct as a patient.

No catalogue of rights can guarantee for the patient the kind of treatment he has a right to expect. A hospital has many functions to perform, including the prevention and treatment of disease, the education of both health professionals and patients, and the conduct of clinical research. All these activities must be conducted with an overriding concern for the patient and, above all, the recognition of his dignity as a human being. Success in achieving this recognition assures success in the defense of the rights of the patient.

A Patient's Bill of Rights, American Hospital Association, Chicago, 1973. Reprinted with the permission of the American Hospital Association.

pointments and for notifying the responsible practitioner or the hospital when unable to do so for any reason.

3. The patient is responsible for his actions if he refuses treatment or does not follow the practitioner's instructions.
4. The patient is responsible for assuring that the financial obligations of his health care are fulfilled as promptly as possible.
5. The patient is responsible for following hospital rules and regulations affecting patient care and conduct.
6. The patient is responsible for being considerate of the rights and property of others.

LEGAL CONCERNS

There are many types of law that affect people in daily life; however, statutory law and common law are the most significant for the radiographer in his professional practice. Statutory laws are derived from legislative enactments. Common law usually results from judicial decisions.

Two major classifications of the law are criminal law and civil law. An offense is regarded as criminal behavior and in the realm of criminal law if it is an offense against society or a member of society. If the accused party is found guilty, he is punished.

Civil law has been broken if another person's private legal rights have been violated. The person who is found guilty of this type of offense is usually expected to pay a sum of money or repair the damage done.

A felony is a crime of a serious nature that is punished by imprisonment for more than 1 year or, in extreme cases, by death. A misdemeanor is a crime of a less serious nature punished by a fine or imprisonment for less than 1 year.

It is possible for the radiographer to be found guilty of a criminal act in his professional practice. Generally, in this situation, the radiographer is likely to be legally liable for malpractice in the commitment of a tort. A tort involves personal injury or damage resulting in civil action or litigation to obtain reparation for damages incurred. A tort may be committed intentionally or unintentionally. An unintentional tort may be committed when a radiographer is negligent in performance of patient care and the patient is injured as a result. An intentional tort is a purposeful deed, such as defaming a colleague's character or committing battery. Battery may be charged by a patient to whom the radiographer has administered treatment against the patient's will. The following are other examples of unintentional torts:

- Improperly marking radiographic images, such as incorrectly labeling intravenous pyelogram films for left and left, which could result in the surgeon removing the healthy kidney, leaving only the diseased kidney
- Omitting to apply gonadal shielding on a female patient with a femur fracture who is subsequently discovered to be pregnant
- Improperly positioning a trauma patient for tibia and fibula projections so that the projections do not adequately demonstrate the entire lower leg, resulting in a fracture being "missed" by the orthopedic physician and the radiologists
- Handing the radiologist the incorrect syringe during myelography, which results in the injection of xylocaine instead of the contrast media
- Leaving an unconscious patient on a gurney while the radiographer develops the radiographs, thus allowing the patient to jar the side rails and fall off the gurney since the safety belt was not secure
- Improperly positioning a footboard on an x-ray table, which results in the patient sliding off the table when the table is placed in the upright position during an examination.
- Not providing parents of pediatric patients the proper protective attire when the parents are aiding in immobilizing their child, especially during fluoroscopic procedures

Ethical and legal issues are frequently combined in the practice of one's profession. The radiographer must be aware of this and take precautions to prevent situations that may lead to problems of this nature. Discrimination and bias shown toward a particular person is an example of this.

The radiographer must understand that it is unlawful to discriminate against any patient or coworker on the basis of race, color, creed, national origin, ancestry, sex, marital status, disability, religious affiliation, political affiliation, age, or sexual orientation. The radiographer must practice in a totally nonjudgmental manner and make no decisions or take any action based upon these issues.

USE OF IMMOBILIZATION TECHNIQUES

Patients may not be immobilized for radiographic imaging procedures simply as a matter of conve-

nience for the radiographer. An order for patient immobilization for a defined period of time to protect the patient's safety must be obtained from the physician in charge of the patient. The method of immobilization chosen must be that which is the least restrictive to the patient's movement and freedom. There must be a *need* to immobilize the patient to achieve the most satisfactory outcome. (The term "restraint" is often substituted for immobilization techniques; the two are used interchangeably in this text.)

Immobilizers must be appropriate to the individual needs of the patient. When they must be used, the reasons for use, the type used, and the length of time it was applied must be documented. Immobilizers must be released for specified periods of time when they are in use. The time and conditions of immobilizer release must also be documented.

The use of medication as a restraining technique occurs only in extreme circumstances and only as prescribed by the patient's physician. Using immobilization techniques improperly or without a physician's orders can be considered false imprisonment and therefore cause for legal action. An institutional policy for use of immobilization must be present in all departments, and user instructions must be clearly visible on all immobilizing devices. The technical aspects of application of immobilizers for adults and children are discussed later in this text.

The radiographer must never assume the role of other medical personnel in the department. It is not within the scope of his practice to read radiographs or other diagnostic tests, or to impart the results of these to the patient or the patient's family. This constitutes medical diagnosis and is the physician's responsibility. If a patient is injured in the radiographic imaging department in any manner, the radiographer must not dismiss the patient from the department until the patient has been examined by a physician and has been deemed safe to be discharged.

UNUSUAL OCCURRENCE REPORTS

Any injury received by a patient or any error made by personnel in the diagnostic imaging department must be documented in an *incident report* as soon as it is safe to do so. The document may be called an *unusual occurrence report* or an *accident report*. An injury may seem slight and not worthy of such a report, but all injuries, regardless of severity, must be reported. An error in medication administration or any other error in treatment must also be documented in an incident report.

When filing an incident report, the radiographer must write in simple terms what occurred, at what time, on what date, in which room or department, to whom, who was present, and what was done to alleviate the situation at the time. The condition of the patient or person injured is also reported. The report is signed by all who participated in the event. All incidents resulting in patient or personnel injury must also be reported by the supervisor of the department to the institution's insurance company. If this is not done, the insurance company may drop the policy.

GOOD SAMARITAN LAWS

All states in the United States now have Good Samaritan laws. These laws were enacted to protect persons who give medical aid to persons in emergency situations from civil or criminal liability for their actions or omissions under these circumstances. State laws vary, but generally, any radiographer who stops to render aid at the scene of an accident is not held liable for any adverse results of his actions.

INFORMED CONSENT

Many procedures performed in radiographic imaging departments require special consent forms to be signed by the patient or, in the case of minor children or other special cases, by their parents or legal representative. The radiographer must be familiar with the procedures that require special consent and not confuse these with the blanket consent forms that are often signed when the patient enters the hospital because these are not valid if an informed consent is required.

Although these special consent forms are usually signed before the patient comes to the radiographic imaging department, it is the radiographer's duty to recheck the patient's chart to be certain that this has been accomplished. He should also ascertain that the patient understands what is going to be done and the essential nature of the choices available to him. If the patient, parent, or legal representative denies knowledge of the procedure, the radiographer must notify the patient's physician of this, and the procedure should be postponed until the matter is satisfactorily resolved. If the case is an emergency and it is not possible to obtain consent from the patient, his parents, or a legal representative, the health care professionals performing the procedure are able to proceed under what it called *implied constructive consent.*

MALPRACTICE INSURANCE

All radiographers should carry their own malpractice insurance, even if their employer carries insurance for them. A radiographer could possibly be named in a lawsuit in which the legal expenses for his defense are not completely covered by his employer. It is not wise to place oneself in this type of professional jeopardy when a professional malpractice policy may be purchased for a reasonable price.

Medical Records and Documentation

A medical record is kept for each patient who seeks medical treatment whether he is an outpatient or has been admitted to the hospital for care. This record, called a *chart,* is begun the moment the patient arrives or is admitted for care and is kept until he is dismissed or discharged from the hospital. The medical record is kept for a number of reasons. They are as follows:

1. To transmit information about the patient from one health care worker to another
2. To protect the patient from medical errors and duplication of treatments
3. To provide information for medical research
4. To protect the health care worker in cases of litigation
5. To provide information concerning quality of patient care for institutional evaluation teams such as the Joint Commission on Accreditation of Healthcare Organizrtions.

The chart contains the patient's identifying data; documentation of all physicians' orders; physicians' consultation notes; patient progress notes; medications and treatments received; around-the-clock nurses' notes; all patient visits for outpatient or ambulatory care; laboratory and radiology reports; medical history and physical examination; admitting and discharge diagnosis; results of examinations; surgical reports; consent forms; education received by the patient; discharge planning; health care team planning; nursing care plans; and discharge summaries. All members of the health care team are expected to document the care they have rendered for the patient on his chart.

There is documentation that is specific to radiographic imaging. The radiographer is accountable for the documentation of any radiograph that he takes including the number of films, the exposure factors, and the amount of fluoroscopic time used during a procedure. He must also document any patient preparation for procedures that he makes, medications that he administers, and adverse reactions to medications or treatments received.

The radiographer must also assume responsibility for obtaining a medical history from the patient that is pertinent to the treatment or examination he is to receive in the department. This information will include vital signs; female patient's response to questions concerning pregnancy and date of last menstrual period if pertinent; history of allergies; trauma if pertinent; contrast media or radionuclide administered; patient education before and after each procedure; names and credentials of the members of the health care team participating in the procedure; and the diagnostic report of the physicians involved following the procedure. Many of these issues are discussed in detail in the following chapters.

Nurses and physicians who participate in radiographic imaging examinations or treatments are also responsible for documentation; however, the radiographer must review the documentation and bring any omissions to their attention. Any item that has not been documented on the chart is considered to be "not performed" in a court of law. All entries on a medical record must list the time and date of the procedure and be signed by the person who administered it. The credentials of the person must also be listed.

Abbreviations must be approved by the institution in which the radiographer is employed. A list of acceptable abbreviations must be on record at that institution and learned by those using them. No others are acceptable.

Charting formats are also made and approved by each institution; however, the contents of the record are reviewed and either approved, disapproved, or changed according to recommendations made by the accreditation bodies inspecting the charts.

If an error is made by the radiographer while writing an entry into a chart, he may draw a single line through the error, write *"mistaken entry"* above the error, and sign his name to the error. He may then write the corrected entry. If documenting by computer, the items listed above must still be included on the chart.

Radiographic films are considered to be part of the patient's medical record and may be used as legal evidence in the event of a lawsuit. For this reason, all radiographic films must be clearly marked. The patient's name, identification number, the name of the facility where taken, and a marker correctly placed must be present. A consent written

and signed by the patient or his legal guardian must be presented before any patient records are released for any reason. Original radiographs should not be released from the department where they are taken; however, there are exceptions to this. Copies are usually made when films are requested.

COMPUTER TECHNOLOGY IN RADIOGRAPHIC IMAGING

The radiographer of the 1990s has evolved into a multicompetent and multiskilled health care worker. He must fit into the new health care environment created by computers and current technology. Computer technology provides methods of quickly storing and retrieving patient information through the use of networks or systems within the radiologic imaging departments, hospitals, health insurance groups, and other nationwide organizations. This is rapidly becoming a major component of diagnostic imaging in health care delivery systems.

One of the most common computer applications in radiologic imaging departments is Picture Archiving and Communication Systems (PACS), or teleradiology systems. The PACS network allows physicians in intensive care units, pediatrics, orthopedics, or any department of medicine to immediately access images. This immediate computer access eliminates problems with lost images that can occur when images are filed or transported as radiographic films to various locations.

Other benefits of this computerized system include improved service to referring physicians and an opportunity for clinicians to work off-site. Such computer systems also allow the patient more flexibility in choosing a health care facility, since their patient records can be accessed immediately by computer.

As the use of this new technology expands, however, ethical and legal issues are being raised. Violation of confidentiality, fraud, and illegal access to personal information are of grave concern. Some other concerns include violation of organizational or institutional confidentiality; pirating of copyrighted software; unauthorized use of another person's computer password, code, or account; and use of vulgar language or harassment via the computer network. All of these are considered illegal and unethical abuse of the system and may result in legal action.

The radiographer must abide by the same rules concerning confidentiality of patient information with computerized records as with previous systems. Written consent by the patient is the only legitimate reason to obtain and pass on confidential material. The student radiographer must familiarize himself with the potential abuses of the new technology so that he will not unknowingly violate the law.

Summary

Radiologic technology has evolved to meet the criteria of a profession by requiring extended training and education; it has a theoretical body of knowledge and leads to defined skills, abilities, and action. It provides a specific service and its members have a degree of decision-making autonomy when working within their scope of practice.

There are several educational choices the student may make when beginning his radiologic technology career. In coming years, the radiographer may be listed as a technical or a professional radiologic technologist. Each category will have defined educational requirements and responsibilities, and all will be expected to fulfill continuing education requirements in order to renew their licenses every 2 years.

The professional radiographer is expected to join and participate in professional organizations. His participation will allow him to keep informed of technological changes and alterations in professional standards. He will also promote the strength of his profession and prevent infringement from groups that desire to assume parts of the professional responsibilities of the radiographer.

In their work, radiographers interface with members of the health care team on a daily basis. It is advantageous for the student to recognize the educational background and the duties of these team members so that he may develop a harmonious working relationship with them built upon professional knowledge and respect. The health care professionals with whom the radiographer works most frequently are the physician, the nurse, the pharmacist, occupational and physical therapists, and the respiratory therapist.

Following completion of the radiologic technology program, there are many choices for the new graduate to make concerning his career. He may select a specialty area in radiography or remain in the role of staff technologist. Some of the areas he may choose from are CT, MRI, mammography, ultrasound, nuclear medicine, and radiation therapy.

The person who selects radiologic technology as a profession must be aware of and willing to accept the ethical and legal constraints that govern his practice as a member of that profession. The radi-

ographer must learn the *Code of Ethics* and the *Principles of Professional Conduct for Radiologic Technologists* and adhere to those principles. He must also understand the rights of the patient and treat each patient as a human being with dignity and worth.

The radiographer must work within the scope of his practice at all times. He must understand that to do otherwise is a violation of the law. There are standards of practice in radiographic imaging, as there are in all areas of health care. The radiographer must understand and follow these standards as he works. He must follow the policies of the institution or health care facility in which he works concerning unusual occurrence and accident reports. Any patient injured during a procedure must not be discharged from the radiographic imaging department without the consent of the physician.

If the patient must be immobilized to obtain a successful examination, the radiographer must obtain a physician's order to do so. The policies of the institution must be followed and documentation of the use of immobilizers must be made. Medication must not be used as an immobilizer unless ordered by a physician. Infants and children must be medicated by a nurse or physician educated in pediatric care.

Documentation and maintenance of medical records is an important aspect of health care. It transmits information to other health care workers, protects the patient from errors, provides information for medical research, protects the radiographer and others in cases of litigation, and provides information concerning the quality of patient care for institutional evaluation.

The radiographer is accountable for documenting the care that he provides for the patient. He must record the number of films taken, the exposure factors, and use of fluoroscopy, contrast media, and other medications or treatments. It is the radiographer's responsibility to learn the documentation procedures required for the agency in which he is employed.

Computer technology is being utilized in radiographic imaging with increasing frequency. The radiographer must abide by the same rules of confidentiality of patient information that have applied to previous methods and he must familiarize himself with other methods of potential abuse when using this new technology.

The radiographer is believed to be a competent professional. As such, he is expected to act in a responsible and safe manner when caring for patients. It is his obligation to communicate effectively with other members of the health care team and document patient care correctly and completely. He is expected to perform in a safe and responsible manner in all areas of patient care including radiation safety; safety in moving patients; infection control; medication administration; knowledge and competency during procedures; and maintenance of patient privacy and confidentiality. He must also respect the patient's right to refuse treatment.

Chapter 1, Pre–Post Test

1. List the criteria for a profession and explain how radiologic technology meets these criteria.

2. The two major professional organizations of radiologic technology are _____ and _____.

3. The documents that represent the application of moral principles and moral values for radiologic technology are _____ and _____.

_____ 4. Match the following:

a. The right to make decisions concerning one's own life.	1. Nonmaleficence
b. The intent is good although a bad result may be foreseen.	2. Autonomy
c. Equal treatment and equal benefits.	3. Truthfulness
d. Honesty to patients.	4. Justice
e. Duty to refrain from inflicting harm.	5. Double effect

_____ 5. The radiographer who mistakenly administers an incorrect drug to a patient may be guilty of a
   a. Tort

b. Negligence
c. Crime
d. Battery

____ **6.** The radiographer refuses to work with a patient because he does not care for persons of the patient's religion. The radiographer is guilty of violating
a. The law
b. The ethics of his profession
c. His moral values
d. Both *a* and *b*

7. Explain the documentation for which the radiographer will be accountable in his department when he participates in a procedure.

____ **8.** Professional ethics may be defined as
a. A set of principles that govern a course of action.
b. Standards of any professional person
c. The same as not violating the law
d. A set of rules and regulations made up by the department in which you work

____ **9.** Which of the following is an example of privileged (confidential) information?
a. Your friend buys a new car and asks you not to tell anyone about it yet
b. A colleague discusses his stock market holdings with you
c. You assist with a diagnostic study and a large adherent mass is discovered in the colon
d. A fellow student is told that he has the highest grades in the class

____ **10.** Following completion of a radiologic technology program, you are employed at the local community hospital in the diagnostic imaging department. You are approached by a colleague who asks you to become a member of the local chapter of your professional organization. You know that you will be expected to pay yearly dues. Which would be your best response to your colleague?
a. You explain that you have just begun your first job and money is in short supply at this time.
b. You laugh and say, "No thanks, I've had all of the organization I can take for a while."
c. You join in 1 or 2 years when your financial status improves.
d. You join at once because you feel that it is an obligation to be a member of your professional organization.

____ **11.** You are the radiographer assigned to the special procedures area to assist with an arteriogram this morning. In the room where the examination is to take place, the patient asks you what this examination is for and what the doctor has planned. You check his chart and find that the consent for the procedure has been signed. The next thing you must do is
a. Explain the procedure to the patient
b. Remind the patient that he has signed the consent form; therefore, he must understand what is going to happen
c. Explain the problem to the physician and ask him to review the procedure with the patient
d. Tell the patient not to worry because he is in capable hands

____ **12.** Information about a patient's condition or prognosis
a. May be freely discussed with close relatives
b. Must always remain confidential
c. Should always be open to discussion since "a well-known fact is no secret"
d. Should be discussed only on a coworker–interdepartmental basis

____ **13.** If a radiographer is unable to solve a professional ethical dilemma, he must present the problem to

a. His attorney
b. The ethics committee of the institution for which he works
c. His colleagues
d. His peers

____ **14.** A radiographer is assigned to a diagnostic imaging procedure for which he has had no education. His best course of action when this occurs would be
a. To proceed as best he can
b. To ask a colleague for directions and then proceed
c. To explain to his superior that he has never worked with this procedure and does not feel competent to perform the procedure without education
d. To state that he is ill and retreat

____ **15.** If a radiographer offers his services at the scene of an accident, he is protected from litigation by the Good Samaritan law.
a. True
b. False

____ **16.** If a patient requests to take his radiographic films to another institution for consultation, the radiographer must remember
a. That the patient must present a signed request before the records can be released
b. That only the original radiographic films can be released
c. That only copies of original radiographic films can be released

○ *Laboratory Reinforcement*

In the school laboratory, take a simulated radiograph assigned by your instructor. When it is complete, correctly document the procedure and label the radiograph.

Critical Thinking Problems

1. Mr. John Teley has just been informed by his physician that he has a terminal illness. The physician then informs Mr. Teley that he has ordered a long course of radiation therapy to prolong his life. Mr. Teley is very concerned about this. You are the radiographer requested to assist with the first radiation treatment and he asks you if you think that he should go ahead with these treatments although he does not want them and he does not trust his doctor. How will you respond?

2. You are a radiographer working the evening shift in a busy radiology department. The radiographer with whom you have been working is frequently unavailable to assist with the work. You observe her frequently going to the restroom where she remains for long periods of time. When she returns, she seems to be in a rather dazed and unaware state of mind although she is very pleasant. You begin to believe that she is taking illegal drugs while on duty. What will you do about this?

2

The Patient in Radiographic Imaging

Basic Human Needs
Critical Thinking
Modes of Thinking
- Recall
- Habit
- Inquiry
- Creativity
- Knowing How You Think

Patient Assessment (Problem Solving)
Data Collection
Data Analysis
Planning and Implementation
Evaluation
Patient Expectations
Communication
Self-Concept and Self-Esteem
Nonverbal Communication
Cultural Variations
Other Factors That Affect Communication
Feedback
Developing a Harmonious Working Relationship
- Establishing Communication Guidelines
- Reducing Distance
- Listening
- Using Therapeutic Silence
- Responding to the Underlying Message
- Restating the Main Idea
- Reflecting the Main Idea
- Seeking and Providing Clarification
- Making Observations
- Exploring
- Validating

Blocks to Therapeutic Communication
The Patient Interview
Patient Education
Loss and Grief
Phase I: Denial
Phase II: Anger
Phase III: Bargaining
Phase IV: Depression
Phase V: Acceptance
Patient Rights Related to Death, Dying, and Medical Treatment
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Explain the basic physical and emotional needs of the patient.
2. Define critical thinking and explain the need for the radiographer to develop this skill.
3. Explain the method used to make an accurate assessment of the patient's needs in the imaging department and explain the rationale for using this method.
4. List expectations the patient may have of the radiographer assigned to his care.
5. Define therapeutic communication and demonstrate its techniques.
6. Explain the interview process and list the requirements for its successful completion.
7. Explain the use of the problem-solving process in patient teaching.
8. Describe the special needs of the terminally ill or the grieving patient in terms of radiographic imaging.
9. Define advance directives and differentiate between various types of advance directive documents.

Glossary

Adhere: to stay fixed or firm
Advance directives: documents (written when client is in good health) giving permission to a responsible person for voicing the desire for medical care by client during times of incapacity
Anaphylactic reaction: a serious or profound state of shock brought about by hypersensitivity to an allergen that may be a drug, food, or other substance
Anxiety: uneasiness of mind, often caused by anticipated illness or injury
Assess: to evaluate; to determine the significance of data
Basic needs: the necessities of life; means of survival
Bias: an inclination or temperament based on personal judgment; prejudice
Common law: decisions and opinions of courts that are based on local customs and habits of an area within a particular country or state
Continuum: continuous whole whose parts cannot be separated
Defending: attempt by health worker to protect self, another person, or institution; a block to communication
Despair: a hopeless state; lack of hope or expectation
Diagnostic imaging: modern term for radiography, encompassing all specialties devoted to producing a picture of a body part
Effective communication: an interaction that produces a satisfying result through an exchange of information
Euthanasia: deliberately bringing about the death of a person suffering from an incurable disease or condition
Grieving process: an emotional state one must go through when a loss is experienced to maintain sound emotional health
Liability: something one is obligated to do or an obligation required to be fulfilled by law; usually an obligation of a financial nature
Litigation: lawsuit
Malpractice: professional negligence that is the cause of injury or harm to a patient
Methodologies: manner of performance of any act or operation
Paralanguage: the sound of speech, rather than its content
Problem solving: the collection and analysis of information, a plan for implementing this information to resolve a difficulty, and the evaluation of the plan
Profession: a calling that requires specialized knowledge and intensive academic preparation
Pyelogram: a radiographic film of the kidneys and ureters
Regressive behavior: gradual movement back to earlier patterns of thinking and acting; returning to childlike behavior
Scientific principle: systematic and exact principles that allow one to understand, explain, quantify, and predict phenomena
Self-actualization: complete development of one's abilities or ambitions
Self-esteem: respect for oneself
Self-understanding: a sense of knowing what one is experiencing
Statutory law: established law that is enacted by a legislative body; failure to obey this law is punishable by court action
Terminal illness: a disease with no known cure that results in death
Therapeutic: healing
Unethical: not conforming to the standards of conduct of a particular profession or group

As a student radiographer, you are obliged to learn to assess the needs of patients assigned to you for examinations or treatments. After you have made this assessment, you must be able to formulate a plan of care that best fits the individual's needs. The plan is then implemented and, finally, evaluated. To follow these steps in assessment, the radiographer must have an understanding of the basic human needs and expectations that a person brings to the radiographic imaging department when presenting for diagnosis or care.

The ability to accurately assess each patient's unique needs and to plan and implement care effectively requires that the radiographer develop skills in critical thinking and problem solving. These skills, when carefully applied, will allow the radiographer to achieve the desired patient care goals.

The ability to communicate effectively and in a therapeutic manner is essential for all health care professionals. This means that the radiographer must leave the patient feeling that his condition has been improved, not worsened, as a result of the interaction.

Patient education is a part of the radiographer's professional obligation. He must be able to assess the patient's educational needs based upon current knowledge and cultural and emotional requirements. When this is done, the radiographer can proceed to design an educational plan that adequately informs the patient concerning the procedure to be performed and the preparation for that procedure.

The radiographer often works with patients who have serious, and sometimes terminal, illnesses. The ability to relate to the grieving patient with understanding and sensitivity is a skill no radiographer should be without. The development of this sensitivity is built on an understanding of the phases of the grieving process and an appreciation of one's own feelings about loss and death.

Basic Human Needs

Health is often seen as existing on a continuum. At the positive end of the continuum, all body organs are functioning at their best and one's mental state is positive. The individual in this state has a feeling of well-being or health. At the negative end of the

continuum, the individual is close to death or is in a state of despair. In the middle, are persons at every stage of mental and physical well-being between these two extremes.

Whatever end of the health–illness continuum an individual is on, he has basic needs that govern his life. When basic needs are met, other, higher needs can emerge. Abraham Maslow, a renowned psychologist, saw humans as governed by a hierarchy of needs, each of which he viewed as a "building block" in a pyramidal structure. At the base of the pyramid are the basic physiologic needs; at the top is self-actualization, the end result of all spiritual growth. These and the other needs are defined as follows:

1. *Physiologic needs.* The basic needs are for food, shelter, air, water, sleep, and sexual fulfillment. If these basic needs are not satisfied, a person is unable to pursue other needs.
2. *Safety and security.* After the individual has satisfied his most basic needs, he begins to seek a place where he can be free from harm and can be sure of being able to earn a living.
3. *Love and belongingness.* When primary needs have been met, the person begins to seek someone with whom to share life and a social group in which he feels accepted.
4. *Self-esteem and the esteem of others.* Everyone thrives on self-regard and the feeling of being favorably regarded by others, beyond his immediate family or circle of significant others.
5. *Self-actualization.* When all of the foregoing needs have been met, the individual begins to grow spiritually. He begins to desire to accomplish deeds that will make him feel that he has attained the ultimate growth in his life.

Persons whose state of mental and physical health is at the most positive end of the health–illness continuum have their basic needs met and are pursuing self-actualization. When illness, whether it be physical or emotional, overtakes an individual, he loses his state of well-being; he no longer perceives himself as one whose basic needs for food, water, air, love, belonging, and self-esteem are being met. Illness may mean the loss of ability to maintain social and economic status. The individual's place in his social group is threatened. As illness progresses, the awareness of unmet basic needs increases, and feelings of great anxiety overwhelm the ill person.

This is often the patient's state when the radiographer meets him. Persons who are in need of diagnostic imaging procedures may present themselves for diagnosis and treatment after a long period of feeling unwell. Others may come to the department immediately after a serious accident has destroyed or threatens to destroy their state of well-being. When one's level of wellness has been compromised and the satisfaction of basic needs is threatened, whatever the cause, regressive behavior may result. A person in such a state has difficulty communicating effectively. He may resort to aggressive demands or may withdraw in silence and not be able to make his needs known at all.

Any radiographer assigned to care for a person must be able to determine that person's state of health or illness. Furthermore, he must understand that the fulfillment of the patient's most basic needs may have been interrupted by illness or trauma, thus causing him to behave in an unpleasant manner.

Critical Thinking

Each patient-care situation the radiographer encounters demands a different application of radiologic skills. Although each procedure must adhere to required standards of practice, each patient presents for care with a unique set of problems that require thoughtful solution. The hallmark of an excellent radiographer consists in the ability to achieve a positive result in a timely, efficient manner, while responding to the unique needs of individual patients.

The initial requirement for excellence in any profession is the ability to think critically in professional situations and to solve problems effectively. A general definition of critical thinking might be an analytical inquiry into any issue presented. A more specific definition is the one used by Richard Paul, a leader in the critical thinking movement, in which critical thinking is described as, "the art of thinking about your thinking while you are thinking in order to make your thinking better: more clear, more accurate, or more defensible" (Paul, 1995, p 643).

Before a person can learn to think critically, he must become aware of the limits of his knowledge. We must each face our learned biases and prejudices and review the life experiences that have created our current thinking methodologies. Self-understanding is the beginning of the development of critical thinking. We must be able to accept the reasons why we think as we do before we can begin to accept the ideas and points of view of others.

MODES OF THINKING

Thinking is comprised of several levels: recall, habit, inquiry, and creativity. Recall and habit make up the lower levels, or modes, of thinking. Inquiry and creativity are higher-order thinking skills. Mastering the ability to analyze how one thinks is another crucial skill of critical thinking. A brief description of the modes of thinking follows:

Recall

The radiographer must learn a large body of scientific facts that he can recall at a moment's notice as he works with patients. Without the ability to bring these facts to mind quickly, he will not succeed.

For instance, you are called upon in the laboratory to make a radiographic exposure of a patient's anterior chest. If you have not learned the basic methodology of this procedure, or have learned it but cannot recall it immediately, you cannot proceed.

Habit

As a radiographer becomes more experienced, he will develop habits that make for the efficient practice of learned skills. There will be no need to think deeply about each procedure prior to performing it, because the radiographer will have become habituated to performing a number of procedures. One who engages in habitual thinking is neither casual nor careless, but rather quick and efficient in performing habitual procedures.

Inquiry

A professional person uses the skills of recall and habit in his work along with a higher mode of thinking called inquiry. To inquire is to process information thoughtfully and to be willing and able to recognize, explore, and challenge assumptions in order to make sense of complex ideas. Inquiry is the essence of critical thinking and includes an ability to analyze, synthesize, validate, and, later, evaluate the work that has followed critical thought.

Creativity

Another aspect of higher-level thinking is creativity. Creativity often follows inquiry and is used in order to solve individual problems and to avoid causing the patient discomfort or pain. A radiographer who is able to conceive of an alternative method of performing a task or accomplishing a procedure, particularly one that is more efficient or less traumatic for a patient, is said to have creatively improved his work.

Knowing How You Think

One's ability to understand how he thinks may be the most difficult aspect of critical thinking. Once again, introspection is required. One must think while thinking. Honesty with oneself is also necessary. Ask yourself the following questions:

1. *Am I remaining in the lower-level thinking modes most of the time, using only recall and habit to solve problems?*
2. *Do I rarely (or never) move beyond these lower levels of thinking into the realm of inquiry by exploring, validating, and analyzing the problems before me?*
3. *Am I combining (synthesizing) thoughts, ideas, and concepts to find better solutions to problems?*
4. *Am I creating new approaches to solve difficult patient care problems?*
5. *Am I carefully evaluating my work?*

Becoming a critical thinker takes practice and time. The successful radiographer will take the concepts presented above and apply them to each patient care problem. If higher-level thinking becomes a habit, thinking through each situation in a critical manner to create a successful solution will become second nature. The ability to recall what was learned in the classroom and to perform radiologic imaging skills from habit are necessary but not sufficient skills for a professional radiographer. These lower-level thinking processes must be combined with the higher modes of thinking to care safely for the patient.

Patient Assessment (Problem Solving)

Each time a radiographer is assigned to perform a radiologic imaging procedure, he must decide how to perform the assignment quickly, efficiently, and as comfortably as possible for the patient. This requires going through a problem-solving process before the task is begun. It is recommended that beginning students write down the problem-solving process. As one attains proficiency, it becomes a mental process. However the process is conducted, critical thinking is necessary to achieve a satisfactory outcome. The ability to recall the sci-

entific principles of the procedure and the habits cultivated in performing various skills will also be needed. Problem solving requires data collection, data analysis, planning, implementation, and evaluation. Each of these are described in the following paragraphs.

DATA COLLECTION

There are basically two types of data, subjective and objective. Subjective data include anything that the patient or a significant other who accompanies him might say that is pertinent to his care. For instance, the patient might say, "The last time I had an x-ray, they gave me some medicine in my vein that made me itch all over," or "When I move it hurts my back."

Either of these statements would be significant subjective data and as such, would need to become part of the radiographer's database. Anything that the patient or a person accompanying the patient to the radiographic imaging department says that can in some way affect the procedure to be done must be considered important subjective data.

Objective data include anything that the radiographer sees, hears, smells, feels, or reads on the patient's chart; anything reported about the patient by another health care worker that may affect the patient or the procedure to be performed is also considered objective data.

DATA ANALYSIS

This is the part of the assessment process that integrates all segments of critical thinking. The radiographer must list all of the subjective and objective data and then begin to analyze it. He must then decide what data is relevant to the assignment. This requires the skill of inquiry. The radiographer must also recall how the procedure to be done is performed. The relevant data (the problems and potential problems) are then listed in order of their priority, beginning with what is most significant to the procedure.

Example

You are assigned to make radiographs of the pelvis of the 84-year-old female who may have a hip fracture. You go to the waiting area to summon the patient and find her on a gurney. You greet her and inquire about her well-being.

The patient says, "I'm very hard of hearing, you'll have to speak louder." You raise your voice and ask the patient again how she is feeling. She responds, "I was very well until last evening when I fell as I was getting into bed. Now I have a lot of pain in my right leg." The patient is then moved to the examining room. During the preceding brief interaction, you have managed to gather the following data:

1. The patient is an elderly female (objective data)
2. The patient is hearing impaired (subjective data)
3. The patient has pain in her right leg (subjective data)

In the examining room, you continue your assessment of the patient. From the data that you gather, you formulate a list of problems and potential problems that you will (or may) encounter as you work with this patient. Remember, considering potential problems up front allows you to anticipate and thus avoid possible difficulties. The problem list might be continued as follows, with problems given in order of priority:

1. Pain and a potential for increasing the patient's pain during your examination (moving the patient may cause further pain)
2. Immobility (the patient is unable to move by herself and will require assistance for safety and to obtain adequate exposures)
3. Potential for impairment of skin integrity (elderly persons have fragile skin that is easily damaged)
4. Potential for further injury (if patient is not moved carefully, the injury may be extended)
5. Hearing impairment (it will be necessary to speak distinctly so the patient will hear directions)

After you have completed your data collection, a goal must be set and a plan for achieving the goal formulated. To do this, you must rely on recall of theoretical principles concerning movement restrictions of a patient with a pelvic injury. You must use inquiry and creativity to plan how you are going to be able to obtain the most effective radiographic images of the patient's pelvis without causing her further pain or an extension of her injury.

Patient involvement in goal setting and formulating a plan to achieve the goal is essential. A patient who is not part of the care planning is not able to cooperate to achieve the desired goal. Collaborating with the patient in planning her care will instill in her a feeling of responsibility for a successful outcome.

Once the assessment is complete and the problems and potential problems have been listed, a goal is established. Next, objectives or outcome criteria for attaining the goal are formulated. The patient outcomes, or objectives, are dependent upon the radiographic exposures needed and the problems identified in the initial patient assessment.

Example

Goal: The radiographs will clearly demonstrate the patient's medical problem.

Example

Outcomes:

1. The patient will be free of pain during the procedure.
2. The patient's skin integrity will not be impaired.
3. The patient's condition will remain stable during the procedure.

PLANNING AND IMPLEMENTATION

Following data analysis, the radiographer establishes a goal with expected outcomes or objectives for achieving the goal. A plan for achieving the goal is written and then implemented. Planning requires the use of all modes of thinking. One must recall the theoretical concepts learned from classroom and textbook instruction. Any practical experience gained in radiography will have given the student the time and opportunity to develop reliable habits for selecting correct exposure factors for each patient assignment. Inquiry is used to analyze the data to assess potential areas where errors can affect a safe and successful outcome. Creativity is necessary to devise a method of performing the procedure given the problems listed.

Example

1. Instruct the patient concerning what is to be accomplished.
2. Obtain assistance from as many persons as necessary to move the patient onto the radiographic table to avoid injury to her skin and to prevent pain.
3. Provide adequate radiation protection for the patient and the radiographer.
4. Set the correct exposure factors for the radiographs needed.
5. Make exposures required.
6. Process the radiographs.
7. Return the patient safely to her room.

This plan is then implemented. Implementation of the plan will depend upon the patient's problems and the need for the radiographer to obtain assistance to achieve the desired goal. The radiographer will also rely on his creativity to solve problems that he has not anticipated during this phase. The patient's safety during the implementation of the plan must always be the chief priority.

EVALUATION

After the plan has been implemented, it must be evaluated. As a beginning student, you will be expected to perform this phase of care in writing or with an instructor's assistance. The radiographer should never cease learning from his patients regardless of how many years of experience he may have. Each patient care situation will differ in some ways from all others encountered; therefore, all patient care experiences are learning experiences.

Radiographs are the tangible evidence of the radiographer's successful attainment of diagnostic goals. However, the condition of the patient following the examination must also be considered. In evaluating the patient care you are giving, you should ask yourself the following questions:

1. Were the patient's needs met?
2. Was the patient's safety maintained during the procedure?
3. Was the patient's skin intact at the end of the examination?
4. Did the patient complain of pain as the procedure was implemented?
5. What problems arose that I did not anticipate?
6. What can I do differently next time to improve my work or to reduce the patient's discomfort?
7. Did I use higher-level critical thinking skills to successfully complete this procedure?

Careful analysis of each patient care situation must be made at the end of each assignment. Radiographic quality is certainly the goal; however, if the patient's safety was jeopardized or the patient was subjected to a great amount of pain as you implemented your plan, the outcome of the proce-

dure was less than perfect. Honest inquiry is the key to evaluation.

The radiologic technology student will not achieve the optimum level of success with each procedure, but the ability to recognize errors and modify subsequent procedures accordingly will allow him to achieve his goals most of the time.

Patient Expectations

In Chapter 1, the radiologic technology student was introduced to the rights of the patient seeking medical care. The patient also has expectations of health care professionals. The patient expects that he will find an articulate, concerned, clean, and well-groomed professional to care for him. While he is in the diagnostic imaging department, the patient also expects to be the focus of the radiographer's concern, to the exclusion of any personal concerns that the radiographer may have at that moment.

Given the prevailing cultural diversity, radiologic technology students should expect to find persons from all parts of the world presenting themselves for health care. And with these ethnically diverse patients come a host of expectations concerning health and illness and medical treatment that are affected by different cultural and religious traditions. The radiographer must convey understanding and sensitivity for each patient's differences. Otherwise, patients may be left with the feeling that their health care experience was less than therapeutic.

The patient's ethnicity and cultural beliefs must be taken into consideration as the initial assessment and patient care plan are made. Every person for whom the radiographer cares must be treated as a person who has dignity and worth and every care plan must be designed with the patient's sociocultural needs in mind. Care rendered by the radiographer should be free of any effects of the radiographer's own feelings of prejudice against particular groups who do not share his beliefs or living habits.

Communication

All members of the health care team must learn to communicate clearly and therapeutically with their patients. They must be able to convey messages in an organized and logical manner. Any problem of communication, whether major or minor, has an impact on the patient's health care. If a patient leaves a health care situation feeling confused or misunderstood, he may choose not to continue care that is necessary to his health. If the patient leaves feeling that he has been treated with dignity and respect, he will probably continue needed treatment.

Most patients' feelings about heath care, be they positive or negative, are the result of communication between the health worker and the patient. Radiographers receive, interpret, carry out, and give directions in their daily work routine. They also offer consolation and reassurance as they care for their patients. For these reasons, being able to communicate effectively is as important to the radiographer as knowing the correct use of the complex equipment in the department.

To become a successful communicator, one must develop skills in listening, observing, speaking, and writing. The student radiographer might feel that since he can hear, see, talk, write, and use a computer he is already skilled in the art of communication. However, this is not necessarily the case. One's ability to accept others with an open mind and interact with people in a perceptive manner is based upon learned attitudes and self-understanding.

In order to communicate effectively, the radiographer must first possess a degree of self-knowledge. He must become aware of his own limitations and understand any feelings, values, and attitudes that might lead to bias or discrimination in interactions with others. Attitudes are a set of beliefs that one holds toward issues or persons that cause him to respond in a predetermined manner. These predetermined behaviors may not be acceptable to another person from a different background.

Human beings are born free of attitudes, beliefs, values, and biases. But, from the first day of life, these begin to develop as a result of exposure to a particular group of people called *significant others*. These significant others may be the mother, father, other relatives in the home, or persons who assume the role of parents. As one grows and matures, this is the group with whom one is in daily contact. Their environment, religious beliefs, morals, food preferences, and preferences for other people become the child's own. As one grows older, friends and mates are sought from this pool of like-minded individuals. This is done to maintain the balance or harmony essential to a peaceful existence.

This need for harmony eventually affects every aspect of a person's manner of perceiving and reacting to the world, but no two people see the world in exactly the same way. For this reason, a

person reacts not to a particular event, but to a personal perception of that event. That perception is the result of learned attitudes. The radiographer must understand this and expect his patients to feel differently than he does about many things. For instance, a patient who is experiencing pain may react with a stoicism learned from past experiences. This may at first puzzle the radiographer, who may be used to more open expressions of discomfort.

The student must use his newly learned skills of critical thinking to assess how he thinks about those with whom he relates. An honest analysis of oneself and one's learned beliefs and biases is required to become a skilled and thoughtful communicator.

SELF-CONCEPT AND SELF-ESTEEM

How a person feels about and would describe himself may be defined as *self-concept*. This self-concept is reflected in every aspect of an individual's behavior.

Self-esteem is a term sometimes used interchangeably with self-concept, but in reality it has a slightly different meaning. *Self-esteem* refers to those feelings concerning our personal worth. In order to be an effective human being (one who can share himself in meaningful communication with another), it is necessary to have a positive self-concept and, by extension, high self-esteem.

Understanding one's own feelings and attitudes and their natural evolution is the beginning of self-acceptance and achievement of a positive self-concept. The radiologic therapy student who enters his or her chosen profession after having completed this process of self-acceptance will have fewer obstacles to overcome when trying to relate to others in a therapeutic manner.

NONVERBAL COMMUNICATION

There is more to communication than the spoken word. The unspoken, or nonverbal, aspects of communication can be defined as all stimuli other than the spoken word involved in communication. In order to understand nonverbal communication, the radiographer must depend on what he *sees* the patient doing as he speaks, what he *hears* in speech other than the spoken words, what he *feels* (if he is touching the patient during the communication), and what he *smells* as he comes closer to the patient. These unspoken messages can often indicate how the patient feels more quickly than any words do. Nonverbal communication functions in the following ways:

It may repeat or stress the spoken message. In this case, the face or body movements are in agreement with what is said. For instance, a patient who states that he is in pain and who is protecting the painful body part and wincing or grimacing as he speaks is stressing his message.

It may contradict the spoken word. As the patient speaks of his severe pain he may smile and seem to enjoy his experience. This nonverbal behavior is obviously not in agreement with what is being spoken.

It may accent the spoken word. As the patient says "no," he slams his fist on the table to make the message clearer or to stress it.

It may regulate the spoken word. If, as a person is speaking, the receiver is nodding his head and giving the speaker an interested look, it is an indication to continue. Conversely, if the receiver is looking away and seems uncomfortable or uninterested, the speaker has a cue to stop speaking.

It may totally substitute in some instances for verbal communication, as in the case of a frown or a nod. A person may get his message across without saying a word.

The perceptive health care worker can learn a great deal about a patient by other types of nonverbal communication. The manner in which a person moves his body and his face can say a great deal. The person with a frown and a set jaw is determined or angry about something. The patient who does not look the radiographer in the eye may feel insecure or mistrustful. The way in which your patient carries his body may tell you how he feels about himself. The person who walks or sits proudly erect probably has a positive feeling about himself. The person who has a poor self-concept or who is depressed may walk slowly and with his head down and his shoulders slumped. While sitting, he will draw his body in and look away from the room.

Social and economic status may also be suggested in nonverbal cues. There may be obvious signs such as those indicated by the clothing worn or by posture. Less obvious status cues might be the patient's manner of speech or the manner in which he enters a room or addresses those in his environment.

The radiographer must understand that the patient who comes to the radiology department for a difficult examination may be fearful but will not wish to express this verbally. The sensitive radiographer will be able to detect the patient's nonverbal expression of fear and anxiety. By using therapeutic communication techniques, he will be able

to establish a trusting relationship with the patient that allows the patient to express his feelings, thereby reducing fear and anxiety.

CULTURAL VARIATIONS

The radiographer must be aware of cultural differences in verbal and nonverbal communication so that he will not offend or be offended, misunderstand or be misunderstood. For instance, in some cultures it is considered courteous to place one's body very close to the body of another person during communication. In the United States, people are very protective of the space close to their bodies and might be offended if one with whom they are not on very friendly terms invades this "personal space."

Nonverbal symbols such as a nod, meaning "yes," or a shake of the head, meaning "no," do not mean the same thing in all cultures. Symbols also have different meanings to different age groups. People of one age group may not understand the symbols of another. A safe rule when communicating with a patient is to use speech instead of symbols if there is any possibility of being misunderstood. Another frequent cause of cultural misunderstanding is the use of humor. Although humor is often an effective communication tool, it must be used with care when there are cultural or age differences. Humor can be an effective means of releasing tension or conveying a difficult message, but it should not be used in life-threatening situations, when there is a possibility of legal action, or when there may be a cultural misunderstanding. The radiographer must remember, too, that a patient's age may affect a common understanding of humor. In other words, if there is any doubt concerning its appropriateness, do not use humor.

OTHER FACTORS THAT AFFECT COMMUNICATION

The rate at which one speaks, along with the volume, fluency, and vocal patterns, is categorized under the term *paralanguage*. Paralanguage has to do with the sound of the speech, rather than the content. The correct pauses and inflections are extremely important if the communication is to be understood. If one speaks without proper inflection, a question will not sound like a question, or the words may run together and be difficult to sort out. Poor knowledge of correct grammatical usage may also make it difficult to understand what is being said.

The radiographer's first obligation is to know the material that he wants to communicate thoroughly so that he can transmit the message correctly. He must assess the patient–receiver's age; sex; educational, social, and economic levels; cultural background; and physical ability or disability before beginning so that he may adapt his communication to the patient. If the patient has difficulty hearing, the radiographer will want to speak in a normal tone of voice but speak more closely to the patient's ear. A patient unable to stand comfortably should be placed in a position in which he is comfortable enough to listen to the message without the distraction of pain. If the patient is accompanied by another person or group of persons, the radiographer must be certain that the patient hears the message.

FEEDBACK

In order to be certain that the transmitted message has been correctly received, feedback must be obtained. In interactions between the radiographer and the patient, this may mean having the patient repeat the directions that were given, or simply having the radiographer observe him to be certain that he is doing as he was instructed. If the message was misunderstood, the patient will not respond in the manner that was anticipated. If he does not, it will be the radiographer's responsibility to restate the message in such a manner that the patient will understand and will demonstrate understanding by giving the correct feedback.

DEVELOPING A HARMONIOUS WORKING RELATIONSHIP

The most important responsibility of the radiographer as a communicator is to develop a harmonious working relationship with the patient. Although interactions with a patient will often be brief, the patient should be made to feel that he is a partner in the examination process, for indeed the patient is the most important member of the health care team. He should be made to feel that he is sharing in the process. The radiographer creates this therapeutic relationship through communication that conveys the message that he is a concerned and caring person. if the patient is made to feel that he is an unimportant object being passed through the radiology department in order to get the job done, he will leave with a feeling of discontent. This atmosphere of discontent is created primarily through communication and is called a *nontherapeutic relationship*. There are a series of communication techniques that the radiography student should cultivate that will help him to become a therapeutic member of the health care team. They include (1)

establishing communication guidelines, (2) reducing distance, (3) listening, (4) using therapeutic silence, (5) responding to the feeling and the meaning of the patient's statements, (6) restating the main idea, (7) reflecting the main idea, (8) making observations, and (9) exploring.

Establishing Communication Guidelines

Since many of the radiographer's relationships with patients are brief, in order to make the best use of the time allowed, guidelines for the interaction should be set as soon as possible. Establishing guidelines will include the radiographer's introducing himself to the patient and an explanation of the examination or treatment to be performed. What will be expected of the patient and what he can expect of the radiology staff should be included in this interaction.

Delivering these instructions to the patient in a clear, concise, and nonthreatening manner requires careful thought prior to the communication. A person cannot deliver accurate messages until his thinking is organized. If the message is not understood, the patient will not be able to comply with the care plan.

Reducing Distance

In order for the communication to be therapeutic, the physical distance between the radiographer and the patient should be reduced. This proximity also makes the patient feel included and involved. Physical barriers or a noisy environment should be avoided. The radiographer should face the patient and make direct eye contact as he speaks and the patient responds.

Crossing arms or legs during a communication creates a physical barrier that nonverbally conveys a lack of receptiveness from the health care worker. Performing other tasks while attempting to communicate also indicates that there is something more important than what the patient is trying to convey.

Listening

Listening in a therapeutic manner is vital. When the patient is speaking, the health care worker must be able to shut out his own feelings and assume a totally nonjudgmental attitude. While the patient is speaking, the radiographer should not be anticipating his own responses, comparing, or interpreting. The goal is to gather accurate information. If the radiographer is planning his response instead of listening, he cannot do so.

Using Therapeutic Silence

Related to listening is the therapeutic use of silence. Short periods of silence give the patient a chance to arrange his thoughts and consider what he wants to say. These periods will also give the radiographer an opportunity to assess the patient's nonverbal communication as well as his own.

Responding to the Underlying Message

When a patient expresses a feeling of frustration, anger, joy, or relief, it is helpful if the radiographer responds in a manner that lets the patient know his feelings about the situation have been heard and understood. An example of this type of response follows:

PATIENT: *I'm really discouraged. I'm not sure that being so sick following these treatments is worth it.*

RADIOGRAPHER: *You feel disheartened because you're sick after the treatments and you aren't certain that they're making you better.*

Restating the Main Idea

Restating or repeating the main idea expressed by the patient is a useful communication technique. It serves to validate the radiographer's interpretation of the message received and also informs the patient that he is being heard. Consider the following dialogue.

PATIENT: *I am having a lot of pain in my left hip, and I might need help to get up on the examining table.*

RADIOGRAPHER: *You think you'll need help getting up on the table because your left hips is hurting?*

PATIENT: *Yes. Could you please help me?*

Reflecting the Main Idea

Reflecting or directing back to the patient the main idea that he has stated is another useful technique. It keeps the patient the focus of the communication and allows him to explore his own feelings about the matter he is discussing. The radiographer in this instance helps the patient to make his own decision. For example, consider the following dialogue:

PATIENT: *Do you think that I should continue this therapy? It's so expensive, and I'm not sure it's doing me any good.*

RADIOGRAPHER: *Do you think that you should stop the therapy?*

Seeking and Providing Clarification

Seeking clarification is another therapeutic technique that the radiographer might use. It indicates to the patient that the radiographer is listening to what is being said but is not sure that he has received the message clearly. In such a situation the radiographer will simply say, "I'm not sure that I understood you. Will you please repeat that?" or, "I'm not sure that I follow what you've said." The radiographer may also clarify directions that he has given a patient.

RADIOGRAPHER: *In order to prepare for this examination, you will have to take all of this medicine at bedtime tonight.*

PATIENT: *How much of this should I take at bedtime?*

RADIOGRAPHER: *Before you go to bed tonight, take all of the medicine in the bottle at one time.*

Making Observations

Making observations or verbalizing the perceived feelings of another is a useful communication technique. For example, the radiographer might say, "You seem to be very tense, Mr. Smith. Are you concerned about this examination?"

Exploring

The patient may offer information about himself that the health care worker wishes him to pursue more extensively. The technique of exploring might be used in this instance. An example of this might be as follows:

PATIENT: *Every time you give me this medicine it makes me feel funny.*

RADIOGRAPHER: *Tell me what it's like when you have this medicine.*

These are a few of the techniques that may be used to communicate with the patient in a therapeutic manner. The guiding principle of therapeutic communication is to keep the communication focused on the patient by asking open-ended questions, questions that allow the patient to expand his answers to questions. "What" and "why" types of questions, or questions that require only a yes-or-no answer should be avoided. It is important that the conversation be kept focused on the patient. The verbal responses of the radiographer should be kept to a minimum, and the communication should always be redirected to the patient. For example:

PATIENT: *Do you have a family, young lady?*

RADIOGRAPHER: *Yes, I have a husband and two children. And you?*

Validating

When speaking to a patient, the radiographer may wish to verify what the patient has told him. This is called validating the message.

RADIOGRAPHER: *Mr. Gleam, you are saying that you have difficulty breathing when you are lying flat.*

PATIENT: *Yes, I must be in a sitting position in order to breathe well.*

BLOCKS TO THERAPEUTIC COMMUNICATION

There are several factors that actually block or destroy the possibility of creating a therapeutic atmosphere in communication. Rapid speech, the use of complex medical terminology, and distracting environments, such as a noisy waiting room or a crowded hallway, are all serious barriers to communication. The radiographer should deliver messages to the patient in a quiet area of the department in a simple and direct manner. He should make sure that the patient understands English. If the patient does not understand English, an interpreter should be made available.

Obtaining incomplete answers or failing to explore the patient's description of a problem are also detrimental to communication. It is essential that the radiographer listen to what the patient tells him. if he is not certain of the message received, he must explore by further questioning until he is certain that he understands. Failure to do this may result in harm to the patient.

Some other blocks to therapeutic communication that may leave the patient alienated include making judgmental statements and offering false reassurance. Judgmental statements place the patient in the position of feeling that he must gain the approval of the health care worker in order to be cared for. These statements can be simple, such as, "That's good," or "That's bad." Or they can take the form of clichés such as, "We have to take the bad with the good, you know." Another nontherapeutic communication is falsely reassuring the client who expresses fear or concern by making a comment such as, "Now don't you worry. Everything will be just fine."

Defending, another block to communication, is an attempt by the health care worker to protect himself, another person, or the institution. This type of communication rejects the patient's opinion and prevents him from continuing to communicate. For instance:

PATIENT: *I'm not sure Dr. Jay knows what to do with me.*

RADIOGRAPHER: *Dr. Jay is an experienced physician, and he has taken care of many people with problems just like yours.*

This type of nontherapeutic answer ends the communication with the patient feeling rejected and unworthy. How much better it would have been had the radiographer simply restated the patient's comments and allowed him to complete his expression of concern.

Changing the subject while the patient is speaking is a nonverbal means of informing him that what he is saying is unimportant.

Also to be avoided are giving advice, offering subjective interpretations of a patient's statements, disagreeing, probing, and demanding explanations, all of which interfere with communication.

THE PATIENT INTERVIEW

The goal of an interview is to unearth information concerning the patient's current and past health status for the purpose of providing a safe examination or treatment. An interview may be structured or unstructured. A *structured* interview consists of a list of written questions that require direct responses; it is conducted before a particular treatment or examination. An *unstructured* interview is informal and is based upon questions asked by the health worker that depend upon patient responses to previous requests for information.

As an interviewer, the radiographer will be asking direct, personal questions of a relative stranger. During an interview, he must convey a professional image to ensure the patient's confidence as he relates confidential information.

Establishing rapport with the patient and providing an atmosphere that is private and as quiet as possible will be the first priority. Because many people are offended if a stranger addresses them by their first name, the radiographer may want to ask the patient how he wishes to be addressed or simply to use the formal address.

Next, the patient is informed of the purpose of the interview; he is also advised that the information will be shared only with medical personnel for whom it is necessary. It is appropriate for a radiologic technology student to inform the patient of his student status and that the information elicited will be shared with his supervisor or instructor.

An interview is composed of open- and closed-ended questions. *Closed-ended questions* are designed to elicit information quickly, as in an emergency situation, or in situations that require only a one- or two-word answer. For example:

RADIOGRAPHER: *What is your age, Mr. Gleam?*

PATIENT: *I'm 24 years old.*

There are many situations when a closed-ended question is inappropriate because the patient is not allowed to expand upon the information requested with these brief responses. When this is the case, an open-ended question is appropriate. An *open-ended* question is used to assess the patient's feelings about a health care problem or to acquire information from the patient's point of view. For example:

RADIOGRAPHER: *Can you tell me what makes your pain worse, Mr. Smith?*

PATIENT: *It hurts all of the time. If I turn on my left side, the pain stops for awhile, but when I'm on my back, it is much worse.*

The therapeutic communication techniques described earlier in this chapter may be used during an interview when seeking information concerning a patient's feelings, as well as to extend or to validate information.

To conduct an effective interview, the radiographer must listen, observe, reply, and question in an organized and analytical manner that requires critical thought prior to action. While the interview is in progress, the radiographer is also analyzing his patient's strengths and weaknesses so that he can utilize this information in his plan of care.

Following a structured interview, it is appropriate for the radiographer to summarize with the patient the information that was gathered. The radiographer can then inform the patient that the interview is concluded and thank him for his cooperation.

Patient Education

When a patient comes to the radiographic imaging department for treatment or diagnosis, he has a right to expect that he will be instructed in the procedure that he is about to receive. It is the radiographer who will provide the instruction, which should include the following:

1. A detailed description of the preparation necessary for the procedure.
2. A description of the purpose of the test, the mechanics of the procedure, and what will be expected of the patient, for instance, frequent

position changes, medications to be taken or injected, and contrast agents to be used.

3. The approximate amount of time that the procedure will take.
4. An explanation of any unusual equipment that will be used during the examination.
5. The follow-up care necessary when the procedure is complete.

The patient who is hospitalized prior to radiographic imaging procedures will receive preexamination preparation from the nurse assigned to care for him. It is the radiographer's obligation as a member of the health care team to communicate the preparation needs for radiographic imaging procedures in his department to other members of the health care team who will be preparing the patient. The member of the health care team who usually prepares hospitalized patients for radiographic imaging examinations is a member of the nursing staff.

The radiographer must be certain that nurses who will be preparing the patient have explicit and current preparation instructions for each procedure to be performed. The radiographer must also plan the scheduling of imaging procedures with other members of the health care team so that the examinations are performed in a logical sequence that meets the patient's health care needs and accomplishes the diagnostic goals in the most time- and cost-efficient manner.

The possible adverse effects of a procedure should be addressed by the patient's physician, before the patient is left in the radiographer's care. It is the radiographer's job to determine the extent of the patient's knowledge of the procedure and his understanding of what is to occur. The techniques of therapeutic communication can be employed to do this effectively. If the patient's understanding is not satisfactory or if he continues to be concerned about what is to occur, the radiographer should not begin the examination until the patient's concerns have been addressed by his physician. The radiographer must also be certain that procedures requiring special informed consent are signed by the patient and are in order.

The problem-solving process is an effective guideline for patient teaching. It can be used to:

1. Establish your teaching goal or expected outcome.
2. Assess the patient's need for teaching and ability to understand instruction. Include:
   a. Previous experience with the procedure to be performed; *a patient who has had a particular procedure previously will not need as much education as a person who has no idea of what is involved in a complex examination.*
   b. Knowledge of the preparation needed for the procedure; *a person who understands how to administer an enema will not need that instruction.*
   c. The patient's age, culture, ethnicity, and educational level; *the parents of a child will need to be instructed as well as the child, depending on age; an elderly person or his caregiver may need additional instruction. Persons from foreign countries or whose cultures prohibit particular medical treatments or examinations will need additional instruction and demonstration of equipment.*
   d. The patient's health status; *a very ill person may not be receptive to teaching. You may need to enlist the help of a family member to facilitate patient teaching.*
   e. The patient's anxiety level and ability to assimilate the instruction; *a highly anxious individual cannot retain information and may need an alternative method of instruction.*
3. Use your critical thinking skills to plan how you will instruct the patient based on your assessment. Everyone has a different learning style. The styles are as follows:
   a. *Global versus linear:* some persons look at an entire picture and then the details (global); some look at each component of the material before looking at the whole (linear).
   b. *Visual:* material must be presented as a graphic design or in pictures.
   c. *Auditory:* learn by verbal explanation alone.
   d. *Kinesthetic:* learn by demonstration and followed by return demonstration.
4. Plan your method of evaluation to be certain that the patient has understood your instruction. This can be done in several ways:
   a. Obtaining verbal feedback
   b. Having the patient perform a return demonstration
   c. Written feedback
5. Implement your plan.
6. Evaluate your plan.

Immediate verbal feedback is usually the best method of evaluating a teaching plan in radiography because of the brief time allowed for teaching. If the patient or his caregiver is able to repeat the instructions given accurately, the radiographer can proceed with the examination. If it seems that the patient does not understand or agree with the ex-

amination, the examination must be postponed until the radiographer can successfully convey the information. This will require reformulation of the educational plan. Another member of the health care team might be able to assist the radiographer in this regard. If the patient is a non-native speaker of English and the radiographer cannot communicate in the patient's language, an interpreter may need to be called. Working with a patient who is poorly instructed will result in frustration for the patient and the radiographer, and the examination may not be successful.

When an examination is completed, the radiographer must reinforce what he initially taught the patient concerning any follow-up treatment or care. The anxiety caused by the procedure may cause the patient to be somewhat forgetful. Written follow-up instructions should be given to the patient along with verbal instruction.

Loss and Grief

Grief is a normal emotional response to the loss of a loved one, a prized possession, social status, or a body function or body part. It is also to be expected when one is faced with one's own imminent death. Unfortunately, the process of grieving is a long and difficult one.

How one manages the process of grieving is largely dependent upon cultural, religious, and economic factors, as well as upon the value placed upon the loss. Grief reactions are often more severe for children and the elderly, especially if they have lost a person on whom they have depended.

In all of the health care professions, exposure to the loss and grief of others is frequent. Radiologic technology is no exception. Prior to exposure to persons who are in various stages of the grieving process, the student must examine his own feelings and attitudes concerning death and loss. It is not unusual for a health care worker to be filled with emotion when he cares for a person who has suffered a tremendous loss; however, these emotions must not prevent him from caring for the grieving patient. If the student feels that he may have difficulty in this aspect of patient care, he is advised to seek counseling or discuss these fears with a respected colleague.

There are a number of concepts and theories that have been presented by scholars that may be used to facilitate understanding of persons who are grieving. Each theory identifies phases in the process of grieving. The radiologic technology student must remember that grieving is a human process and, as such, will not follow an orderly sequence. The grieving person may go from one phase of grief to another and then return to a previous phase; he or she may even be in more than one phase of grief at a time.

I have selected the theory of grieving proposed by Dr. Elisabeth Kubler-Ross to summarize the phases of the grieving process in a concise manner. The student must remember that the picture of the grieving person presented here is general and will vary with each individual. The radiographer's ability to care for the grieving patient is enhanced by assessing the patient prior to beginning care to determine which phase of the grieving process he may be going through.

PHASE I: DENIAL

When a human being has an illness that will ultimately lead to death, he usually senses that he is dying before he is informed of this fact by his physician. It is the physician who informs the patient of approaching death, and no other member of the health care team should assume this responsibility. Often a sensitive physician will wait for the patient to bring up the matter. When verification of a terminal illness or permanent disfigurement has been made to the patient by his physician, the initial response is usually one of shock and denial. This first response is used by the patient as a defense until he can become accustomed to the idea. The idea of one's own death is difficult to face. Death happens to other people, "not me." If the radiographer is questioned about the possibility of death or permanent disability, he should respond with reflective answers and give support without being unrealistic. For example:

PATIENT: *Do you think my disease is incurable?*

RADIOGRAPHER: *You feel that you have an incurable disease?*

PHASE II: ANGER

If the illness preceding death is lengthy, or as the recognition of disfigurement and handicap is verified, the patient moves into the second phase of the grieving process. In this phase, the client becomes angry. He may hurl criticism and abuse at family members or at health care workers. He feels that he has been done a serious injustice, and hopeless rage is his only defense. If the radiographer is insulted or verbally abused, he should not take the abuse personally. He should be matter-of-fact and understanding in his responses. Releasing anger is therapeutic to these patients and should be permitted.

PHASE III: BARGAINING

The third phase in the grieving process is a period of bargaining. The patient becomes a "good patient." He tries to follow all medical advice and becomes submissive. He may feel guilty for his outbursts of anger. He has hopes that if he is "good" he will be spared. Perhaps, he thinks, there will be a miraculous cure or, at least, less pain and suffering.

During this phase, the person who has a terminal illness may seek alternative modes of treatment, some of which may seem unusual or even nontherapeutic.

PHASE IV: DEPRESSION

The fourth phase in the grieving process is a period of depression. The patient accepts the reality of his impending death, permanent disability, or disfigurement. He begins to mourn for his past life and all that he has lost or is losing. He is often silent and retiring at this time. Quiet support is the best response of the health care worker during this period.

PHASE V: ACCEPTANCE

The fifth phase in the grieving process is a period of acceptance. If the patient is dying, he will lose interest in the outside world and become interested only in his immediate surroundings and the support of persons near him. He deals with his pain and illness and begins to disengage from life. The health care workers should be quietly supportive during this time. Communication should be reflective, and the client should be allowed to discuss whatever he desires.

If the client is facing a permanent disability or disfigurement and not death, this is the time when he makes his first attempts at rehabilitation. He faces the reality that he must make the most of his life. This does not mean that the disability is forgotten or totally accepted. The disabled person may have a longer grieving period than the person who suffers the loss of a loved one because he is constantly reminded that he is no longer the person that he once was. The radiographer must remember this and use consideration and understanding. The rehabilitating patient must be allowed to direct his own care as much as possible. The radiographer should stand by to assist, rather than take the lead. He should also be matter-of-fact as he cares for the disabled patient and complies with requests for assistance.

Persons who are going through the process of grieving may not wish to avoid the subject of their grief. Many persons, when confronted with a grieving person, avoid the grief issue because of their own discomfort with the topic. However, many grieving persons have a desire to discuss their problem. The radiographer who is an astute and sensitive communicator is able to differentiate those who wish to discuss their grief from those who do not. If the patient refers to his grief issue, a simple reflective statement will allow the patient to proceed if he wishes to do so. For example:

PATIENT: *It's been 6 months since I lost my leg, but I still feel that it is not true.*

RADIOGRAPHER: *You sometimes find it hard to believe that this has happened to you?*

Grief is a normal human reaction to loss. The process of grieving is often not complete for 1 or 2 years if the person or object lost was of vital importance in the individual's life. However, there are some situations in which the grieving process becomes maladaptive. This may happen if grief cannot be expressed adequately or if there is a feeling of guilt concerning the relationship of the survivor with the deceased. If the loss results in social dysfunction and mental illness, the grieving person must seek or be taken to a counselor or psychiatrist for assistance to resolve the grief.

Patient Rights Related to Death, Dying, and Medical Treatment

The science of medical care has advanced to the point that life can be maintained by mechanical means almost indefinitely, or at least long after the quality of life has deteriorated. This may not be in the patient's best interest. Indeed, it is likely that if he were able to make the decision himself, the patient would refuse this type of treatment.

To keep their families from being caught up in the potential legal and ethical issues associated with decisions concerning prolonged medical treatment, many people are choosing to draw up, well in advance of need, legal documents for use by significant others in the event these decisions must be made. These documents are called *advance directives* for health care. These directives give to a responsible person designated by the patient when he was in good health the legal authority to act on the patient's behalf should he become incapable of doing so for himself. The radiographer must become familiar with these types of legal documents as they are frequently part of a patient's chart. In

an emergency situation, he must be able to understand the patient's wishes. The various directives that are currently in use are as follows:

1. *Living Will:* a document that states exactly what the patient wishes at the time of death; usually, the document states that no measures be taken to prolong life if there is little prospect of recovery.
2. *Durable Power of Attorney for Health Care:* a legal document signed by the patient that authorizes another person to carry out the wishes of the patient if he is unable to do so for himself.
3. *Do Not Resuscitate* (the front of the chart may be marked *DNR* or *NO CODE*): Part of a legal document that states that the patient has directed that no cardiopulmonary resuscitation (CPR) or other life-saving measures be implemented if the need should arise.

Summary

All human beings have basic needs. The patient who seeks medical care does so because his basic needs are no longer being met due to illness. When a person is ill, his behavior often regresses because he feels threatened owing to the inability to have his needs satisfied. The patient who comes to the diagnostic imaging department for diagnosis or treatment may be unable to relate to the health care worker in a pleasant manner. The radiographer must be able to recognize that the patient is behaving in a regressive manner because of unmet basic human needs. If this is understood, he will be able to care for the patient in a sensitive and caring manner regardless of how the patient behaves.

To succeed in the profession of radiologic technology, the student must learn the skill of critical thinking. Many students feel that they are competent if they use the lower modes of thinking, recall and habit. In order to become a competent radiographer, the student must also acquire the ability to use inquiry and creativity, two higher modes of thinking.

To learn these skills, the student must understand how he thinks. This requires introspection and honesty with one's self. The student must become aware of the limits of his current knowledge and understand the reasons for his limitations, which are often the result of personal biases. He can then begin to improve his ability to think in a critical manner. To become skilled in critical thinking takes time and practice.

Each patient care assignment involves problem solving that requires both lower and higher modes of thinking. The steps in the problem-solving process are data collection, analysis of data, planning, implementation, and evaluation. The patient's racial and cultural differences must be considered when planning care.

When a patient enters the diagnostic imaging department for care, he expects to encounter a professional health care worker who is articulate, clean, well-groomed, and caring. He also expects to be treated as a person of dignity and worth.

Communication is central to all health care situations. The radiographer must be able to communicate in a therapeutic manner with his patients. This begins with self-understanding. He must understand his own biases and attitudes. He must recognize how he feels about himself and develop a positive self-concept before he can be an effective communicator.

The radiographer must understand that the patient who comes to the diagnostic imaging department for a difficult examination may be fearful, but will not wish to express this verbally. The sensitive radiographer will be able to detect the symptoms of fear and, by use of therapeutic communication techniques, be able to allow the patient to express his feelings of fear.

The radiologic technology student must learn to use the techniques of therapeutic communication and recognize potential blocks to therapeutic communication. When these techniques are applied correctly, the patient will leave the imaging department feeling positive about his treatment.

The interview is another form of communication used frequently in health care. The radiographer must use his critical thinking skills to determine when it is appropriate to use open- or closed-ended questions in conducting a successful interview.

Patient education prior to procedures is an obligation of the radiographer. He must assess his patient's level of knowledge and his cultural differences prior to making an instructional plan. The radiographer must then design his teaching based upon each individual's need. Assessment of the teaching plan can be done by obtaining a return demonstration or by requesting verbal or written feedback from the patient.

Patients who are suffering from loss of a body part or body function or are grieving from another type of personal loss must have special considera-

tion. The radiographer must be able to assess the needs of these people and communicate with them in a manner that conveys understanding and sensitivity.

The student must also familiarize himself with the various types of advance directives used in health care. These are often on the patient's chart and are important in emergency situations.

Chapter 2, Pre–Post Test

1. All persons have basic needs that must be met. Match the situations listed below with the basic need that is not being satisfied:

- **a.** A patient waiting alone on a gurney in a corridor. Everyone rushes by without offering explanations or communicating with him.
- **b.** No food was allowed prior to this examination since dinner the previous evening. The examination is late; it is now 11:00 AM.
- **c.** A middle-aged patient who is having a lower GI series has an involuntary evacuation of barium on the examination table.
- **d.** A young mother is studying music in her leisure time.
- **e.** A child is taken from his parents into the diagnostic imaging department for examination. The parents will wait outside.

1. Physiologic need ____
2. Safety and security need ____
3. Love and belonging need ____
4. Self-esteem need ____
5. Self-actualization need ____

2. Define *critical thinking* and list and define the modes of thinking.

____ **3.** You are preparing for an anatomy examination. You are certain that the instructor will ask you to identify the bones of the skull. What type of answer will this question demand?

- **a.** Synthesis
- **b.** Analysis
- **c.** Recall
- **d.** Inquiry
- **e.** Habit

4. You have just completed your first barium enema with your instructor's supervision. Your next step will be to complete a written evaluation of your work. What questions will you ask yourself as you write this evaluation?

5. Jim Hardbone is in an introductory radiologic technology class and is beginning his first clinical assignment, an AP film of the chest. The patient is a very obese female who has difficulty moving because of a fractured right femur. Mr. Hardbone recalls how to conduct the basic procedure; however, he does not know how he will obtain the necessary exposures since the patient cannot move easily. List the steps in the problem-solving process that Mr. Hardbone will need to use before beginning this procedure, and define the critical thinking modes necessary in this process.

____ **6.** How a patient feels about his health care experience is most often the result of

- **a.** The expense of the procedure
- **b.** The time of the visit
- **c.** The knowledge level of the technologists
- **d.** The communication skills of the health care persons caring for him
- **e.** The diagnosis

____ **7.** Miss Myrtle Mulberry has just been informed that she has been accepted into the radiologic technology program at Glucose State University. She is very happy

about this; however, she begins to worry about her ability to succeed in this program. She is concerned about her manner of speaking, her ability to help other people, and her appearance. One might say that Ms. Mulberry has

a. Low self-esteem
b. A negative self-concept
c. Depression
d. A grief reaction
e. Poor critical thinking skills

8. A patient who speaks little English is assigned to you for care. You are not able to communicate in the patient's language. In this situation, if no interpreter is available, how will you plan your communication with this patient?

9. Merry Mae is an 83-year-old Caucasian female. She has been admitted to the hospital to which you are assigned for your clinical education. Ms. Mae must have a computed tomography scan of the abdomen, and you have been asked to assist with preparing her for this. You approach the patient and greet her. She is silent for a moment and then begins to cry. Your best response to this situation might be
   a. To ignore the fact that she is crying and begin to explain the procedure
   b. To take her hand and after a moment say, "You seem to be upset, Ms. Mae. Can you tell me about it?
   c. Approach her and say, "Don't worry, Ms. Mae. Everything will be all right."
   d. Leave the patient alone for a few minutes
   e. Call for help

10. You are interviewing a patient prior to placing him on the examining table. He tells you that it is difficult for him to move from a sitting to a standing position. You say, "You feel that you need help to stand?" This therapeutic communication technique is called
    a. Exploring
    b. Silence
    c. Making observations
    d. Probing
    e. Validating

11. The concerns of the radiographer preparing to interview a patient must include
    a. Privacy and a quiet environment
    b. Ensuring confidentiality
    c. His own personal appearance and professional demeanor
    d. Establishment of rapport with the patient
    e. a, b, c, and d

12. As a specialist in his area of health care, the radiographer has patient-teaching responsibilities. These responsibilities include
    a. A description of the preparation, purpose, time involved, and equipment used for examinations
    b. A description of the adverse reactions possible and the diagnosis made during the examination
    c. The toxic effects of the barium and the amount of work involved for the radiographer
    d. The risk to the patient, the family, and the health care team

13. The process of grieving, albeit painful and difficult, is normal and cannot be avoided in the case of a significant personal loss.
    a. True
    b. False

14. Mr. Nathan Nilhouse was diagnosed with cancer 6 weeks ago and told that the disease is incurable. He has decided to seek treatment that promises instant cure

with natural herbs in another country. One might conclude that Mr. Nilhouse is in the Denial stage of grieving.

a. Denial
b. Anger
c. Bargaining
d. Acceptance
e. Depression

15. Define *advance directives* for health care.

B **16.** You are the student assisting with the treatment of a patient who has been diagnosed with a terminal illness. During the treatment, the patient stops breathing. You recall that you saw a note on the front of the patient's chart that said DNR. You realize that this means

a. That the emergency resuscitation team must be called
b. That the patient has specified that he does not wish to have cardiopulmonary resuscitation if the question should arise
c. That you should begin cardiopulmonary resuscitation

○ *Laboratory Reinforcement*

1. In the school laboratory, pick a fellow student and have a 5-minute discussion with him about his background and immediate concerns. When the 5-minute discussion is complete, write a report of the subjective and objective data that you collected from your colleague during the discussion. Evaluate the information with the student chosen for the discussion for completeness and accuracy of content.

2. Select a patient and interact with him following the techniques of therapeutic communication. Submit a written report using the format described below to the instructor for evaluation based on the criteria listed in the chapter.

A. *Introduction.* Explain the setting, using the patient's initials only, and give his approximate age. Record the patient's sex and include a brief explanation of his background (*i.e.*, his culture and social history).

B. *Dialogue.* Divide a sheet or two of paper in half. On one side of the paper write the radiographer's verbal comments with an explanation of the technique of communication used. If a nontherapeutic comment was made, include it. Write an explanation of why the comment was or was not therapeutic. On the other half of the paper write the patient's responses or comments.

C. *Analysis.* Briefly discuss what you felt during the communication. Describe the nonverbal communication that you observed in your patient and yourself. Explain what changes you would make during the next assignment to improve your communication skills.

Critical Thinking Problems

1. In the hospital laboratory, using a patient to whom you are assigned, write a care plan using each step in the problem-solving process.

2. In the school laboratory, identify (or have your instructor assign to you) a patient care problem to solve. When you have completed this, write a paragraph defining your own thinking processes and identify when you used recall, habit, inquiry, and/or creativity in the problem-solving process.

3

Infection Control and Institutional Safety

Nosocomial Infections
Microorganisms
Bacteria
Fungi
Parasites
Viruses
Elements Needed to Transmit Infection
The Body's Defense Against Disease
The Process of Infection
Immunodeficiency
Agencies Controlling Institutional Safety
Human Immunodeficiency Virus (HIV)
Phases of HIV Infection
Diagnosis and Treatment
Universal Precautions and Body Substance Isolation
Techniques of Infection Control
Dress in the Workplace
Hair
Hand Washing
Gloves
Eye Protection
Cleaning and Proper Waste Disposal
Disinfection
Additional Infection-Control Techniques
Methods of Isolation Precautions
Strict Isolation
Entering and Leaving the Strict Isolation Unit
Transferring the Patient With a Communicable Disease
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Define the terminology used in this chapter.
2. Describe the four known types of microorganisms that may cause infection.
3. List and define the factors needed to develop an infectious disease.
4. List, describe, and demonstrate the methods of controlling infection in health care settings.
5. Discuss HIV and AIDS and describe the means of transmission.
6. Define the seven category-specific methods of isolation.
7. Explain universal precautions and blood and body substance precautions.
8. Demonstrate the correct method of entering and leaving an isolation unit using strict isolation technique.
9. Explain the precautions to be taken following a needle-stick injury or exposure to blood or body substances in the course of work.
10. List the regulatory agencies that set guidelines for safety in health care settings.

Glossary

Acid-fast bacillus (AFB): a type of bacillus that resists decolorizing by acid after accepting a stain
Amebiasis: a protozoal infection transmitted by food or water contaminated with human feces that primarily affects the colon, but also the liver and other sites
Amniotic fluid: a liquid produced by the fetal membranes and the fetus during pregnancy
Angiography: the radiographic visualization of the internal anatomy of the heart and blood vessels after administration of a contrast agent
Anorexia: lack or loss of appetite resulting in the inability to eat
Antigen: any substance eliciting an immunological response, such as production of an antibody specific for that substance
Antimicrobial: a type of agent that kills or inhibits the growth or replication of microorganisms
Antiseptic: any substance that inhibits the growth of bacteria
Asepsis: freedom from infectious material
Asymptomatic: exhibiting or producing no symptoms
Autoimmune: a condition in which an immune response is directed against constituents of an organism's own body
Body fluid: any fluid produced by the human body
Cannula: a tube for insertion into a duct or cavity
Cardiopulmonary resuscitation (CPR): a basic emergency procedure for life support that consists of artificial respiration and manual external cardiac massage
Carrier: a person or animal who harbors and spreads a disease-causing organism to others without becoming ill
Cerebrospinal fluid: the fluid that flows through and protects the four ventricles of the brain, the subarachnoid space, and the spinal canal
Chemotherapy: the treatment of infections and other diseases with chemical agents
Chronic: a type of disease or condition lasting a long time that has periods of improvement and periods of increased illness and is incurable
Ciliate: of or having cilia; a cell having hairlike projections on its surface
Contaminate: to make unclean; to introduce microorganisms into an area where they did not live before
Convalescence: a period of recovery at the end of an illness
Cyst wall: an abnormal sac formed by microorganisms when they are inactive or dormant that may serve as a reproductive structure
Cytotoxic drugs: chemical substances used to destroy or prevent multiplication of particular cells; used in treatment of cancer
Dementia: deterioration or loss of intellectual faculties, reasoning power, memory, and will, due to organic brain disease
Disinfectant: an agent that destroys or inhibits the microorganism causing disease
Dormant: concealed, inactive potential
Enteric: pertaining to the intestine
Enzymes: proteins produced by living cells that assist in chemical actions on organic matter; present in all living organisms
Epidemic: a disease that is widespread and rapidly affects a great number of people in one location
Etiology: the causes of a disease
Exudate: types of fluid, cell, or other substance with a high content of cellular material from blood vessels
Fatigue: a state of exhaustion, or a loss of strength or endurance
Flagella: whiplike projections on protozoa, whose movements propel the organism
Flora: plant life adapted for living in a specific environment; may be microscopic in size
Fomes: (plural, *fomites*) inanimate object that may be contaminated with infectious organisms and thus serves to transmit disease
Ganglion: a knot or knotlike mass; in neurology designates a group of nerve cell bodies
Gastrointestinal: pertaining to the stomach and intestines
Germicide: substance that kills bacteria on contact
Helminth: a class of parasitic worms
Hemophilia: a group of hereditary bleeding disorders in which there is a deficiency of one of the factors necessary for blood to coagulate, or clot
Heterosexual: sexual orientation toward the opposite sex
Histamine: a compound found in all cells produced by the breakdown of histidine; functions to dilate capillaries, to constrict bronchial smooth muscles, and to induce gastric secretion
Host: an organism in which another, usually parasitic, organism is nourished and harbored
Immunosuppression: the administration of agents that interfere with the ability of the immune system to respond to antigenic stimulation by inhibiting cellular and humoral immunity
Infectious disease: one due to organisms ranging in size from submicroscopic viruses to parasitic worms visible with the naked eye
Inflammatory reaction: the reaction of the tissue to injury, characterized by heat, swelling, redness, pain, and loss of function
Interferon: a protein formed by animal cells in the presence of a virus that prevents viral reproduction
Intravenous: within the vein
Isolation: separation of patient from rest of community or from other patients to prevent the spread of communicable diseases or for other reasons
Latent phase: when disease is not manifesting symptoms
Lipoprotein: a protein in which lipids (substances insoluble in water) form an integral part of the molecule
Lymphocyte: a leukocyte (white blood cell) that participates in humoral and cell-mediated immunity
Lysis: disintegration or dissolution, as of cells, bacteria, or tissue
Malaise: a feeling of bodily weakness or discomfort that often proceeds illness
Metabolic rate: the amount of energy liberated or expended in a given period of time
Microbe: a microorganism
Microorganism: a microscopic, living plant or animal
Mucous membrane: any one of four kinds of thin sheets of protective tissue that cover or line various parts of the body
Neuropathy: any disease affecting neurons
Nosocomial: infections acquired while receiving medical care
Parasite: an organism that spends part of its existence on or in another organism, its host, at whose expense it obtains nourishment and is able to survive

Pathogenic: capable of producing a disease
Pericardial: referring to the sac that surrounds the heart and the roots of the great vessels of the heart
Peristalsis: progressive wave of contractions seen in tubes, such as gastric intestinal tract, that provide the means by which contents of the tube are forced toward an opening
Phagocyte: a cell that is able to surround, engulf, and digest microorganisms and cellular debris
Prostaglandins: one of several potent, hormone-like, unsaturated fatty acids that act to stimulate uterine and other smooth muscle contractility, to lower blood pressure, and to effect action of hormones in the body
Protozoa: broad, basic classification of unicellular animals
Pseudopod: protruding process of protozoa used for purpose of movement and obtaining nourishment
Purulent: producing or containing pus
Replicate: to repeat, duplicate, or reproduce
Resistance: the means by which the body defends itself against invasion by infectious organisms and their toxic byproducts
Serum: any serous fluid (the clear portion of any animal liquid)
Staphylococcal infection: an infection caused by a pathogenic species of staphylococci, commonly characterized by formation of abscesses of the skin or other body organs
Synovial fluid: a transparent, viscous fluid secreted by the synovial membranes that acts as a lubricant for many joints, bursae, and tendons
Transducer: any of the various devices that transmit energy from one system to another
Transmission: transfer of disease from one person to another
Tuberculosis: a chronic, granulomatous infection caused by an acid-fast bacillus that affects the lungs or other body organs
Universal precautions: a widespread set of procedures and regulations instituted for the safe handling and disposal of blood and body substances
Vector: an agent that carries microorganisms from an infected person to another, previously uninfected person
Vegetative: inactive
Vehicle: a transporting agent
Virulence: the disease-producing power of a microorganism
Virus: minute microorganism that cannot be seen under an ordinary microscope

Infection control in health care institutions is essential to the safety of patients, their families, and health care workers. All health care workers are taught the concepts and procedures for infection control before they begin to work in their various specialty areas, and all are responsible for complying with infection-control precautions. To overlook this aspect of health care is a violation of professional ethics and the law because the violator is disregarding the safety of his patient, his coworkers and himself.

Patients who seek care in a hospital or any other type of health care facility are also responsible for complying with infection-control measures while in that institution. Their visitors, too, must comply. This has become a standard regulation because infractions in technique by one person affect the safety of all others in that institution.

People come to the diagnostic imaging department from many different environments, and the possibility that they will bring disease with them is perhaps even greater here than elsewhere. Though some patients seem to be in good health, all must be regarded as potential carriers of disease and treated as such.

The acquired immunodeficiency syndrome (AIDS) epidemic in the United States and throughout the world has forced all health care workers to be more vigilant in the practice of infection control in order to protect themselves and others from acquiring this fatal disease. The increase in the incidence of tuberculosis and the constant threat of hepatitis B in health care settings are two other reasons why knowledge of infection-control measures is a necessity.

Universal precautions and body substance isolation techniques must be understood and practiced by the radiographer at all times. Correct cleaning of equipment, hand washing, and proper disposal of contaminated waste must be part of every procedure in diagnostic imaging to guard against the spread of infection.

Nosocomial Infections

In spite of increasing use of infection-control measures, the incidence of infections in patients while they are receiving health care has increased. Infections acquired in the course of medical care are called *nosocomial infections.* This term is most often applied to infections contracted in an acute care hospital. However, it also applies to infections a patient receives while in extended care facilities, outpatient clinics, and psychiatric hospitals. Infections contracted at birth by infants of infected mothers are also classified as nosocomial. Although the patient acquires the infection while in the health care facility, symptoms of the illness may not develop until the patient has left the health care environment.

The three major risk factors that are related to nosocomial infections in health care facilities are as follows:

1. *Environment:* Infections are caused by air contaminated with infectious agents, other patients who have infectious diseases, visitors, food contaminated with infectious microorganisms, equipment, and hospital personnel.
2. *The therapeutic regimen:* Use of immunosuppressive and cytotoxic drugs to treat cancer and chronic disease therapy decrease the patient's resistance to infection. Antimicrobial therapy alters the bacterial flora of the body and encourages growth of resistant strains of microbes that are called *hospital bacteria.*

   Equipment used in medical treatment such as indwelling urinary catheters, intravenous tubing and cannulae, respiratory therapy equipment, gastrointestinal tubes, and contamination during procedures such as dressing changes may increase growth of pathogenic microbes.
3. *Patient resistance to infection:* Persons who are hospitalized for treatment are generally in a poor state of health with a decreased ability to resist infections. This is particularly true of the elderly, children, patients with open wounds, and persons who have chronic or terminal illnesses which make them especially vulnerable to nosocomial infections.

The most frequent site of nosocomial infection, the urinary tract, is associated with the use of indwelling catheters. Wound infections following surgical procedures and respiratory tract infections also occur frequently. Early removal of urinary and intravenous catheters and other types of invasive treatment devices is recommended whenever possible to reduce the incidence of nosocomial infections.

Microorganisms

There are basically four major groups of microorganisms known to produce diseases: bacteria, fungi, viruses, and parasites. If a microorganism is known to produce disease, it is called a *pathogenic microorganism,* or a *pathogen.* There are believed to be unidentified pathogens that produce newly recognized diseases. Within the known groups of microorganisms, there are many different species that may produce infections in humans; many are useful or, at least, not harmful. Microorganisms are used in a variety of ways: in food and drug processing, to destroy waste, and, frequently, as a means of effecting a positive change in the environment.

Some microorganisms that are natural flora in one area of the body produce infection if they are accidentally relocated to a site other than their natural habitat. For example, *Escherichia coli,* which normally inhabits the human intestinal tract, will not cause disease there; however, should it gain entrance to the urinary bladder, it can cause a urinary tract infection. Often, it is the number of microorganisms in an area that produces infection. A small number of a particular bacteria in the body may be harmless; however, if the number increases, it may produce an infection.

Another factor that determines the pathogenicity of a microorganism is its ability to find susceptible body tissue to invade. For example, the skin is a normal habitat for staphylococci; however, if this microorganism enters the lungs, it can cause an infection. Some microorganisms are more virulent than others. This means that some microbes are more certain to cause disease if they enter the human body than others.

BACTERIA

Bacteria are minute, one-celled organisms without a typical nucleus. They contain both deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). DNA carries the inherited characteristics of a cell, and RNA constructs cell protein in response to the direction of DNA.

Bacteria are classified according to their shape, which may be either spherical (cocci), oblong (bacilli), or spiral (spirilla). They may be classified according to their divisional grouping as diplococci (groups of two), streptococci (chains), or staphylococci (grapelike bunches) (Fig. 3–1). Bacteria may also be classified by their reaction to various staining processes in the laboratory. They may be gram-positive, which means that the bacteria take the stain; gram-negative, which means that they do not take the stain; or acid-fast, which means that the bacteria are resistant to decolorization by acid alcohol.

Rickettsiae are smaller than other bacteria and can grow only within animal cells. These bacteria are pathogens that are transmitted from animal to animal by the bite of an infected arthropod vector such as ticks or fleas (Fig. 3–2).

Some types of bacteria form spores. A *spore* is a protective coat that surrounds the nucleic material

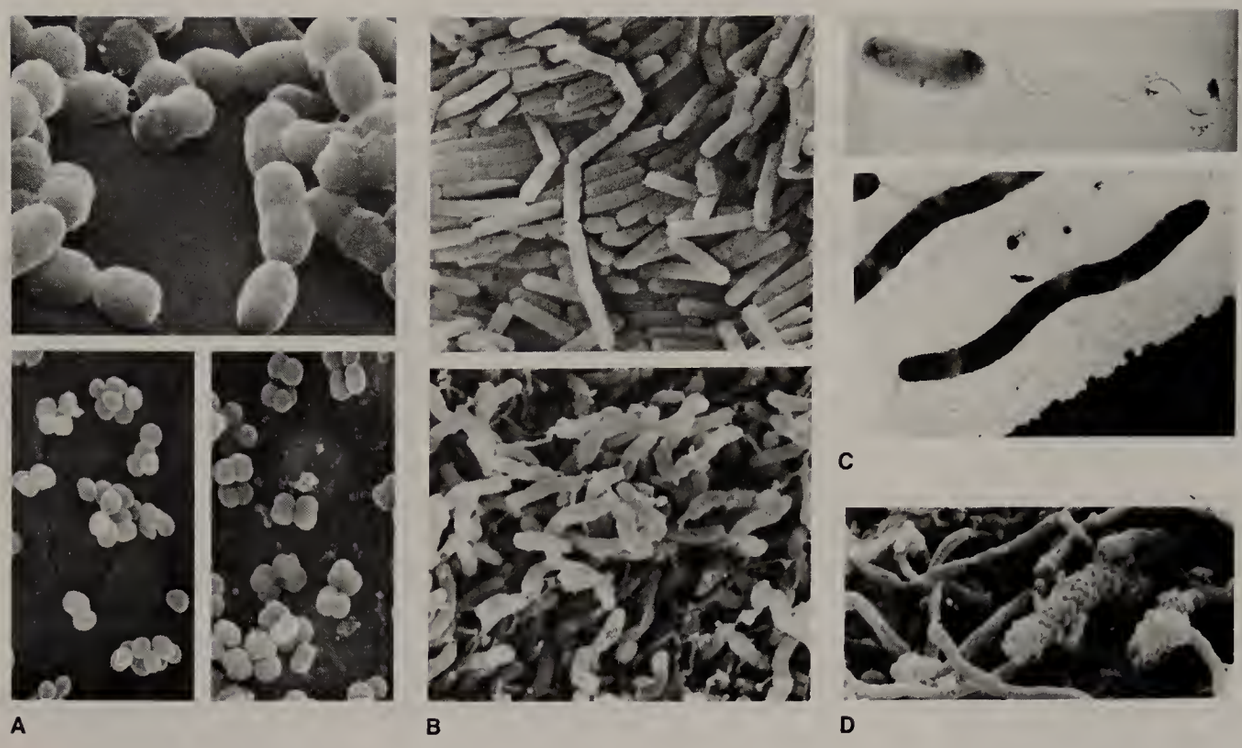


Figure 3–1
Forms of bacteria (**A**) Cocci. *Top: Streptococcus mutans,* demonstrating pairs and short chains. (×9400). *Bottom left:* Single cells and small clusters of *Staphylococcus epidermis* (×3000). *Bottom right:* Pairs, tetrads, and regular clusters of *Micrococcus luteus* (×3000). (**B**) Bacilli. *Top:* Single cells and short chains of *Bacillus cereus* (×1700). *Bottom:* Flagellated bacilli (unnamed) associated with periodontitis (×3700). (**C**) *Top:* A cell of *Vibrio cholerae;* note curved cell and single flagellum (×8470). *Bottom:* The spirillum, *Aquaspirillum bengal;* note polar tufts of flagella (×2870). (**D**) Variety of organisms in dental plaque after 3 days without brushing (×1360). (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

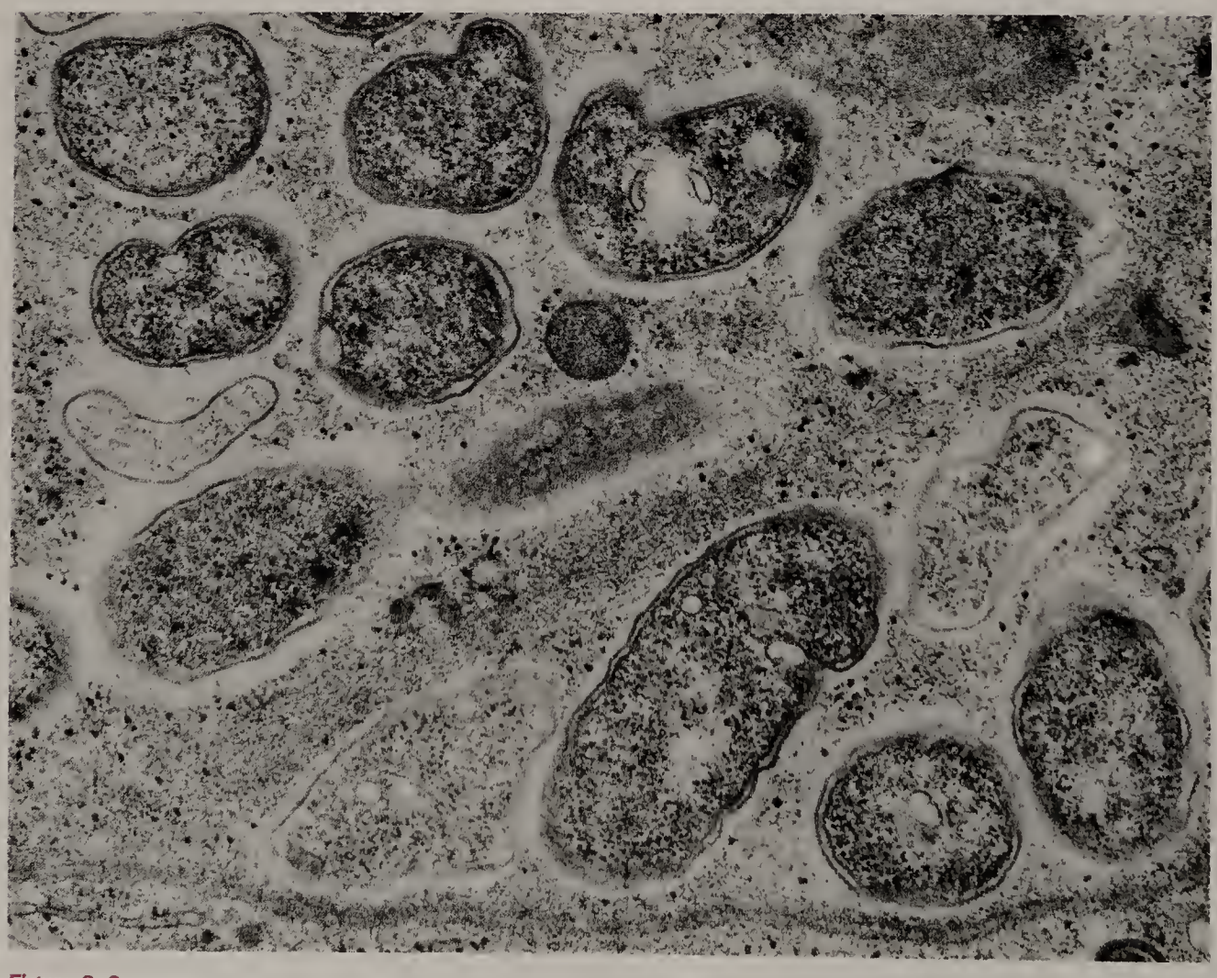


Figure 3–2
Rickettsia prowazekii in experimentally infected tick tissue. (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

of a bacteria. Spores are formed to protect the bacteria when it is in an unfavorable atmosphere for growth and reproduction. When the environment is again suitable for life and function, the spore germinates, and the bacteria resumes its normal life. Spores are more difficult to destroy than are the vegetating bacteria; therefore, many methods of destroying pathogenic bacteria do not affect their spores (Fig. 3–3).

Bacteria are often opportunists. That is, they are able to adapt to any situation and carry on their lives. They may also learn to resist or thrive in the presence of antimicrobial drugs and disinfectants.

Diseases caused by bacteria include tuberculosis, streptococcal infections of the throat, staphylococcal wound infections, salmonella poisoning, Lyme disease, and syphilis.

FUNGI

Fungi exist in two forms, yeasts and molds. Yeasts are one-celled animals, whereas molds have many cells. Some fungi have the characteristics of both yeasts and molds. Fungi reproduce by budding or spore formation (Figs. 3–4 and 3–5). Fifty percent of all fungi may cause disease in humans, but they require moisture and darkness in order to do so. Many pathogenic fungi infect the skin and scalp of humans and are difficult to cure because they produce spores that remain under the outer skin and reproduce when environmental conditions are favorable. Fungal infections affect body systems and are difficult to treat because most anti-infective drugs are not effective against fungi.

Common diseases caused by fungi are those caused by *Candida albicans:* thrush, "black hairy tongue" infections, and vulvovaginitis. A frequently seen skin disease caused by fungi is *tinea* (ringworm).

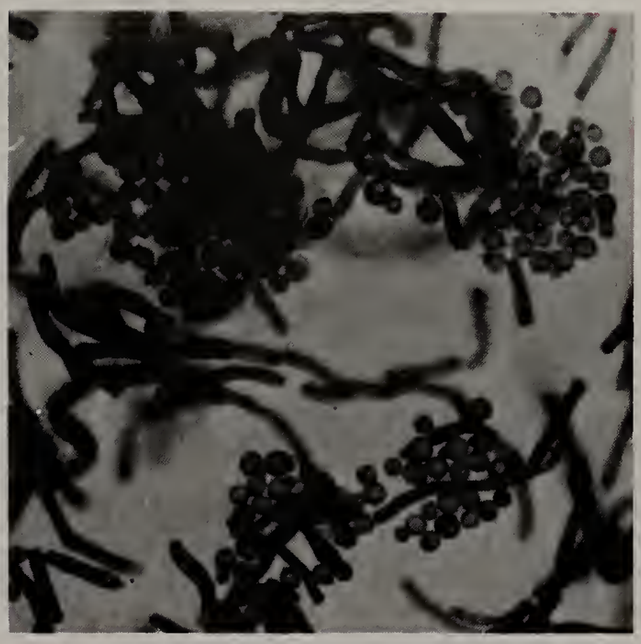


Figure 3–4
Yeast cells of *Pityrosporum furfur* among hyphae or pseudohyphae (×700). (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

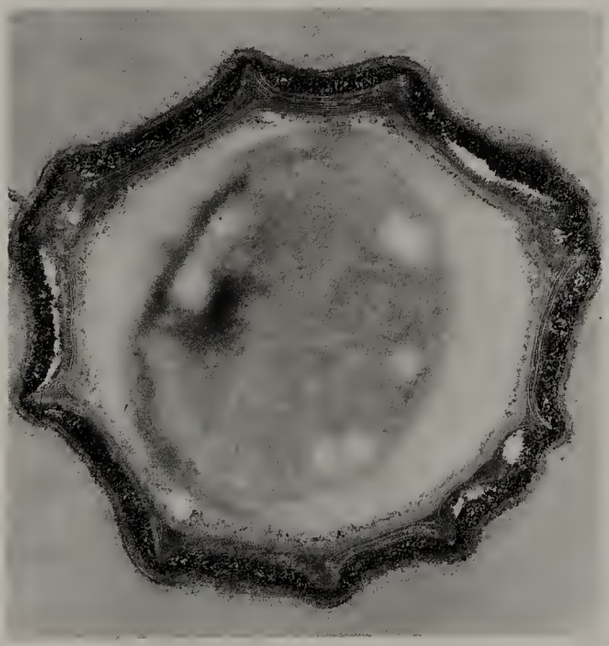


Figure 3–3
Bacillus fastidiosus (×53,590). (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

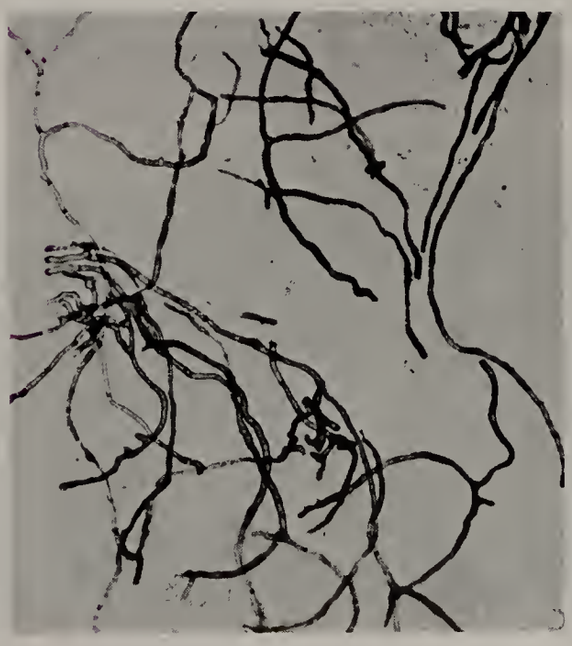


Figure 3–5
Mycelial strands of *Microsporum canis* (×250). (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

PARASITES

There are a large number of parasites that produce disease. They can be roughly classified as *protozoa* and *helminths*.

Protozoa

Protozoa are more complex one-celled microorganisms than those described in the preceding paragraphs. They are often parasitic and are able to move from place to place by pseudopod formation, by the action of flagella, or by cilia.

Pseudopod movement is an amoeboid action in which a part of the cell is pressed forward and the rest of the cell rapidly follows. Flagella are whiplike projections on the protozoa, which move the cell by their swift movements. Cilia are smaller and more delicate hairlike projections on the exterior of the cell wall, which move swiftly and in a synchronous manner to propel the microorganism (Fig. 3–6). Many protozoa are able to form themselves into cysts, which are protected by a cyst wall in adverse conditions to prolong their existence.

Many of the diseases in humans caused by the protozoa affect the gastrointestinal tract, the genitourinary tract, and the circulatory system. Some of the common protozoal diseases are amebiasis, giardiasis, trichomoniasis, malaria, and toxoplasmosis.

Helminths

Helminths can be simply described as parasitic worms classified as either *Platyhelminthes* (flatworms) or *Aschelminthes* (roundworms). Many of these worms can live in the human intestinal tract for long periods of time if they are not treated. Some of the more pathogenic types migrate to other body organs, where they cause serious illness. Although some can be seen with the naked eye, an examination of their eggs is necessary to make a positive identification prior to treatment. Common diseases caused by helminths are enterobiasis (pinworm) and trichinosis (Fig. 3–7).

VIRUSES

Viruses are minute microorganisms that cannot be visualized under an ordinary microscope (Fig. 3–8). They are the smallest microorganisms that are known to produce disease in humans. The genetic material of a virus is either DNA or RNA, but never both. This genetic material is protected by a capsid, or outer coat, and some viruses are also surrounded by an envelope, which is composed of a lipoprotein. Viruses must invade a host cell in order to survive and reproduce.

Whatever its structure, the virus is transported by way of its capsid to a host cell that has receptor sites on its surface that are suitable to a particular virus, which it invades. A virus does not invade a cell at will. It must attach itself at a membrane receptor site for which it has a specificity; that is, it is specific for that particular type of host cell and no others.

Once in the cell, production of new viral particles does not take place with certainty. Other factors in the cell environment must be favorable in order for the multiplication to take place. There are various theories concerning what makes the environment favorable. These include, but are not limited to, poor nutritional status of the host, increased life stress for the host, or excessive use of drugs and alcohol.

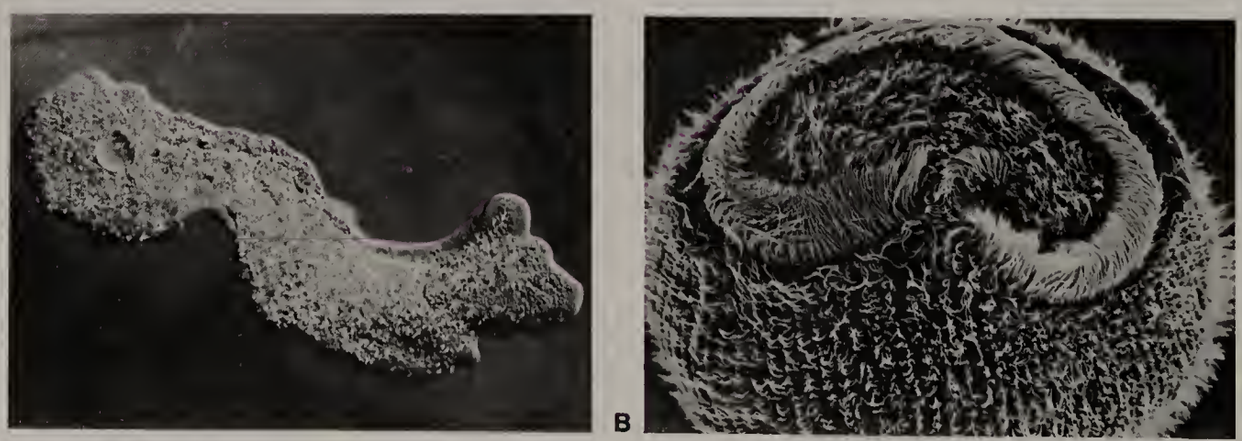


Figure 3–6
(**A**) *Amoeba proteus canis* (×154). (Taylor DL, Department of Biology, Harvard University.) (**B**) Scanning electron micrograph of the ciliate *Stentor careless* (×336). (Paulin JJ and Steiner A, Department of Zoology, University of Georgia. In Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

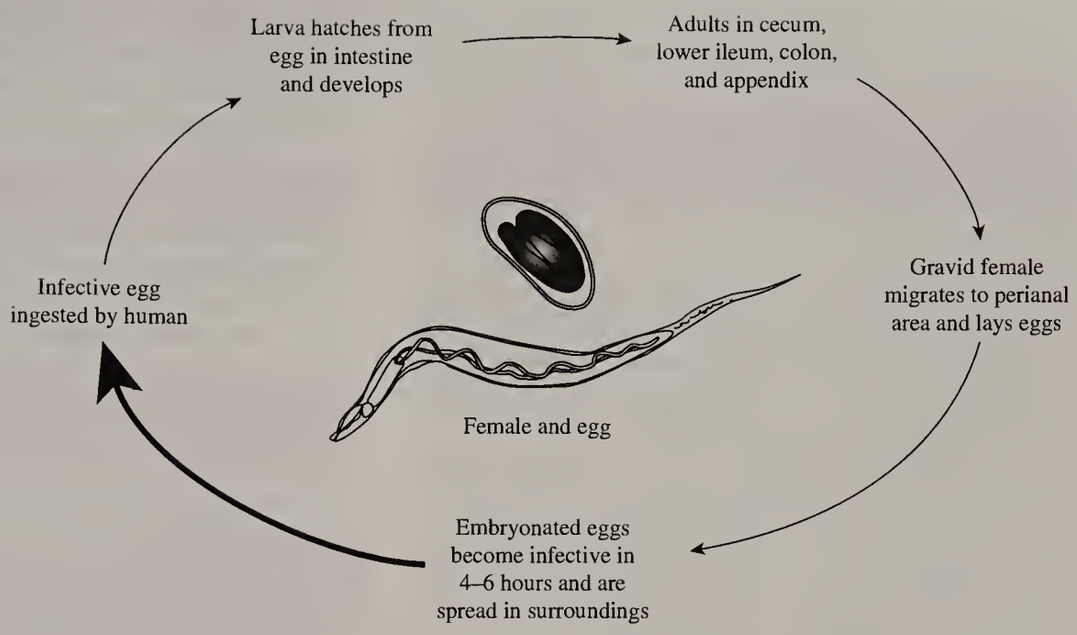


Figure 3–7
Life cycle of the pinworm, *Enterobius vermicularis*. (Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

To reproduce, the virus uses the genetic machinery of the host cell. When reproduction is complete, new viruses leave the original host cell. As some types of virus leave the host cell, they destroy the cell by the rapid release of new viruses. This is called *lysis*. The second type of viral replication produces viruses which lie dormant, but very much alive and destructive, within the host cell.

Some viruses have the capacity to invade nerve ganglia and leave their genetic material in the ganglia in a latent phase after an acute infective period. The virus remains there until the body is under some type of stress such as fever, a stressful event or, as in the case of the herpes virus, prolonged exposure to sunlight. This often induces the virus to take over nearby cells and produce more viruses. Such viral infections may occur repeatedly.

Viruses are usually classified on the basis of their genetic composition (*i.e.*, a virus containing DNA is classified as a DNA virus). Viruses may infect plants, animals, or humans. Some common viral diseases that affect humans include influenza; the common cold; mumps; measles; hepatitis A, B, C, D, and E. Other viral diseases are varicella-zoster and AIDS.

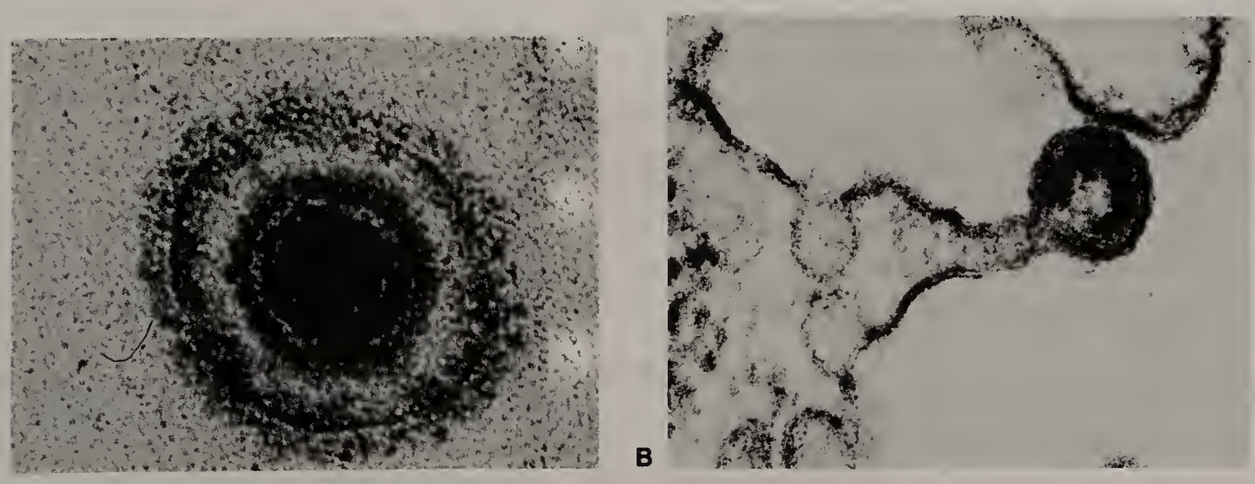


Figure 3–8
(**A**) Section through a herpes virus (×330,000) (Roizman B, Committee on Virology, University of Chicago.) (**B**) A C-type RNA virus budding from an infected cell (×168,000). (Cardamone JJ Jr,, and Youngner JS, Department of Microbiology, University of Pittsburgh School of Medicine. In Volk WA, Benjamin DC, Kadner RJ et al.: Essentials of Medical Microbiology, 5th ed. Philadelphia, Lippincott-Raven, 1996.)

Elements Needed to Transmit Infection

Infection cannot be transmitted unless the following elements are present:

1. *An infectious agent, which may be a bacterium, a fungus, a virus, or a parasite.* Infectious agents vary in their ability to cause disease. These characteristics are pathogenicity, virulence, invasiveness, and specificity.

   Pathogenicity refers to the causative organism's ability to cause disease.

   Virulence refers to the causative organism's ability to grow and multiply with speed.

   Invasiveness is the term used to describe the organism's ability to enter tissues.

   Specificity characterizes the organism's attraction to a particular host.

2. *A reservoir or an environment in which the pathogenic microbes can live and multiply.* The reservoir can be a human being, an animal, a plant, water, food, earth, or any combination of organic materials that support the life of a particular pathogen.

3. *A portal from which to exit the reservoir.* In the case of a human reservoir, the portals of exit might be the nose, mouth, urinary tract, intestines, or an open wound from which blood or purulent exudate can escape. There can be more than one portal of exit.

4. *A means of transmission.* This may be by direct or indirect contact; by droplet; by vehicle; by vector; or by airborne route. Contact is direct when a person or an animal with a disease, or his blood or body fluids are touched. This contact can be by hands, by kissing, or by sexual intercourse.

   Indirect contact is defined as the transfer of pathogenic microbes by touching objects (called *fomites*) that have been contaminated by an infected person. These objects include dressings, instruments, clothing, dishes, or anything containing live infectious microorganisms.

   Droplet contact involves contact with infectious secretions that come from the conjunctiva, nose, or mouth of a host or disease carrier as he coughs, sneezes, or talks. Droplets can travel from approximately 3 to 5 feet and should not be equated with the airborne route of transmission, which is described later.

   Vehicles may also transport infection. Vehicle route of transmission includes food, water, drugs, or blood contaminated with infectious microorganisms.

   The airborne route of transmission indicates that residue from evaporated droplets of diseased microorganisms is suspended in air for long periods of time. This residue is infectious if it is inhaled by a susceptible host.

   Vectors are insect or animal carriers of disease. They deposit the diseased microbes by stinging or biting the human host.

5. *A portal of entry into a new host.* Entry of a pathogenic microorganism into a new host can be by ingestion, by inhalation, by injection, across mucous membranes or, in the case of a pregnant woman, across the placenta.

   A human host can be any susceptible person. Persons particularly susceptible to infection are those who are poorly nourished or fatigued. Those at greater risk are persons with chronic diseases such as diabetes mellitus or cancer.

   Socioeconomic status and culture also play a role in host susceptibility. Persons living in poor environments are more likely to contact some diseases due to poor hygienic conditions and the poor diets that they are forced to endure. Some diseases have a strong hereditary aspect, which makes them more prone to occur in particular races or families who are genetic carriers of the disease.

The Body's Defense Against Disease

The human body has both specific and nonspecific methods of warding off contamination and infection. The radiographer should be aware of these defenses, because this knowledge will play a role in his professional and personal life.

The nonspecific defense system is not selective when dealing with foreign material, usually a protein or microbes that attempt to invade the body. The skin, the hair, ciliated mucous membranes in the upper respiratory tract, and the acidic mucoid linings of body organs all react to any foreign substance or microbe to prevent infection from beginning. The composition and flowing action of urine prevents urinary tract infections. Lysosome in human tears protects the eyes against infection.

In the gastrointestinal tract, the acidic condition of the stomach and intestines, pancreatic enzymes, bile, and normal bacterial flora inhibit infection. Peristaltic action mechanically empties pathogenic microorganisms.

In the bloodstream, white blood cells called macrophages and neutrophils try to destroy foreign antigens. In the tissues, wandering tissue macrophages rush to an area of contamination and indiscriminately destroy the invading molecules.

The human body has a highly complex immune system that reacts to specific invaders able to bypass the nonspecific body defenses by forming antigens. Antigens are foreign or unrecognizable organic substances that invade the body and induce it to produce antibodies. An antibody is a protein substance produced by a particular white blood cell, the lymphocyte or, more specifically, the B-cell. B-cells work with other lymphocytes called T-cells, macrophages, and neutrophils. Together, the components of this highly complex system attempt to destroy invading antigens. Antibodies may also be called immunoglobulins (Ig). Antibodies in the bloodstream and in other body systems react against specific antigens to produce an immunity to further infection by a particular antigen.

Antibodies are also found in human tears, saliva, and colostrum. Colostrum is the fluid initially secreted from the mammary glands of a new mother. If given to the infant during breast feeding, it protects the infant during its early months of life because it contains antibodies and some lymphocytes that the newborn infant's body is not capable of producing for itself.

Humans are born with immunity to some diseases and may also acquire an immunity by actually having the disease and producing antibodies that prevent re-infection. Vaccination with dead or weakened strains of the infecting microorganism (called attenuated vaccine) or their products also effects immunity. These methods of achieving immunity are called *active immunity.*

Passive immunity may be acquired by injection of antibodies of a particular infection into an individual, or they may be passed from mother to fetus in utero to protect the infant until the neonatal immune system is mature enough to function. Passive immunity is a short-term immunity because as the injected or transmitted antibodies are broken down, they are not replaced.

Occasionally antibodies function as antigens and produce diseases called *autoimmune diseases.* This occurs when substances identical to one's own tissues stimulate antibody production and these substances react with the host's tissues in an adverse manner. In other words, one's own antibodies destroy healthy tissue.

If the body is unable to ward off invading microbes initially, a second line of defense, a process called an inflammatory reaction, begins. This process includes cellular secretion of interferon, prostaglandins, and histamine. It is followed by the activation of serum proteins, chemical changes, and phagocytosis. Phagocytosis is a process in which invading particles are surrounded and "swallowed" by particular white blood cells. The toxic particles are then neutralized, debris is disposed of, and damage to the cell is repaired.

When viruses invade the body, a substance called interferon is produced. Interferons are specific to a particular host. That is, interferon produced by one individual is not effective in another; however, it is not specific to a particular virus in the host. When a virus infects a cell, interferon is secreted in small amounts and leads to the formation of enzymes which produce antiviral activity.

Interferon can now be produced in laboratories for clinical use. Its clinical uses are still in the experimental phase, but interferon is known to be effective against some herpes infections and chronic hepatitis B. Its use in the treatment of cancer is still in the trial phase but it shows promise as a chemotherapeutic agent.

The Process of Infection

Infection invades the body in a progressive manner, that is, "in stages." Although some diseases are considered to be infectious (contagious or communicable) during only one or two of their stages, the radiographer should deal with all diseases as if they were highly infectious at all stages, since it is difficult to be certain of the period of infectivity.

The first stage in the course of an infection is the latent period. This is the stage at which the pathogenic microorganism enters the body and lies dormant. The dormant period ends when the microbe begins to shed. At this point, the disease becomes communicable. The second stage is the incubation period. During this phase, the microbe reproduces and the disease process begins. The third stage is the actual disease period, when the signs and symptoms of the disease may reach their fullest extent or produce only vague, subclinical symptoms. The disease is most communicable during this phase.

The fourth stage is the period of convalescence. During this phase, symptoms begin to diminish and eventually disappear. Some diseases go into a latent stage and reoccur from time to time. These diseases may or may not be communicable during their latent periods and then again become contagious when the symptoms exacerbate. Malaria, tuberculosis, gonorrhea, genital herpes, and type I herpes are examples of such diseases. Although many infectious diseases are not communicable during a latent phase, the radiographer should continue to assume that they are for his own, his coworkers', and his patients' safety.

There are varying signs and symptoms of infectious diseases; however, symptoms common to most are fatigue, malaise, anorexia, weakness, general aches and pains, and fever. Fever, in general, is a protective mechanism. The nervous system regulates body temperature and when the body is threatened by disease, pyrogens (agents produced by the body's immune system or by the pathogenic microorganisms themselves) send a message to the body's heat-regulating system to increase its temperature. The increase in temperature increases the metabolic rate of the body and hastens the assistance of phagocytes and lymphocytes. Unfortunately, when a body temperature increase is too intense, delirium, convulsions, and irreversible cell damage may result.

IMMUNODEFICIENCY

A person whose body does not adequately defend itself against disease is said to be *immunodeficient.* This condition may be present at birth or may occur as the result of medical treatment, disease, injury, or an unknown cause later in life. A person who has this problem is said to be immunocompromised and is unable to neutralize, destroy, or eliminate invading antigens. These conditions are usually chronic with no known treatment. The immunocompromised person has frequent, sometimes life-threatening infections. HIV, which causes AIDS, is an example of an infection that can have disastrous consequences for the body's immune system.

Agencies Controlling Institutional Safety

There are international, federal, state, and local agencies that control safety in health care agencies. They are licensed to prevent infection, illness, and injury to patients, staff, and the public. It is required by law that incidents of particular diseases or health care problems be reported by public health agencies, physicians' offices, school health offices, outpatient clinics, long-term care facilities, and acute care facilities. This information is used to formulate statistical data on the incidence of infection and other health care problems for use in preventing epidemics and other problems in health care. The agencies that the radiographer is most likely to encounter in his work are as follows:

Joint Commission on Accreditation of Healthcare Organizations (JCAHO): Sets requirements for hospital safety, infection-control practices, and patient care that must be met if the institution is to receive accreditation.

Centers for Disease Control and Prevention (CDC): Does basic research and compiles statistical data concerning infectious disease based on information received from local practitioners and agencies; conducts large, multicenter studies on diseases based on statistical data; and publishes a weekly outline of statistics on infectious diseases called *Morbidity and Mortality Weekly Report* for infection control officers.

World Health Organization (WHO): Receives data concerning infectious diseases from all countries and compiles this information into reports for every country.

Food and Drug Administration (FDA): An agency of the Department of Health and Human Services organized to regulate the manufacture and sale of medications to protect the public's health. Requires that preclinical tests for toxicity of new drugs be performed on animals and that the effects of the medication then be tested clinically on humans in three phases prior to marketing.

Occupational Safety and Health Administration (OSHA): A federal agency that protects workers from work-related injuries or illnesses. Regulations are made and enforced by this agency.

Human Immunodeficiency Virus (HIV)

Because HIV and AIDS are critical health conditions that have a huge impact on health care workers, it is necessary for the radiographer to understand the underlying disease process.

HIV usually results in AIDS, a disease that currently is incurable and has a high mortality rate.

Before it was understood how the spread of HIV could be controlled, health care workers were insecure, and in some cases frightened, when caring for persons known to be infected with HIV or who had symptoms of AIDS. They were also frightened of caring for potential HIV-positive carriers who had not yet been identified as being infected with this virus.

HIV is a retrovirus. This means that it converts its viral material from RNA to DNA after penetrating the host cell. Retroviruses have an enzyme complex called *reverse transcriptase,* which boosts their ability to replicate and destroy the host cell. Once the host has been destroyed, it then leaves to infect other cells. As retroviruses in the body increase in number, they begin to destroy the cells of the immune system. The infected T4 cells malfunction and cause the entire immune system to lose its ability to protect the body from infections.

There are two known subtypes of HIV: HIV-1 and HIV-2. HIV-1 is the virus most commonly isolated in most parts of the world. HIV-2 is found in West Africa and causes a somewhat different illness that occurs primarily in heterosexual populations. Infected females transmit the infection to their children at birth or in utero, which ultimately results in a large number of HIV-infected children.

PHASES OF HIV INFECTION

HIV enters the body and begins its gradual assault on the human immune system. The process of infection has been divided into five phases. It is not until the infected person reaches the fifth phase that he is diagnosed as having AIDS. The CDC has established criteria for reporting persons with AIDS based on a uniformity of symptoms. The five phases of the HIV infection process are as follows:

Phase 1: HIV enters the body and replicates in the bloodstream. During this time there may be no signs of infection and laboratory tests may not indicate HIV infection; however, HIV is transmissible during this phase.

Phase 2: A brief period of illness that may mimic "flu-like" symptoms. The infected individual may have enlarged lymph nodes, fever, a skin rash, and malaise. Occasionally, during this phase more severe symptoms may occur. These might include headache, high fever, stiff neck, seizures, and an altered level of consciousness. At this time there are sufficient detectable antibodies for diagnosis of HIV infection. Unfortunately, most persons at this phase attribute their brief illness to a simple viral infection and, as a result, do not receive HIV testing. They may, therefore, continue to transmit the virus without knowing it.

Phase 3: There are no external symptoms of illness. This phase may last from 1 to 20 years and is called the asymptomatic phase; however, the immune function of the body is declining during this phase and T lymphocytes (also called CD4+ cells) are decreasing in number.

Phase 4: The infected individual develops persistently enlarged lymph nodes (lymphadenopathy); has low-grade fevers, night sweats, mouth lesions, weight loss, and rashes; fatigues easily; and develops changes in cognition and peripheral neuropathy.

Phase 5: During this phase, the infected individual has become immunosuppressed and meets the criteria for the diagnosis of AIDS set by the CDC. Of persons with this diagnosis, 80% to 90% die within 3 years. The diagnosis includes all persons who have a CD4+ T lymphocyte count of less than 200 cells/mm. The infected person suffers from multiple opportunistic viral, protozoal, and bacterial infections as well as cancer. Some of the infectious diseases commonly seen in persons with AIDS are *Pneumocystis carinii,* a type of pneumonia; cytomegalovirus infection; *Candida;* and herpes simplex. Kaposi's sarcoma (a malignant tumor of the endothelium), AIDS dementia complex (in which it is believed nerve cells are directly attacked, resulting in dementia), tuberculosis, and many other diseases are also seen in the AIDS patient.

HIV is a bloodborne infection that may be transmitted through sexual contact (heterosexual or homosexual); by transfusion of contaminated blood; by use of contaminated needles; by exposure to infected body fluids on mucous membranes or in open lesions; or from mother to child in utero, at delivery, or through breast feeding.

Worldwide, the transmission of HIV occurs predominantly through heterosexual contact. In the United States, 57% of males with AIDS have had homosexual and bisexual contact. The incidence of AIDS in the United States has increased 3.6% for males and 15% for females. Persons of both sexes who have used illegal intravenous drugs constitute 22% of AIDS victims.

The incidence of AIDS among health care workers contracted in their work situation is extremely low; however, it has occurred and must be considered at all times by the radiographer at work. The most frequent accidents in health care settings that have resulted in the health care worker con-

tracting HIV have been needle-stick accidents. There was also an infection with HIV following a health care worker's exposure to infected blood on her skin while caring for an emergency patient. To prevent HIV infection, health care workers must follow at all times the universal blood and body fluid precautions listed later in this chapter. Safeguards must also be used to protect oneself from contracting this disease in private life by sexual contact or by illegal drug use.

When a patient with AIDS comes to the diagnostic imaging department for treatment or diagnosis, the radiographer must treat this person in the same nonjudgmental and professional manner that he would any other person. It must be remembered that persons with AIDS realize that they have a terminal disease and are going through the grieving process.

Health care workers who are HIV positive are a potential risk to patients for whom they are caring. They must receive special counseling and instruction prior to working in a patient care capacity. Assisting in or performing an invasive procedure in which a needle stick or scalpel cut would expose the patient to an infected health care worker's blood presents the greatest risk to the patient.

All health care workers who are HIV positive must wear gloves for direct contact with mucous membranes or broken skin of all patients. If the HIV-infected health care worker has a weeping wound or a dermatitis, he must not be involved in direct patient care.

The health care worker who is HIV positive is also more susceptible to infections to which he is exposed in the clinical setting and has a greater susceptibility to complications. He may be excluded from working in areas of direct patient care for this reason.

DIAGNOSIS AND TREATMENT

Confirmation of the presence of HIV is made most often by analyzing the blood for HIV antibodies. The initial test for HIV infection is done to screen for enzyme-linked immunosorbent assay (ELISA). If the ELISA is positive, the test is repeated on the same blood sample because there are a significant number of false positive results from this examination. If ELISA is positive a second time, a test called the Western Blot test is performed on the same blood sample. It may take up to 6 months for HIV to be detected in the bloodstream. During this time, a person who is HIV positive may infect another person.

There are a number of other laboratory tests for HIV antibodies or antigen. Some of these can detect the presence of HIV earlier; however, they are more laborious. Those mentioned above are the most widely used for HIV screening. It must be remembered that these tests indicate only that the person has been infected with HIV, not that he has AIDS.

At present there is no cure for AIDS; however, it has been demonstrated that early detection of HIV and early initiation of treatment can delay the onset of serious illness. In the years that the infected person is being treated, perhaps a definitive cure may be found.

The person infected with HIV is treated with antiviral drugs, either singly or in combination. At present, the most common drugs used are zidovudine (AZT or Retrovir); dideoxyinosine (ddI, Videx); and dideoxycytidine (ddC, Hivid). There are several new drugs and vaccines being tested that are promising. They have not, as yet, received FDA approval. The conditions and diseases that present as the immune system is suppressed are treated medically as current therapy indicates. For example, infections such as *Pneumocystis carinii* pneumonia and *Mycobacterium avium* complex, which are opportunistic diseases contracted by many AIDS patients, currently are treated with antibacterial and antifungal drugs.

The patient with HIV is also monitored to ascertain his immune status. The level of CD4+ T cells are tested as these are the cells destroyed by HIV. Initially, following diagnosis, a CD4+ T cell count is done to establish a baseline and thereafter obtained periodically to measure disease progression. Persons who are HIV positive and have a normal CD4+ T lymphocyte count can live a number of years symptom free.

Educating HIV-positive persons is an important part of treatment. They need to understand the slow progression of the disease, its potential for infecting others, and the need to be treated to retard disease progression. Since this virus may be transmitted by sexual contact, the individual must also be instructed to avoid behaviors that can infect others.

The radiographer must remember that the patient with HIV infection or with AIDS has a right to confidentiality in regard to his diagnosis. Maintenance of strict confidentiality is mandatory when caring for persons with a known AIDS diagnosis or with a patient who is known to have an HIV-positive blood test. In some areas of the United States, violation of the patient's right to confidentiality concerning this issue is punishable by fine and, in some cases, imprisonment. The chart of a patient containing information concerning an AIDS diagnosis or HIV-positive test must be

kept in a place where it cannot be inspected by anyone other than the persons directly caring for that patient. The radiographer must not discuss the diagnosis with anyone other than the patient's immediate caregivers. Patients who are HIV positive and are not ill feel that their livelihood or status in their family or in the community are threatened if this confidentiality is violated.

If a health care worker is accidentally exposed to HIV while working with a patient diagnosed with HIV or AIDS, he must report the incident to his superior immediately. If a radiographer receives a needle stick or other penetrating injury while working, he must report the incident and follow the policy of his institution and of the state in which he resides concerning testing to determine the HIV status of the person to whose blood he was exposed.

Universal Precautions and Body Substance Isolation

Blood and body fluid precautions were formulated and prescribed by the CDC and the U. S. Department of Health and Human Services for all persons working in situations where they might come into direct contact with human blood or body fluids. The threat of HIV and hepatitis B infection, two highly infectious diseases, was the impetus for these guidelines. The rationale for instituting universal precautions was to relieve health care workers of the unnecessary burden and the unreliable results of trying to differentiate persons infected with these diseases from those who are not. Universal precautions work because they are based on the assumption that every patient is already infected with HIV or hepatitis B. Strict adherence to these principles greatly reduces the threat of infection by forcing health care workers to handle all body fluids and substances with extreme care.

Infection with hepatitis B (HBV), a bloodborne virus, is more common than HIV infection and affects a greater number of persons in the health care field each year. HBV is one of five viruses that cause liver disease. This is a serious and sometimes fatal illness that may be contracted by exposure to the blood of a carrier of the disease and can be transmitted in the health care setting by a needle stick or other penetrating injury. HBV is spread by sharing contaminated needles or by intimate contact.

OSHA amended federal regulations concerning infection control in the workplace to state that all workplaces in which employees may be exposed to human blood or other body fluids shall formulate a plan to control employee exposure to pathogenic microorganisms borne by these fluids. This plan was to be implemented in all workplaces in which these infections were likely to crop up by spring of 1992. A copy of this plan is to be available for review by all employees, and the employer is obliged to provide methods and materials necessary for compliance with the plan.

Gloves, gowns, goggles, and methods to dispose of syringes and needles without recapping, as well as immunization against hepatitis B, and follow-up care for employees inadvertently exposed to bloodborne and body-fluid–borne pathogens, are to be provided by all employers to whom these regulations pertain. Other requirements include stamping warning labels in orange or orange-red on containers of regulated waste, refrigerators, freezers, and other containers used to store or transport blood or other potentially infectious material. Either use of universal precautions for all specimens or warning labels on potentially infectious specimens is required. Annual training, and documentation thereof, for employees concerning universal precautions is mandatory. Confidential records must be kept on any employee who has been exposed to bloodborne pathogens in the workplace for the duration of his employment and for 30 years after exposure.

Needle-stick injuries in health care continue to be a threat regardless of the rules instituted to prevent them, such as not recapping needles and always using gloves. Latex gloves are superior to vinyl gloves in withstanding accidental needle sticks; however, needle sticks may penetrate any glove. Newer and stronger gloves with added chemical protection against infection are now being manufactured. The Food and Drug Administration is authorized to test all gloves manufactured for production quality.

All health care workers, without exception, are now obliged to follow universal precautions or body substance isolation guidelines. If an employee or the institution in which he is employed is remiss in this activity, legal action can be used to enforce these rules (Federal Register, 1991).

The radiographer must be aware of these precautions and use the method that is implemented in his workplace. The variations are as follows:

Universal precautions apply to the following potentially infectious materials: blood, semen, vaginal secretions, cerebrospinal fluid, and pleural fluid; body substances in which blood is visible; any unidentifiable body fluid; and saliva from dental procedures.

Body substance isolation procedures define all body fluids and substances as infectious (National Safety Council, 1993). Body substances and fluids that may be infectious include vaginal secretions, semen, breast milk, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid. Urine, feces, nasal secretions, tears, saliva, perspiration, sputum, and any purulent or nonpurulent drainage from wounds are also considered potentially infectious.

During the course of a regular work day, a wide range of procedures that the radiographer performs involve exposure to blood or body substances. By adhering to these precautions, the radiographer can protect himself, the patient, his coworkers, and others from infection.

For convenience, this text uses body substance isolation as the infection prevention technique of choice; it is a simple matter to adapt these procedures in the event that universal precautions are preferred by your employer. All health care workers should routinely follow these precautions any time there is a possibility of having their skin or mucous membranes splashed with any person's blood or body substances. Use of this procedure eliminates the need for a category of isolation later described called "blood and body fluid precautions." Body substance isolation precautions are as follows:

1. Gloves should be worn for touching blood, body fluids, mucous membranes, or nonintact skin of any patient.
2. Gloves should be worn for handling items or touching surfaces soiled with blood or body fluids. This includes radiographic examinations and treatment.
3. Gloves should be changed and hands washed after each patient contact.
4. Masks or face shields and eye protection should be used any time that there is a chance splashes or droplets of blood or body fluid may touch the face or eyes.
5. Gowns and impermeable aprons must be worn when clothing is likely to become soiled by splashes of blood or body fluids.
6. Great care must be taken to avoid needle sticks or cuts from scalpel blades or other sharp instruments that are used for penetrating the skin.
7. Hypodermic needles should not be recapped, bent, broken, or separated from the syringe. Immediately after use, they must be placed in a puncture-resistant container meant for this purpose (Fig. 3–9).
8. Puncture-resistant containers for used equipment must be readily available throughout the hospital or diagnostic imaging department.
9. Items that are to be reused must be placed in a designated puncture-resistant container for transport to the area designated for recleaning.
10. Mouthpieces and resuscitation bags must be kept in all diagnostic imaging examination and treatment rooms so that mouth-to-mouth contact with the patient can be avoided in the event of cardiopulmonary resuscitation (Fig. 3–10).

There are times in the imaging department when invasive procedures are necessary. A procedure is invasive if it involves penetration of body tissues, cavities, or organs for diagnosis, surgery, or repair of traumatic injuries. Invasive procedures also include cardiac and arterial catheterizations or other angiographic procedures performed in diagnostic imaging. Dentistry also involves invasive procedures. Special barrier precautions should be taken by all participants in such procedures to prevent contact of health workers' skin and mucous membranes with blood and body fluids. These special barrier precautions include the following:

1. Wearing gloves, surgical masks, and face shields.



Figure 3–9
Place used needle uncapped into a puncture-resistant container.



Figure 3–10
Use a protective mask with a mouthpiece to perform cardiopulmonary resuscitation.

2. Wearing a gown and protective apron made of impermeable material.
3. If a glove is torn or other injury occurs during an invasive procedure, the glove must be removed and replaced with a new glove as soon as safely possible.
4. Needles or instruments that have caused injury to a health care worker must be removed from the field.
5. The health care worker must be cared for according to institutional policy as quickly as possible following a needle stick or other injury.

A patient may not be familiar with these relatively new requirements and may feel that the health care worker questions his sanitation practices when he sees them wearing gloves or other protective items. The health care worker must inform the patient concerning these required precautions and make the patient understand that these precautions also protect him from infection by the health care worker.

Techniques of Infection Control

Controlling infection or breaking the cycle of infection is the duty of all health care workers. Medical aseptic practices and use of universal blood and body fluid precautions must become routine for the radiographer.

People who are ill are particularly susceptible to infection. It is the radiographer's duty to practice strict medical asepsis at all times in his work. There is a difference between medical asepsis and surgical asepsis. *Medical asepsis* means that insofar as possible, microorganisms have been eliminated through the use of soap, water, friction, and various chemical disinfectants. *Surgical asepsis* means that microorganisms and their spores have been completely destroyed by means of heat or by a chemical process. It is not practical or necessary to practice surgical asepsis at all times, but one must always adhere to the practice of strict medical asepsis.

Most health care institutions now require that all students and staff involved in patient care be immunized or show proof of immunity to hepatitis B, rubella, rubeola, poliomyelitis, diphtheria, and tuberculosis.

Some institutions require varicella titers for health care workers.

DRESS IN THE WORKPLACE

Fingernails must be short. Shoes must have closed, hard toes. Jewelry, such as rings with stones, and cracked or chipped nail polish harbor microorganisms that are difficult to remove. These items should not be worn by the radiographer when involved in patient care. A plain wedding band and a wristwatch are the only pieces of jewelry that are acceptable for the health care worker to wear in the patient-care setting.

The radiographer should always wear freshly laundered, washable clothing when working with patients. Uniforms are recommended because they will not be worn for other purposes. Short sleeves are recommended because cuffs of uniforms are easily contaminated. If a laboratory coat is worn to protect clothing, it should be buttoned or zipped closed and removed when one is not in the work area.

Laboratory coats and uniforms must be washed daily with hot water and detergent. A chlorine

bleach is recommended for clothes that have become heavily contaminated.

A protective gown should be worn when working with any patient who may soil the health care worker's clothing or if blood or body fluids may contaminate clothing. Gowns for isolation patients are discussed later in this chapter. On some occasions, a moisture-proof apron may need to be worn along with a gown.

HAIR

Hair follicles and filaments also harbor microorganisms. Hair is a major source of staphylococcus contamination. For these reasons, hair must be worn short or in a style that keeps it up and away from your clothing and the patient. Hair should be shampooed frequently.

HAND WASHING

Microbes are most commonly spread from one person to another by human hands. It follows that the best means of preventing the spread of microorganisms is hand washing. Correct handwashing procedure before and after handling supplies used for patient care and before and after each patient contact is required even if gloves have been worn for the procedure. All blood and body fluids (secretions and excretions) must be treated as if they contain disease-producing microorganisms and be disposed of correctly. Then hands must be washed. Any exposed breaks in your skin must be covered by a waterproof protective covering. If the radiographer has an open or weeping wound, he should not be in the workplace until it has healed.

There is a specific hand-washing technique that is accepted as medically aseptic that should be followed by the radiographer when working with patients. This technique must not be confused with the surgical scrub procedure, which will be described later in this text. The medically aseptic hand-washing technique is as follows (Figs. 3–11*A* to *D*):

1. Approach the sink. Do not allow your uniform to touch the sink because the sink is considered contaminated.
2. Turn on the tap. A sink with foot or knee control is most desirable but is not always available. If the faucet is turned on by hand, use a paper towel to touch the handles, then discard the towel.
3. Regulate the water to a comfortably warm temperature.
4. Regulate the flow of water so that it does not splash from the sink.
5. During the entire procedure, keep your hands and forearms lower than your elbows. The water will drain by gravity from the area of least contamination to the area of greatest contamination.
6. Wet the hands and soap them well. Liquid soap is most convenient. When using bar soap, rinse the bar before using it and hold it during the entire procedure. The soap dish is considered contaminated; if the soap bar is replaced during the procedure and then reused, the hands will be recontaminated. Soap tissues are the most desirable method of applying soap for handwashing, but are not readily available in many institutions.
7. With a firm, circular rubbing motion, wash the palms, the backs of the hands, each finger, between the fingers, and finally the knuckles.
8. Rinse the hands well under running water.
9. Wet the wrists and forearms to the elbows. Apply soap and rub with the same circular motion.
10. Rinse, allowing the water to run down over the hands.
11. Clean the fingernails with a brush or an orange stick carefully once each day before beginning work, and again if the hands become heavily contaminated. Scrubbing heavily contaminated nails with a disposable brush is recommended.
12. Rinse the fingers well under running water.
13. Repeat the washing procedure as described above.
14. Rinse the soap well and replace it in the dish. Do not touch the sink or the soap dish.
15. Turn off the water. If the handles are hand-operated, use a paper towel to turn them off in order to avoid contamination of the hands.
16. Dry the arms and hands using as many towels as necessary to do the job well.
17. Use lotion frequently on the hands and forearms. It helps to keep the skin from cracking and therefore helps prevent infection.



Figure 3–11
(**A**) Approach the sink and turn on the tap. Do not allow your uniform to touch the sink. (**B**) Your hands and knuckles and the areas between your fingers are cleaned with a firm, rubbing motion. Continue to hold the soap while doing this. (**C**) Clean your fingernails with running water to flush away dirt and microorganisms. (**D**) Clean your wrists and forearms with a firm, circular motion, then drop the soap into the soap dish.

The foregoing procedures should be performed at the beginning of each work day, when in contact with a patient's blood or body fluids, when preparing for invasive procedures, before touching patients at greatest risk of infection, and after caring for patients with known communicable diseases. This is the case even if gloves are worn. A 30-second hand washing should precede and follow each patient contact. Time does not allow for a 2-minute hand washing every few minutes.

GLOVES

Disposable, single-use gloves are to be worn any time that the radiographer feels that he might touch a patient's blood or body fluids in the course



Figure 3–12
(**A**) Pull the first glove off by grasping it on the outside with the other gloved hand. (**B**) Hold the glove that has been removed in the remaining gloved hand. (**C**) With the bare fingers, reach inside the top of the remaining soiled glove and pull it off. (**D**) Turn the glove inside out and encase the other glove inside it. (**E**) Drop the soiled gloves into a designated waste receptacle.

of a procedure. These gloves should be readily available in containers in each treatment room. Since these gloves are to be used for medical aseptic purposes and not for surgically aseptic purposes, they may be donned simply by pulling them on after handwashing. When they are no longer needed, the gloves should be removed by use of the following technique to prevent contamination of the radiographer's hands or clothing (Fig. 3–12).

1. With the gloved right hand, take hold of the upper, outside portion of the left glove and pull it off, turning it inside out as you do so (see Fig. 3–12*A*).
2. Hold the glove that you have just removed in the palm of the remaining gloved hand (see Fig. 3–12*B*).
3. With the clean, bare index and middle fingers reach inside the top of the soiled glove and pull it off, turning it inside out and folding the first glove inside it as you do so. Be careful to touch only the inside of the glove (see Figs. 3–12*C* and *D*).
4. Drop the soiled gloves into a receptacle for contaminated waste (see Fig. 3–12*E*).
5. Wash your hands.

EYE PROTECTION

If the radiographer is in a patient-care situation in which there may be a spattering of blood or body fluids, he must wear goggles to protect his eyes from becoming contaminated. These goggles must have side protectors. If eye glasses are worn for enhancement of vision, the goggles must fit over the glasses (Fig. 3–13). Hands must be kept away from eyes during the course of work so that infection is not introduced into them.

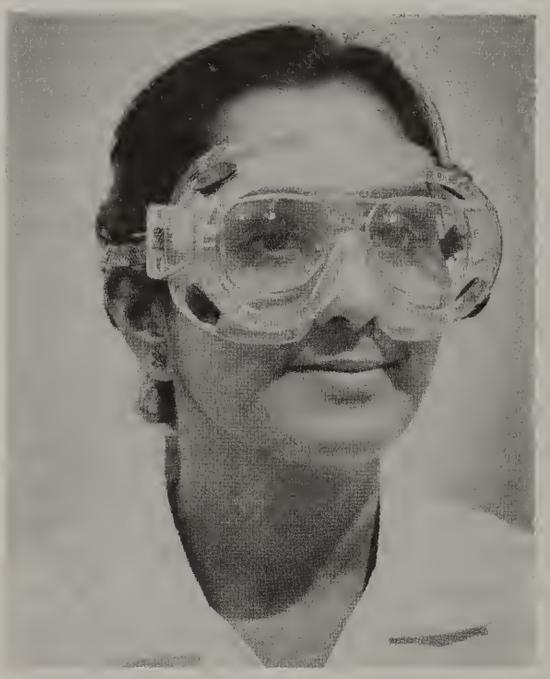


Figure 3–13
Goggles with side protection that can be worn over corrective lenses.

CLEANING AND PROPER WASTE DISPOSAL

Not all disinfectants are equally effective. Before a disinfectant is chosen for the diagnostic imaging department, it should be thoroughly studied by an infection-control consultant. Microorganisms begin to grow in disinfectant solutions left standing day after day. This is also true in liquid-soap containers. If such items are used, they should be changed and cleaned every 24 hours. A more detailed description of disinfection and sterilization methods is presented in Chapter 5. The following are guidelines for the disposal of waste or the cleaning of equipment after each patient use in the diagnostic imaging department:

1. Wear a fresh uniform each day. Do not place your uniform with other clothing in your personal closet. Shoes should be cleaned and stockings should be fresh each day.
2. Pillow coverings should be changed after each use by a patient. Linens used for drapes or blankets for patients should be handled in such a way that they do not raise dust. Dispose of linens after each use by a patient.
3. Flush away the contents of bedpans or urinals promptly unless they are being saved for a diagnostic specimen.
4. Rinse bedpans and urinals and send them to the proper place (usually a central supply area) for resterilization if they are not to be reused by the same patient.
5. Use equipment and supplies for one patient only. After the patient leaves the area, supplies must be destroyed or resterilized before being used again.
6. Keep water and supplies clean and fresh. In the radiology department it is best to use paper cups and dispose of them after a single use.
7. Floors are heavily contaminated. If an item that is to be used for patient care falls to the floor, discard it or send it to the proper department to be recleaned.

8. Avoid raising dust because it carries microorganisms. When cleaning, use a cloth thoroughly moistened with a disinfectant.

9. The radiographic table or other imaging or treatment equipment should be cleaned with a disposable disinfectant towelette or sprayed with disinfectant and wiped clean and dried from top to bottom with paper towels after each patient use.

10. When cleaning an article such as a radiographic table, start with the least soiled area and progress to the most soiled area. This prevents the cleaner areas from becoming more heavily contaminated. Use a good disinfectant cleaning agent and disposable paper cloths.

11. Place dampened or wet items such as dressings and bandages into waterproof bags and close the bags tightly before discarding them in order to prevent those handling these materials from coming in contact with bodily discharges.

12. Do not reuse rags or mops for cleaning until they have been properly disinfected and dried.

13. Pour liquids to be discarded directly into drains or toilets. Avoid splashing or spilling them on clothing.

14. If in doubt about the cleanliness or sterility of an item, do not use it.

15. When an article that is known to be contaminated with virulent microorganisms is to be sent to a central supply area for cleaning and resterilizing, it should be placed in a sealed, impermeable bag and marked "contaminated." If the outside of the bag becomes contaminated while the article is being placed in the bag, a second bag should be placed over it (Fig. 3–14).

16. Needles and syringes used in the diagnostic imaging department should always be treated as if they are contaminated with virulent microbes. Needles should not be recapped or touched after use and should be placed immediately (needle first) in a puncture-proof container labeled for this purpose. No attempt should be made to bend or break used needles because they may stick or spray the health care worker in the process.

17. Specimens to be sent to the laboratory should be placed in solid containers with secure caps. If the specimen is from a patient with a known communicable disease, the outside of the container must be labeled as such. Avoid contaminating the outside of the container, and place the container in a clean bag. If a container should become contaminated, it must be cleaned with a disinfectant before placing it in the bag. Specimens must be sent to the laboratory after collection for examination (Fig. 3–15).

18. Medical charts that accompany patients to the diagnostic imaging department must be kept away from patient-care areas to prevent contamination. Keep charts in an area where only those directly involved in patient care may read them.



Figure 3–14
Place contaminated bag into a second bag that is not contaminated.



Figure 3–15
Specimens must be sent to the laboratory in a clean container and then encased in an outer bag.

DISINFECTION

Disinfection is a term used to describe the removal, by mechanical and chemical processes, of pathogenic microorganisms, but frequently not their spores, from objects or body surfaces. Usually in reference to body surfaces, the term *antisepsis* or *antiseptic* is used rather than disinfect or disinfectant. Items are disinfected when they cannot withstand the process necessary to sterilize them or when it is not practical to sterilize. This is often the case with objects leaving an isolation unit. If an object leaving an examining room or isolation unit has been contaminated, it is cleaned first by vigorous scrubbing (mechanical means) and then disinfected by wiping it with, or soaking it in, a chemical selected by the institution for this purpose.

When a patient enters the diagnostic imaging department and the radiographer knows or suspects that the patient has a contagious disease, it is his responsibility to prevent the spread of infection. If the patient is coughing and sneezing, the radiographer must provide him with tissues and a place to dispose of them. He should instruct the patient to cough and sneeze into the tissues and then discard them safely. The patient should be removed from a crowded waiting room in order to prevent infecting other persons. The radiographer should put on a gown in order to protect his uniform. A mask and goggles should be donned if necessary. The patient should be cared for and returned to his room or discharged as quickly as possible.

After the patient has been cared for and leaves the department, the radiographer must wash his hands thoroughly and then disinfect the radiographic table and anything in the room that the patient has touched. This can be accomplished with a disinfectant solution. The radiographer should then remove his gown, goggles, and gloves, and scrub his hands again.

ADDITIONAL INFECTION-CONTROL TECHNIQUES

Universal precautions or body substance isolation are to be used by all health care personnel when caring for all patients. There are particular diseases that require the radiographer to take additional precautions to prevent infection of health care workers and to keep the disease from spreading to other patients. These precautions may be called *barrier precautions* or *isolation precautions.*

The CDC isolation guidelines describe these techniques as *category-specific isolation* and *disease-specific isolation.* Infection control teams in every institution select the method that is most effective for their purposes. These two techniques have been simplified and formatted as instruction cards, which are posted outside of rooms, for the use of staff and visitors. These instruction cards list the isolation requirements to be observed and are categorized as follows:

CATEGORY-SPECIFIC ISOLATION This method groups diseases requiring similar isolation precautions together according to the commonality of method of transmission. For instance, hepatitis B and AIDS are both categorized with diseases requiring blood and body substance precautions under universal precautions.

For this method, category-specific precautions are posted outside the patient's room with the requirements necessary for the particular situation (Fig. 3–16). The disadvantage of these precautions is that the broad disease categories in this group may result in overisolation. The categories are listed in Table 3–1.

DISEASE-SPECIFIC ISOLATION Institutions that use the disease-specific method of isolation place on the door to the patient's room a card that lists all possible isolation specifications for any infectious disease. They would include gown, gloves, mask, goggles, and private room. The infection control officer in the institution checks which items will prevent transmission of the disease in question. This is an efficient method of isolating infectious diseases. However, it requires additional staffing and education and may not be affordable in all institutions.

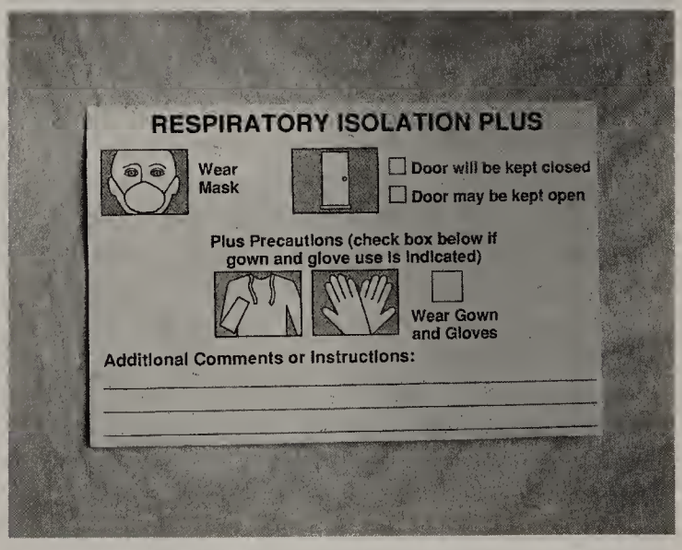


Figure 3–16
Category-specific poster.

TABLE 3–1
Category-Specific Precautions

Category	Private Room	Mask	Gown	Gloves	Examples of Diseases
Drainage secretion precautions	No	No	If soiling possible	Yes, if touching infected sites	Abscesses, wounds, burns not requiring protective isolation
Enteric precautions	If patient has poor hygienic practices	No	If soiling possible	Yes, if touching infectious material	Diarrhea of suspected etiologies, viral meningitis, hepatitis A, cholera
Acid-fast bacteria isolation	Always	Yes	Only for gross contamination	As for universal precautions	Tuberculosis (pulmonary and pharyngeal); measles, mumps, pertussis, pneumonia, meningococcal meningitis; methicillin-resistant *Staphyloccus aureus;* scabies, rabies, herpes simplex
Respiratory	Always	For close contact	No	As for universal precautions	
Contact isolation	Always	For close contact	If soiling possible	As for universal precautions	
Strict isolation	Always	Always	Always	Always	Varicella-zoster (chickenpox); pharyngeal diptheria; zoster (shingles, in immunocompromised patients)
Blood and body substance precautions	If patient has poor hygienic practices	If contact with blood or body fluids is possible	If splashing with blood or body fluids is possible	If contact with blood or body fluids is possible	AIDS, hepatitis B and C; malaria

Methods of Isolation Precautions

Isolation or barrier precautions separate the patient who has a contagious illness from other hospitalized patients. This separation may be accomplished in a hospital ward or in a private hospital room. The option chosen depends on how the pathogenic microorganisms are transmitted and the reliability of the patient with the disease. If the patient is very young or cannot be relied upon to use necessary hygienic practices to control infection, he must be isolated in a private room.

If a disease can be transmitted only by direct contact, the reliable patient may remain in a ward or room with other patients. If the disease is spread by an airborne route, a private room is necessary; however, two patients having the same disease may share a room.

Drainage-secretion precautions are used to prevent infections that are transmitted by direct or indirect contact with purulent material, drainage, or secretions from an infected site on the body. Enteric precautions are used to prevent infection transmitted by direct or indirect contact with fecal material. Respiratory isolation is used for diseases spread by droplet contact as the patient talks, coughs, or sneezes. Contact isolation is used for diseases spread by close or direct contact. Blood and body substance isolation is used to prevent spread of diseases caused by blood or body substances and has been described in a preceding section.

The incidence of tuberculosis has increased in recent years and tubercle bacilli now have the ability to resist multidrug therapy. Factors that have led to the increase of this once controlled disease in the United States are the HIV epidemic, the increase in immigration of people from countries with a high prevalence of this disease, and the declining status of health care in this country. CDC recommends that employers educate all health care employees about tuberculosis and screen them for the disease. It also recommends environmental controls that reduce the concentration of the infectious tubercle bacilli. These controls include specially designed rooms that control air flow and masks that have special filters and fit tightly against the face (Fig. 3–17). The radiographer assigned to take portable radiographs in a room that has acid-fast precautions must plan his care with the nurse assigned to the patient before entering the room.



Figure 3–17
Duck-billed tuberculosis mask

STRICT ISOLATION

Strict isolation procedure is used for patients with diseases transported by airborne or contact routes. Microorganisms isolated by this means are highly infectious and their spread is difficult to control.

Mask, gown, and gloves are worn by all persons entering a strict isolation unit. Hand washing and decontamination of materials used for patient care are as described for other isolation categories. A private room or a room shared with another patient with the same disease is indicated. The door to the room should be kept closed.

Diseases requiring strict isolation are pharyngeal diphtheria, Lassa fever, pneumonic plague, varicella (chickenpox), and zoster (localized in immunocompromised patients or disseminated in any patient).

Strict isolation technique is also used on some occasions for patients who are themselves at high risk for infection because of a debilitated state, for immunosuppressed patients, for patients with severe burns, and for high-risk infants. This category was previously called *protective* or *reverse isolation.*

Entering and Leaving the Strict Isolation Unit

The strict isolation category generally encompasses procedures needed for all category-specific or disease-specific isolation situations. If the radiographer learns to enter and leave this type of isolation unit, he will be able to maintain the requirements of any other category or isolation with little difficulty.

Whatever isolation technique is used, the radiographer must always adhere to four basic principles when dealing with patients who have a communicable disease. They are as follows:

1. Hands are washed using the procedure prescribed earlier in this chapter.
2. All items used for patient care are sterilized, disinfected, or disposed of to prevent spread of infection.
3. Items removed from isolation rooms are bagged and labeled as contaminated before being sent for disinfection.
4. All hypodermic needles must be placed in labeled, puncture-resistant receptacles used only for this purpose. Needles must not be bent or recapped after use.

In order to enter and leave a strict isolation unit, the radiographer will need the assistance of another radiographer or a member of the nursing team who is caring for the patient in the unit. Remember that the patient who is in a strict isolation unit may feel alone and rejected. These patients are forced to remain in solitude for long periods of time and are often treated by visitors and hospital personnel as if they are undesirable. It is possible to carry out strict isolation procedure and treat the patient as a human being with dignity and worth. Before beginning your work with the patient, spend a few moments explaining the radiologic procedure to him. When the procedure is complete, allow a few moments for discussion and respond in a therapeutic manner to any questions that the patient may have.

When a patient is placed in a strict isolation unit in the hospital setting, a special room is set aside for this purpose. At the entrance to the room there is a sink for hand washing, a stack of paper or cloth gowns, a container for masks and caps, and a box filled with clean, disposable gloves. Many items in the isolation unit that are used for patient care remain in the unit until the patient leaves it.

Before entering the isolation room, the radiographer must have the portable radiographic machine prepared with as many cassettes as are needed on hand. Protective plastic cases must cover the cassettes to keep them from becoming contaminated. Extra pairs of clean gloves should also be placed on the machine before placing it in the patient's room. Have an assistant available and then use the following procedure (Fig. 3–18):

1. Assemble supplies and equipment needed.
   Rationale: Prevents loss of time and reduces risk of breaking isolation procedure.
2. Stop in area where you will don your protective clothing. Remove any jewelry that you



Figure 3–18
(**A**) Pin jewelry or watches inside your uniform pocket before preparing to enter an isolation room. (**B**) If your hair touches your collar, a protective cap must be donned. (**C**) Cover your nose and mouth with a mask. (**D**) Put on lead apron before gown. (**E**) Put on the gown by placing arms into sleeves and working it on. (**F**) Tie the gown in back and make certain that the back of your uniform is completely covered. (**G**) Make certain that the cuffs of the gloves cover the cuffs of the gown. (**H**) Put extra gloves on the machine before entering the room.

are wearing and pin it into your uniform pocket so it will not be lost (see Fig. 3–18*A*).

3. Wash your hands as for medical aseptic practice.
   Rationale for steps 2 and 3: Prevent transmission of microorganisms.
4. If your hair touches your collar, you must wear a cap (see Fig. 3–18*B*).
   Rationale: Hair collects and transmits microorganisms.
5. Remove a mask from the container and put it on, making certain that it covers mouth and nose tightly (see Fig. 3–18*C*). Put on lead apron (see Fig. 3–18*D*).
6. Take a gown from the stack. Hold it in front of you and let it unfold. Place your arms into









Figure 3–18 ***(Continued)***

the sleeves and pull it on at the shoulders (see Fig. 3–18*E*).

7. Tie the back of the gown, making certain that the gown covers all of your clothing (see Fig. 3–18*F*).
8. Put gloves on, making certain that the cuffs of the gloves cover the cuffs of the gown (see Fig. 3–18*G*). Put extra gloves on machine (see Fig. 3–18*H*).
   Rationale for steps 5, 6, 7, 8: Protect patient from microorganisms that might be transmitted from radiographer to patient and protect the radiographer from being infected by infectious microorganisms from patient.
9. Push machine into the room; introduce yourself to the patient and explain the procedure. Make necessary adjustments to the machine at this time.
   Rationale: The patient's anxiety will be reduced if he understands what is to occur. It also gives the patient the opportunity to refuse the procedure if he chooses to do so. Once you have touched the patient, you must change gloves before touching the machine again.
10. Place the cassette for the exposure (Fig. 3–19).
11. Remove contaminated gloves as described earlier in this chapter and discard them in a waste receptacle.
12. Put on clean gloves that were placed on the portable machine before entering the room.
    Rationale for steps 10, 11, and 12: Once you have touched the patient, your gloves are contaminated. To prevent the machine from being contaminated, change gloves before touching it.
13. Make the exposure. If additional exposures are necessary, it may be necessary to change gloves again. Place cassettes in contaminated plastic covers at the end of the patient's bed or on a bedside stand.
    Rationale: The machine is not to be touched with contaminated gloves or it will be contaminated. The cassettes that have been placed near or against the patient are contaminated and cannot be replaced in the portable machine until the plastic covers are removed.
14. When radiographic exposures are completed and before you contaminate your gloves by removing the last cassette, push the machine out of the room and notify your assistant to prepare to receive the cassettes.
15. Take the covered cassette or cassettes to the door of the unit where your assistant is waiting. Slide the plastic covering back from the cassette and allow the assistant to remove it. Discard the contaminated cassette cover in the waste receptacle in the patient's room (Fig. 3–20).
    Rationale: prevents contamination of cassettes that must be taken to another part of the hospital for processing.
16. Return to the patient. Make him comfortable. Place the bed in the low (closest to the floor) position, put the side rails up and the call button in the patient's reach.
    Rationale: The patient's safety and comfort are the highest priority and must always be every health care worker's first concern.
17. Leave the patient's room and return to the area prepared to receive your contaminated garments.



Figure 3–19
Place the cassette under the patient.



Figure 3–20
Slide the cassette from its covering and allow the assistant to take it.



Figure 3–21
Untie lower waist ties with gloves on.

a. Untie waist ties of gown (Fig. 3–21).
b. Remove your gloves according to the procedure for removing contaminated gloves and place them in the waste receptacle.
c. Untie mask strings and top gown ties and drop mask into waste receptacle touching only the strings.



Figure 3–22
Remove the cap without touching your hair.



Figure 3–23
Remove the first sleeve of the gown by placing your bare hand under the cuff of the sleeve and pulling it over the hand.

d. Pull off cap, if cap was worn (Fig. 3–22).
e. Remove the first sleeve of the gown by placing your fingers under the cuff of the sleeve and pulling it over the hand (Fig. 3–23).
f. Remove the other sleeve with your protected hand inside the gown (Fig. 3–24).
g. Slip out of the gown and fold it forward so that the inside of the gown is facing the outside (Fig. 3–25).

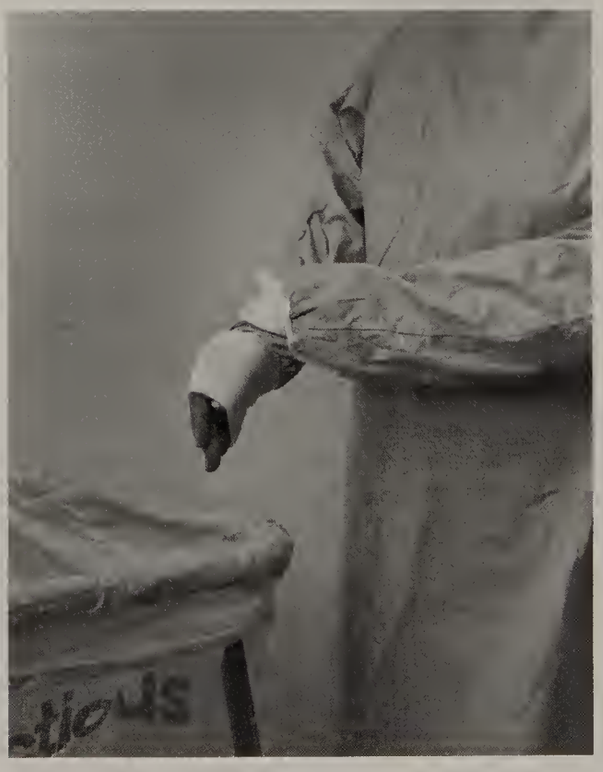


Figure 3–24
Remove second sleeve with protected hand.



Figure 3–25
Fold the soiled gown inside out and away from you.

h. Drop the soiled gown into the receptacle provided for it.

Rationale for steps 17 a, b, c, d, e, f, g: Contaminated items must be removed in a manner that protects the radiographer from contamination.

18. Wash your hands for 2 minutes.
Rationale: Remove possible infectious microorganisms.

19. Clean the portable machine by spraying it with a disinfectant and wiping it with paper towels. Discard paper towels in receptacle for contaminated waste. Wash your hands for 30 seconds.
Rationale: Removes any possible contaminants from machine and hands.

TRANSFERRING THE PATIENT WITH A COMMUNICABLE DISEASE

Occasionally, it is necessary for a patient with a communicable disease to come to the diagnostic imaging department for radiographs or treatment. Precautions must be taken to prevent infecting anyone else and also to prevent contaminating a room or the equipment.

1. The patient must be transported by wheelchair or by gurney. If he has a disease that may be transmitted by droplet, airborne, or contact route, place a mask properly on his face and wear a gown and mask to protect yourself. (Patients with tuberculosis must wear special masks as hospital policy directs.)
2. Place a sheet on the gurney or wheelchair, then cover it completely with a cotton blanket. Transfer the patient and wrap the cotton blanket around him (Fig. 3–26).
3. When the patient arrives at his destination, open the blanket without touching the inside.
4. Place a protective sheet on the radiographic table, transfer the patient to the table, and place a draw sheet over him. Make the necessary exposures. Arrange your work so that the patient does not have to spend any more time than is necessary in the department.
5. Return the patient to the wheelchair or gurney. Wrap the cotton blanket around him and return him to his room.
6. Adjust the bed to the position that is lowest to the floor, put the side rails of the bed up, and give the patient the call button.



Figure 3–26
Place a mask on the patient with an infectious disease before transferring her.

7. Notify the ward personnel that the patient has returned.
8. Once outside the patient's room, dispose of the soiled sheet and blanket and wash your hands. Untie your gown and remove it as described. Clean the wheelchair or gurney with disinfectant, then rewash your hands.
9. Return to the diagnostic imaging department and clean the table and all of the equipment that was used. Again, wash your hands.

Summary

Infection control is the obligation of all persons entering a health care facility. This includes hospital personnel, patients, and their visitors. Radiographers must learn the concepts and procedures for infection control, including universal blood and body fluid precautions, before beginning to work in their chosen specialty area. It is their legal and ethical obligation to practice these procedures in all health care situations in order to prevent nosocomial infections and the spread of infectious diseases.

Nosocomial infections are caused by four basic types of microorganisms: bacteria, fungi, parasites, and viruses. Various forms of these microbes produce "hospital infections," which are becoming increasingly difficult to control in spite of the body's own elaborate defenses against disease. This may be due to the hospital environment, the patient's therapeutic regimen, or the lowered resistance of the patient to infectious agents.

The elements needed to transmit an infection are a reservoir, or an environment, in which pathogenic microbes can live and multiply; a portal of exit from the reservoir; a means of transmission; and a portal of entry into a new host. It is the radiographer's duty in his daily work to adhere strictly to infection-control techniques in order to break the cycle of infection.

The threat of HIV and the disease that it produces, AIDS; the prevalence of HBV in health care institutions; and the increasing resistance of tuberculosis to standard treatments create an increased need for the radiographer to practice strict infection-control measures. This can be done by always adhering to universal precautions or blood and body substance isolation; by hand washing between each patient care situation, and by correct disposal of waste.

There are federal, state, and local agencies that control the safety of both patients and staff in health care institutions. The radiographer must be aware of the duties of each of these agencies and of his obligation to abide by their regulations.

In his personal life, the radiographer should maintain a health care regimen that includes adequate rest, a nutritious diet, and meticulous hygienic practices. This will help him to remain healthy and infection free.

Chapter 3, Pre–Post Test

1. List and explain the three major risk factors that are related to nosocomial infection.
2. Explain some of the factors that determine the pathogenicity of microorganisms in the body.
3. Ruth Glisclock is a 6-year-old girl who was exposed to streptococcal infection 3 days ago as she played with another child at school. Later that same day, Ruth's playmate developed a sore throat and a fever. Today, Ruth has begun to complain of a sore throat and has a fever. The physician who sees Ruth informs her mother that the child has tonsillitis and he suspects a streptococcal infection. The throat culture later confirms the physician's diagnosis. Which elements needed for this bacteria to cause infection were present in this case?
   a. Pathogenicity
   b. Virulence
   c. Invasiveness
   d. a, b, and c
   e. b and c

____ **4.** Match the following agencies with their particular function:

1. Food and Drug Administration
2. Centers for Disease Control and Prevention
3. World Health Organization
4. Joint Commission on Accreditation of Healthcare Organizations

a. Conducts multicenter studies on diseases and publishes a weekly outline on the statistics of infectious diseases in the United States
b. Receives data concerning infectious disease from all countries and compiles a report for every country
c. Regulates the manufacture and sale of medications to protect health of U.S. citizens
d. Sets requirements for hospital safety and infection control practices

A **5.** An individual who has recently been infected with HIV may have no symptoms of disease but is able to transmit HIV to another person.
a. True
b. False

A **6.** HIV, or the disease that it produces, is transmitted by direct or indirect contact with infected blood or body fluids.
a. True
b. False

B **7.** The method by which all health care workers can control the transmission of bloodborne diseases is
a. Enteric precautions
b. Universal precautions
c. AFB precautions
d. Strict isolation

A **8.** The radiographer should always dress for the workplace with infection control in mind. This means
a. Clothing must be washable; fingernails must be kept short; shoes must be comfortable and have closed toes; and no jewelry is worn except a wristwatch and a wedding band.
b. The radiographer must look unattractive because anything that looks good spreads infection.
c. A scrub suit must be worn at all times.
d. The rules are to be followed when JCAHO is inspecting the institution in which you work.

9. Microorganisms that need a host cell to reproduce and are virtually unresponsive to antimicrobial drugs are
a. Bacteria
b. Fungi
c. Protozoa
d. Viruses

10. When one is in the incubation period of the disease process, the radiographer has no control over its transmission.
a. True
b. False

11. The radiographer must use strict infection-control measures that include blood and body fluid precautions
a. For every patient who enters the diagnostic imaging department
b. For patients who have known communicable diseases
c. Only for patients who have AIDS and hepatitis B
d. For patients who seem ill

12. Blood and body substance precautions include
- **a.** Use of clean, disposable gloves for sick persons
- **b.** Use of clean, disposable gloves for contact of the hands with blood or body fluids, a mask and goggles if blood or body fluids may spray on your face, and a gown if the blood and body fluids may touch your clothing, for any patient care that may involve contact with blood or body fluids
- **c.** Clean, disposable gloves as necessary
- **d.** Gown, gloves, mask, and goggles for all patient care

13. The most common means of spreading infection are
- **a.** Soiled instruments
- **b.** Infected patients
- **c.** The human hands
- **d.** Domestic animals

14. A continual threat for HIV or HBV infection for the health care worker is
- **a.** The water supply
- **b.** Careless patients who do not adhere to infection-control guidelines
- **c.** Needle-stick injuries
- **d.** Tuberculosis

15. If a radiographer is assigned to a patient who has a notice for AFB precautions posted on his door, he must
- **a.** Wear a gown and goggles when caring for the patient
- **b.** Adhere to rules of reverse or protective isolation
- **c.** Plan the patient's care with the nurse in charge of the patient before entering the room
- **d.** Wear gloves, as this is a disease spread by direct contact only

16. The elements needed to produce an infection are a source, a host, and a means of transmission. An example of a source of infection might be
- **a.** A radiography student who has a cold and comes to work
- **b.** A visitor in the hospital who has a "fever blister" on her mouth
- **c.** A patient who develops pneumonia
- **d.** a, b, and c

17. A safety precaution that must be taken when disposing of used hypodermic needles and syringes is
- **a.** To place the needles in a waste basket as soon as possible
- **b.** To recap the needle and dispose of it quickly
- **c.** To place the syringe with the uncapped needle attached directly into the contaminated waste receptacle provided for them immediately after use
- **d.** To detach the needle from the syringe and place only the needle in the contaminated waste receptacle

18. Match the following means of transmitting infection with the correct definition:

1. Touching objects that have been contaminated with disease-producing microbes
2. Ingesting contaminated water, food, drugs, or blood
3. Inhaling air contaminated with infectious microbes
4. Contact with secretions transferred by sneezing, coughing, or talking
5. Touching contaminated material with hands

- **a.** Direct contact 2
- **b.** Indirect contact 1
- **c.** Droplet contact 4
- **d.** Vehicle contact 5
- **e.** Airborne contact 3

19. List and define the six categories of isolation.

20. When caring for a patient you know to be infected with HIV who does not have AIDS, you use universal blood and body fluid precautions and
    a. Share the information with the technologist in the next room who has no contact with the patient
    b. Keep all information concerning the patient confidential
    c. Keep the patient's chart in a place where it cannot be read by others

Laboratory Reinforcement

1. In the school laboratory, demonstrate the proper method of hand washing for medical asepsis.
2. In the school laboratory, remove linens from a radiographic table that has been used for a patient with an infectious disease and demonstrate the proper method of cleaning the equipment and the table.

Critical Thinking Problems

1. Mrs. Gray is in an isolation unit on Ward B. She has staphylococcal pneumonia. Her physician has ordered radiographs of her chest. She is too ill to be transferred to the imaging department and must have the radiographs taken in her room. You are the radiographer assigned to do this. In the school laboratory, demonstrate how you will do this.
2. In the school laboratory, demonstrate transferring a patient who has a communicable respiratory disease to and from the imaging department.

4

Basic Patient Care and Safety in Radiographic Imaging

Care of Patient's Belongings
Body Mechanics
Moving and Transferring Patients
Assessing the Patient's Mobility
Methods of Moving Patients
- By Gurney
- By Wheelchair
- Using a Gait or Transfer Belt

Use of Immobilizers
Positioning the Patient for Diagnostic Imaging Examinations
Assisting the Patient to Dress and Undress
The Disabled Patient
The Patient With an Intravenous Infusion
Skin Care
Preventing Decubitus Ulcers
Cast Care and Traction
Assisting the Patient With a Bedpan or Urinal
The Bedpan
The Male Urinal
Departmental Safety
Fire Safety
Prevention of Falls
Poisoning and Deposition of Hazardous Waste Materials
Radiation Safety
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Give clear verbal instruction to an ambulatory patient concerning the correct manner of dressing and undressing for a radiographic imaging procedure.
2. Correctly assess a patient's need for assistance in order to complete an imaging examination safely.
3. Demonstrate the correct method of moving and positioning a patient to prevent injury to self or to the patient.
4. Demonstrate the correct method of assisting a disabled patient with dressing or undressing for a radiographic procedure.
5. List the safety measures that must be taken when transferring a patient from a hospital room to the radiographic imaging department.
6. Describe steps the radiographer must take to protect the patient's integumentary system from injury.
7. Explain the criteria to be used if immobilization of a patient is necessary.
8. List the types of immobilizers or restraining devices available and demonstrate the correct method of applying each one.
9. List the precautions to be taken if a patient is in traction or wearing a cast.
10. Demonstrate the correct manner of assisting a patient with a bedpan or urinal.
11. Explain the radiographer's responsibilities concerning radiation safety.

12. List the departmental safety measures that must be taken to prevent and control fires, patient falls, poisoning or injury from hazardous materials, and burns, and to evacuate patients in case of a disaster.

Glossary

Ambulatory: walking, or able to walk
Atrophy: decrease in the size of the organ, tissue, or muscle
Blanch: to become pale
Catheter: a hollow, flexible tube that can be inserted into a vessel or cavity of the body to withdraw fluids
Chronic obstructive pulmonary disease (COPD): a progressive and irreversible condition that produces diminished inspiratory and expiratory lung capacity
Compression: the act of pressing upon or together
Contracture: a drawing together; a shortening or shrinkage
Debility: lack or loss of strength; weakness
Decubitus ulcer: a pressure sore or ulcer
Defecation: evacuation or elimination of fecal matter from the rectum
Disinfectant: any substance that inhibits the growth of bacteria
Distal: farthest from a specified point of reference
Dyspnea: labored or difficult breathing
Fasted: having gone without food or fluid for a long period of time for a particular reason
Fluoroscope: a device used for the immediate projection of a radiographic image on a fluorescent screen for visual examination
Footdrop: drooping of foot from paralysis of the anterior muscles of leg, associated with bedrest and immobility, resulting in the inability to put heel on the ground
Friction: the act of rubbing
Hydrotherapy: the use of water immersion in the treatment of various mental or physical disorders
Hypnotic: an agent that produces sleep
Intravenous infusion: administering fluids or nutrients into the vein
Ischemia: deficiency of blood in a part, due to functional constriction or actual obstruction of a blood vessel
Lumbar vertebrae: the fine vertebrae between the thoracic vertebrae and the sacrum
Perineum: the pelvic floor and associated structures occupying the pelvic outlet
Plantar flexion: extension of the foot so that the toes are pointing downward from their normal physiologic position
Psychoactive drug: a drug that affects behavior
Range of motion: the range, measured in degrees of a circle, through which a joint can be extended and flexed
Reactive hyperemia: an increase in blood flow to a particular area following its restoration after a temporary interruption
Sacrum: the triangular bone at the base of the spine usually formed by fine, fused vertebrae that are wedged dorsally between the two hip bones
Scapula: the flat bone in the back of the shoulder; the shoulder blade
Sedative: a drug used to calm anxious and disturbed patients and to produce drowsiness
Sensory deprivation: a condition in which an individual receives less than normal sensory input
Shear: an applied force that tends to cause opposite but parallel sliding motion of the planes of an object
Shearing force: one of the mechanical forces at work in skin breakdown, e.g., when a client slumps in the chair, the skin around the buttocks is stretched by the movement and this interferes with circulation
Subcutaneous: beneath the layers of the skin; the layer between the dermis and the muscle
Tissue necrosis: localized death of tissue due to injury or lack of oxygen
Toxic chemicals: harmful or poisonous substances
Trochanter: a broad, flat process in the femur, at the upper end of its lateral surface
Ulceration: an area of tissue necrosis that penetrates below the epidermis; excavation of the surface of any body organ
Urination: the discharge of urine from bladder; also called *voiding* the urine

A patient who comes to the radiographic imaging department as an outpatient is frequently required to remove all or some items of clothing before an examination or treatment can be performed. It is usually the radiographer who receives the patient and determines which items of clothing are to be removed. The patient's discomfort or embarrassment can be decreased if the radiographer approaches this situation in a courteous and professional manner.

The patient should be taken to the specific dressing area and shown how to close the dressing room door or draw the curtain of the cubicle while undressing. The radiographer should clearly explain how the patient is to don the examining gown and where he is to go for the examination once he is prepared. (Remember that not everyone knows that some types of examining gowns open at the back rather than at the front; this information should be part of the explanation.) Doing this will take only a few moments, and it will make the patient feel more comfortable.

The patient should be given hangers for his clothing. If it is permissible for him to leave his clothing in the dressing room, this should be explained to him. If he cannot leave his clothing, he

should be shown what to do with it. Purses, jewelry, and other valuables should be treated with special care so that they will not be lost or stolen.

The radiographer is responsible for protecting himself and his patients from injury in every way possible. Health care workers are often injured while moving and lifting patients, yet almost all of these injuries are preventable with the use of correct body mechanics and adherence to the rules of safety. Patients are also victims of injuries caused by being improperly moved or lifted. Most of these injuries can also be prevented.

The radiographer must protect the patient's integumentary system from damage. This is of particular concern when the patient is unable to move himself. The radiographer must be aware of this potential for injury and use care to prevent skin damage.

Occasionally, it may be necessary to immobilize a patient for his own safety during an examination. Not only must the radiographer learn the institution-specific rules concerning immobilizers (restraints), he or she must be able to use various types of immobilizing devices safely.

Adhering to the rules of radiation safety, preventing and controlling fires, the correct use and disposal of hazardous chemicals, and observing other rules of patient and departmental safety are an important part of the radiographer's education.

Care of Patient's Belongings

Many patients wear jewelry or carry a purse or other valuable items with them to the radiographic imaging department. The dressing rooms in most diagnostic imaging departments are not safe places to leave these items, and the patient may feel justifiably uneasy about leaving them there. Again, the radiographer must consider the patient's concern and explain what must be done with personal items in order to keep them safe.

Metal items such as necklaces, rings, and watches are not to be worn for most diagnostic examinations and must be removed before the examination or procedure can begin. An envelope or other container large enough to accommodate all such items should be offered to the patient. Identifying information should be written on a receipt, and all items should be tagged and placed in the designated safety area by the radiographer. This procedure will prevent losses that may result in inconvenience and expense for both the patient and the department.

The radiographer should not place value on a patient's belongings. An item that may seem insignificant to the radiographer may be the patient's most treasured belonging. Every article of clothing or jewelry or other personal effect that a patient brings to the diagnostic imaging department should be treated with care.

Body Mechanics

Constant abuse of the spine from moving and lifting patients is the leading cause of injury to health care personnel in all health care institutions. The radiographer will be less fatigued and will avoid injury to himself and to his patients if he employs the rules of correct body mechanics. These rules are based on the laws of gravity.

Gravity is the force that pulls objects toward the center of the earth. Any movement requires an expenditure of energy to overcome the force of gravity. When an object is balanced, it is firm and stable. If it is off balance, it will fall because of the pull of gravity. The center of gravity is the point at which the mass of any body is centered. When a person is standing, his center of gravity is at the center of the pelvis (Fig. 4–1).

Safe body mechanics require good posture. Good posture means that the body is in alignment, with all parts in balance. This permits the musculoskeletal system (the bones and joints) to work at

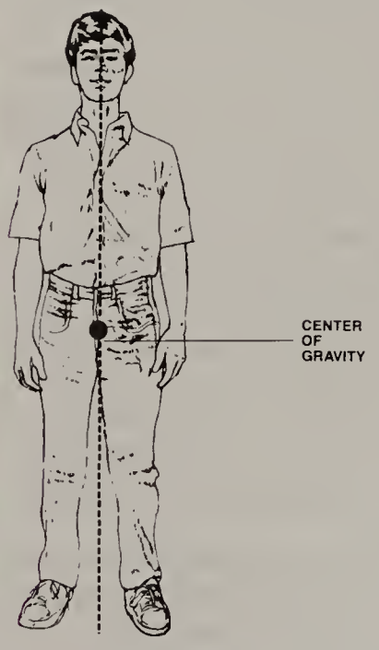


Figure 4–1
When a person is standing, his center of gravity is at the center of the pelvis.

maximal efficiency with a minimal amount of strain on joints, tendons, ligaments, and muscles. Good posture also aids other body systems to work efficiently. For instance, if the chest is held up and out (the musculoskeletal system), the lungs (the respiratory system) can work at maximal efficiency.

Rules for correct upright posture are as follows:

Hold chest up and slightly forward with the waist extended. This allows the lungs to expand properly and fill to capacity.

Hold head erect with the chin held in. This puts the spine in proper alignment, and there is no curve in the neck.

Stand with the feet parallel and at right angles to the lower legs. The feet should be 4 to 8 inches apart. Keep body weight equally distributed on both feet.

Keep the knees slightly bent; they act as a shock absorber for the body.

Keep the buttocks in and the abdomen up and in. This prevents strain on the back and abdominal muscles.

When one moves and lifts objects, one must overcome the forces of weight and friction. The center of gravity must be determined and a plan made to surmount the weight of the object or person. This can be done by keeping the heaviest part close to the body. If this is not possible, another person or persons should assist with moving or lifting the load.

The force of friction opposes movement. When one moves or transfers a patient, friction must be reduced to the minimum to facilitate movement. This can be done by reducing the surface area to be moved or, in the case of a patient, by employing some of the patient's own strength to assist with the move, if possible. If the patient is unable to assist, the radiographer should reduce friction by placing the patient's arms across his chest to reduce the surface area. The surface over which the patient must be moved must be dry and smooth. Pulling rather than pushing also reduces friction when moving a heavy object or person. A sliding board or pull sheet placed under an immobile patient will also reduce friction. Directions for the use of these items are presented later in this chapter.

To avoid self-injury when moving heavy objects, the radiographer must remember to keep his body's line of balance closest to the center of the load.

There are protective belts available in some workplaces. They should be worn to support the



Figure 4–2
Keep your body balanced over your feet to provide a broad base of support.

back. These are somewhat controversial, and should be worn only if prescribed by a physician or if it is the policy of the institution.

When picking up an object from the floor, bend the knees and lower your body. Do not bend from the waist.

The biceps are the strongest arm muscles and are effective when pulling; therefore, pull heavy items or patients rather than pushing them.

When assisting a patient to move, balance the weight over both feet. Stand close to the patient, flex your gluteal muscles, and bend your knees to support the load. Use your arm and leg muscles to assist in the move.

The spine must always be protected. Instead of twisting your body to move with a load, change your foot position. Always keep your body balanced over your feet, which should be spread to provide a firm base of support.

Make certain that the floor area where you are working is clear of all objects (Fig. 4–2).

Moving and Transferring Patients

The radiographer may be called upon to transfer or assist in transferring a patient from a hospital room to the diagnostic imaging department. At times, he may be the person appointed to instruct a porter in the correct method of transferring a patient. Whatever the case, several precautions must be taken when a patient is moved from his room to the imaging department. They are as follows:

1. Establish the correct identity of the patient. You may accomplish this by going to the nurses' station on the unit housing the patient, identifying yourself, and giving the patient's name and type of procedure for which he is being sought.

Rationale: The correct patient must receive the correct procedure.

2. Request pertinent information concerning the patient's ability to comply with the physical demands of the procedure.

Rationale: Many radiographic imaging procedures require that the patient move about on a relatively narrow surface. You should be informed of the patient's condition and apprised of any mind-altering medications that the patient may have received during the previous 2 hours that may prevent him from complying with the demands of the procedure without special assistance.

3. Request information concerning the patient's ability to ambulate and any restrictions or precautions to be taken concerning the patient's mobility.

Rationale: If a patient has restrictions in movement or weight bearing, you must know so that you do not violate any of these restrictions, thus causing the patient injury. If you need help moving the patient to and from the bed to the gurney or wheelchair, request it at this time. A radiographer or a porter must never attempt to transfer a patient from a bed to a gurney or a gurney to a bed without assistance. A patient must never be allowed to transfer to or from a wheelchair without assistance.

4. Move the patient to the imaging department according to the necessary restrictions after greeting and identifying him and providing an explanation of what is to occur.

Rationale: The patient must always be a part of the planning process and be given an opportunity to refuse a treatment or procedure. The correct patient must be taken for the correct procedure. The patient in the hospital wears an identification band, usually on his wrist. Procedures require that you, the radiographer, request that the patient state his name and then check the name against what is written on the identification band.

When the procedure is completed, return the patient to his room using the following procedure:

1. Stop at the appropriate nurses' station, return the chart, and inform the unit personnel that the patient is being returned to his room. If you need help, request it at this time.

Rationale: If the unit personnel are not informed of the patient's return, they may not know that he has returned and his care may be overlooked.

2. Return the patient to his room and assist him into bed, and make him comfortable and safe.

Rationale: Never allow the patient to transfer from a wheelchair without assistance. Place the patient's bed in the position that is closest to the floor, with the side rails raised and the call button within reach in case the patient needs assistance.

ASSESSING THE PATIENT'S MOBILITY

Before the radiographer begins to move a patient, he must use his skills in critical thinking and problem solving to plan the most effective manner of accomplishing this task. The expected outcome of this plan will be to accomplish the move without causing additional pain or injury to the patient or to himself. This is done by using interviewing skills and assessment skills.

The radiographer must look for the following as he assesses the patient:

1. *Deviations from correct body alignment.* Deviations in normal, physiologic body alignment may result from the following: poor posture, trauma, muscle damage, dysfunction of the nervous system, malnutrition, fatigue, or emotional disturbance. Support blocks or pillows, which are used to assist the patient during the procedure, must be available.
2. *Immobility or limitations in range of joint motion.* Any stiffness, instability, swelling, inflammation, pain, limitation of movement, or atrophy of muscle mass surrounding each joint must be noted and considered in the plan of care.
3. *The ability to walk.* Gait includes rhythm, speed, cadence, and any characteristics of walking that may result in a problem with balance, posture, or independence of movement. The radiographer must plan for the amount of assistance needed to complete the move and the procedure safely.
4. *Respiratory, cardiovascular, metabolic, and musculoskeletal problems.* Obvious respiratory or cardiovascular symptoms that impair circulation and signal potential problems in positioning must be considered in the radiographer's plan. Metabolic problems such as diabetes mellitus or rheumatoid arthritis may be discovered during the interview process and planned for as necessary (symptoms and care of patients with medical problems will be discussed in Chapter 7).

Other assessment considerations are as follows:

1. The patient's general condition: how well or how poorly is he functioning?
2. Range of motion and weight-bearing ability: has the patient had a surgical procedure that restricts motion or limits weight bearing until it is healed?
3. The patient's strength and endurance: will he become fatigued and be unable to complete the transfer with only stand-by assistance?
4. The patient's ability to maintain his balance: can he sit or stand for as long as the procedure requires?
5. The patient's ability to understand what is expected of him during the transfer: is he responsive and alert?
6. The patient's acceptance of the move: does he fear or resent the transfer? Will the transfer increase his pain? Does he feel that it is unnecessary?
7. The patient's medication history: has he received a sedative, hypnotic, or other psychoactive drug in the past 2 or 3 hours? Will any medication that he has taken affect his ability to move safely? (Medications will be discussed in Chapter 12.)

The radiographer must decide how the patient can be transferred safely and comfortably, whether it be by gurney or by wheelchair. Hospitalized patients are seldom allowed to walk to and from the diagnostic imaging department for reasons of safety.

Before going to the patient, a consultation with the nurse in charge of the patient is recommended so that the patient's condition and limitations can be understood. If assistants are needed, they must be on hand. A patient must never be moved without adequate assistance; to do so may cause injury to the patient or to the radiographer. The radiographer must always be at the patient's side as he moves. The following rules should be observed during a move:

1. Give only the assistance that the patient needs for comfort and safety.
2. Always transfer a patient across the shortest distance.
3. Lock all wheels on beds, gurneys, and wheelchairs before the move begins.
4. Generally, it is better to move a patient toward his stronger side while assisting him on the weaker side.
5. The patient should wear shoes for standing transfers. Slippery slippers should not be worn.
6. Inform the patient of the plan for moving and encourage him to help.
7. Give the patient short, simple commands and help the patient to accomplish the move.



Figure 4–3
Pull sheet.

METHODS OF MOVING PATIENTS

There are essentially three ways of transferring patients: by gurney, by wheelchair, and by ambulation.

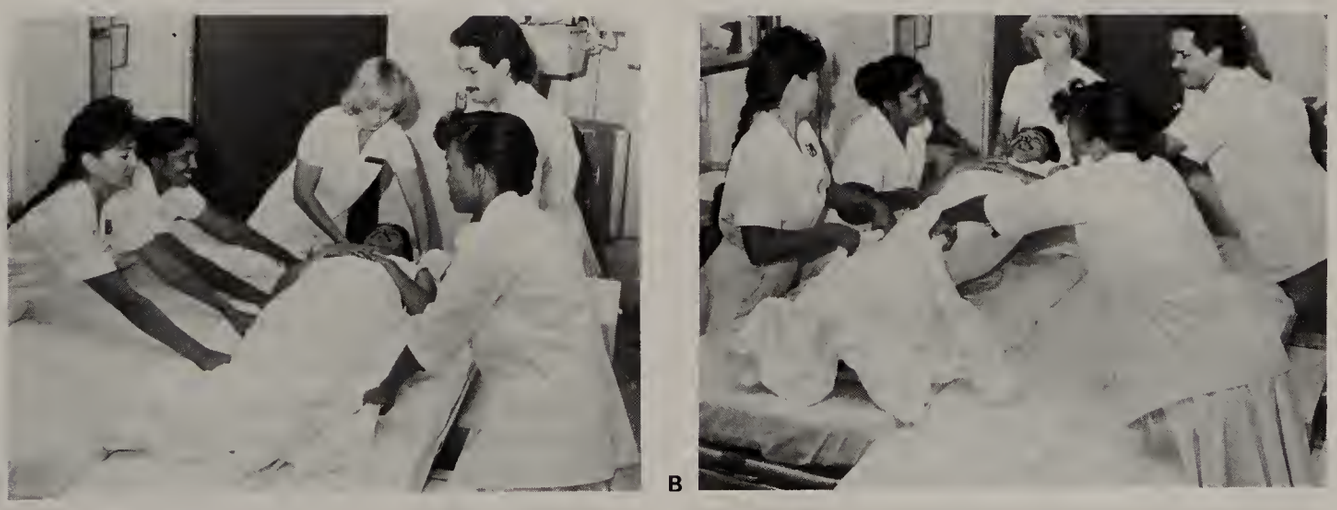
By Gurney

When a patient is moved from a gurney to a radiographic table, or the reverse, great care must be taken in order to prevent injury. If the patient is unconscious or unable to cooperate in the move, his spine, head, and extremities must be well supported. Convenient and safe ways to do this are by using a sliding board or a sheet to slide the patient from one surface to another.

USING A SHEET FOR TRANSFER To place a sheet under a patient, the following procedure should be used: The radiographer obtains a heavy draw sheet or uses a full bed sheet and folds it in half. If an assistant is needed, there should be one person on each side of the bed or table. The patient is turned onto his side and moved to the distal side of the bed or table. The sheet is placed on the table or bed and then one half of the sheet is rolled as close to the patient's back as possible (Fig. 4–3). The patient is told that he will be turned back toward the radiographer and that he will be moving over the rolled sheet. Then the radiographer turns him across the sheet roll and has his assistant straighten the sheet on the distal side. The patient may then be returned to a supine position, and the transfer may begin.

If the patient is an adult, three or four people should participate in the maneuver. One person stands at the patient's head to guide and support it during the move, another should be at the side of the surface to which the patient will be moved, and the third person should be at the side of the surface on which the patient is lying. If there are four people, two may stand at each side. The sheet is rolled at the side of the patient so that the radiographer can easily grasp it in his hands close to the patient's body. In unison (usually on the count of three), the team transfers the patient to the other surface (Fig. 4–4).

If the radiographic table is a stationary cradle type, extra padding should be placed over the metal parts of the table's edge to protect the patient from being bruised as he is moved. Some cradle tables have a floating top. In this case, the top



A B

Figure 4–4
In unison, transfer the patient to the other surface.

should be moved forward, close to the edge of the gurney. Conscious patients should be cautioned that the center part of these tables is lower than the surface, so that they are not frightened when lowered into it.

Tube housing above radiographic tables should be moved out of the way when patients are being moved, in order to protect both patient and radiographer from bumping into them. To avoid bumping into a stationary device such as a fluoroscopic unit, the patient should be warned not to sit up, and the radiographer must also be careful not to injure himself.

SLIDING BOARD TRANSFER The sliding board (also called a smooth mover and a smoothie) is a glossy, plasticized board approximately 1.7 meters (5 feet 10 inches) in length and about 75 centimeters (2 feet 6 inches) wide. Use of this item facilitates moving patients from one surface to another, usually from a gurney to an examining table. The sliding board usually requires fewer personnel to make the move because it creates a firm bridge between the two surfaces over which the patient can be easily moved. The procedure is as follows:

1. Obtain the sliding board and spray it with antistatic spray, if necessary.
2. Enlist the assistance of one other person if the patient is of average size and weight; if the patient is very large, three people may be necessary to move the patient safely.
3. Move the gurney up to the table and place it against the table; lock the wheels of the gurney.
4. Assist the patient to turn to the distal side of the table and place the sliding board under the sheet upon which the patient was lying (Fig. 4–5*A*).
5. Place the sheet over the board and allow the patient to move onto the board.
6. Create a bridge with the board over the edge of the radiographic table and the edge of the gurney (see Fig. 4–5*B*).
7. Place the sheet on the gurney over the sliding board.
8. With one person at the patient's head and the other at the side of the gurney, slide the patient onto the gurney (see Fig. 4–5*C*).
9. Place a pillow under the patient's head, if this is permitted, and put the side rails of the gurney up. Place a soft immobilizer over the patient. The patient may then be transferred.
10. When the move is complete, discard the soiled linen that was used on the radiographic table, and clean the sliding board and the table with a disinfectant spray.
11. Wash your hands and place clean linen on the table.

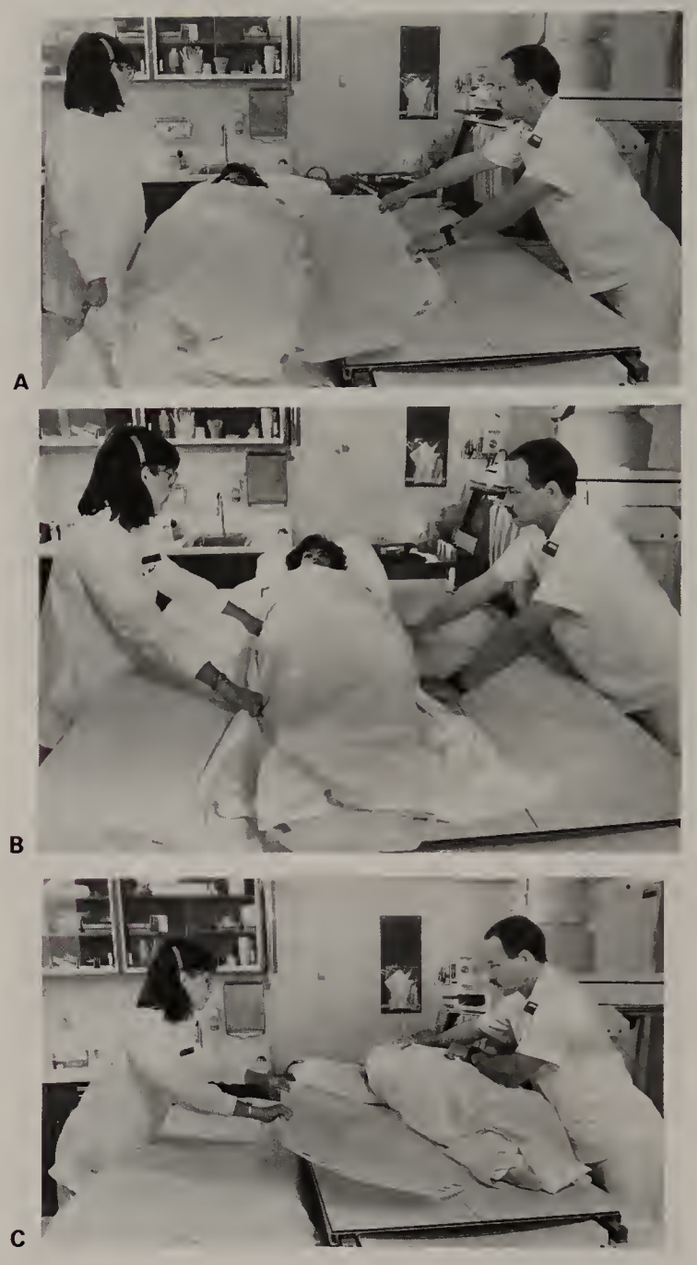


Figure 4–5
(**A**) The patient is positioned on her side and the sliding board is under the sheet on which she is lying. (**B**) Create a bridge by placing the sliding board over the table and the gurney. (**C**) As a team, slide the patient onto the gurney.

LOG ROLL Occasionally, it is necessary to turn a patient without flexing his neck or back. This type of move is called a log roll. Five persons are necessary to negotiate this patient move safely, so the

radiographer must call for four assistants. Two persons stand at each side of the table or bed on which the turn will take place. One person keeps the head and neck immobile by placing his hands flat against the sides of the patient's face with palms held firmly at the angle of his jaw. Two assist with maintaining alignment of the torso and two with the legs. Use the sheet that is under the patient as a turnsheet.

The patient should be prepared for the move as follows:

1. Place the patient's arms across his chest and ask him to hold himself rigid if he is able to assist.
2. Place a pillow or support bolster between the patient's knees in order to prevent pressure and to assist with maintenance of body alignment as he is turned.
3. Place another bolster in the place where the patient's head will rest when the turn is complete to support the head and neck in alignment.

When the patient is prepared and each member of the team understands his duty as the patient is turned, move the patient as follows:

1. Bring the sheet up over the patient's distal side. The sheet should be grasped by the two persons on that side close to the patient's body. The person in charge of the head and neck stands at the head of the table or at the top side of the table and positions his hands for firm support. The fourth member of the team assists with maintenance of the patient's torso alignment.
2. In unison, the team rolls the patient to the desired side as if he were a log, keeping his head, neck, and torso immobile during the move (Fig. 4–6).
3. When the turn is complete, the patient's head should be resting on the bolster positioned before the move began. The back must be firmly supported with bolsters or pillows. The upper leg may be flexed after the move is completed.



Figure 4–6
The *log roll* method of moving a patient.

By Wheelchair

If a patient must be moved from a bed or radiographic table to a wheelchair, or the reverse, he must be helped. The radiographer should never allow a patient to get off a table or onto a wheelchair without some assistance. The patient is often not as strong as he believes himself to be. The sudden movement may cause dizziness, and the patient may fall.

If the patient has been in a supine position and is to be helped to a sitting position, the radiographer should have him turn to his side with his knees flexed. The radiographer then places himself in front of the patient with one arm under his shoulders and the other across his knees.

1. If the patient can assist, instruct him to push up with his upper arm when told to do so (Fig. 4–7*A*).
2. Then, on the count of three, move the patient or help him to move to a sitting position at the edge of the table. Before helping the patient to stand, allow him to sit for a moment and regain his sense of balance. Then, if the patient needs further assistance, stand in front of him and place his arms across your shoulders (see Fig. 4–7*B*). If firm support is necessary, put your knees around the patient's knees.
3. Help him to stand and pivot, and then lower him onto the chair, bending your knees and keeping your back straight as you do so (see Fig. 4–7*C*). If the patient needs only minimal assistance, you may stand at his side and take his arm in order to help him off the table.
4. If the radiographic table is high, you should never allow a patient to step down without

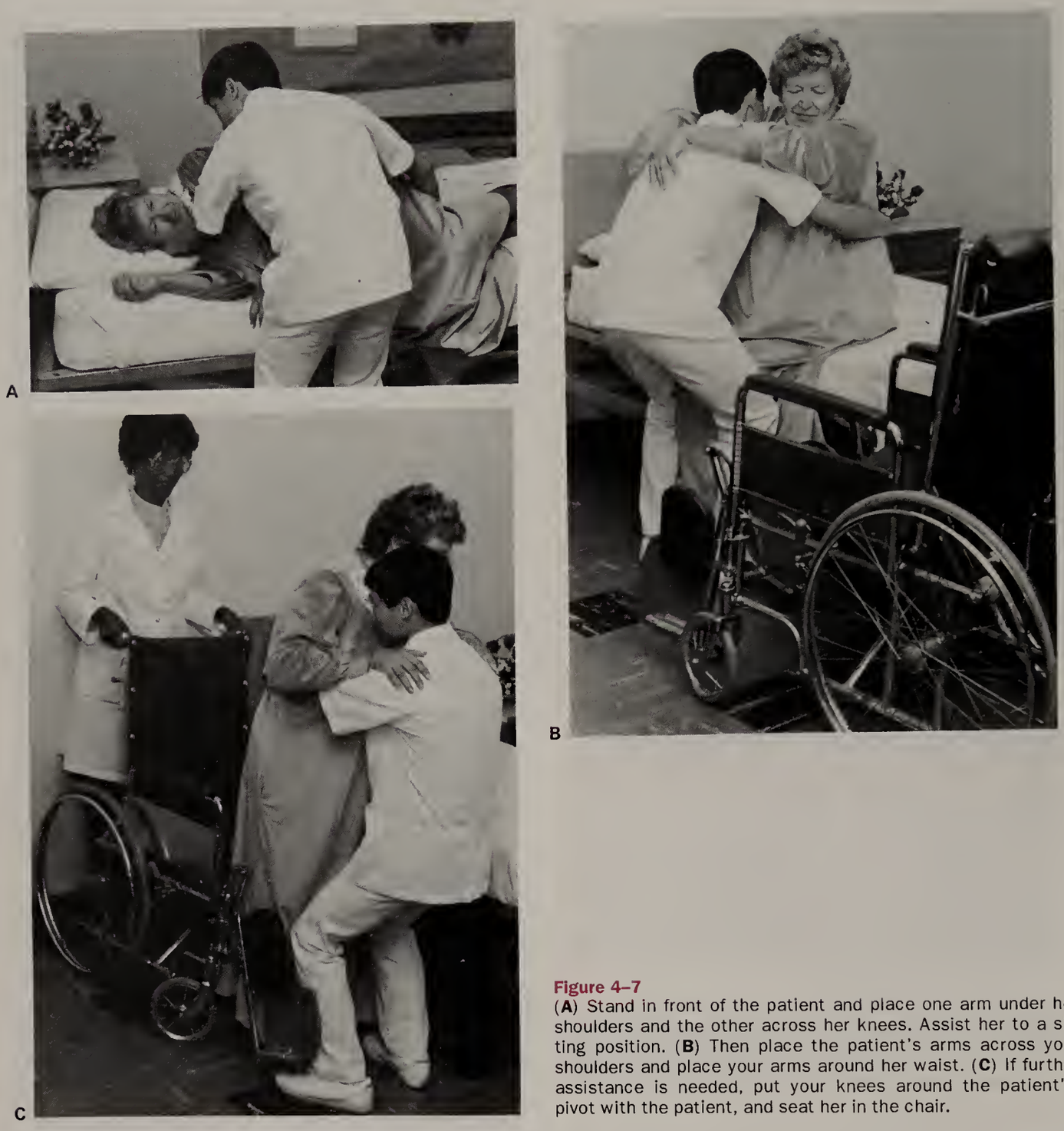


Figure 4–7
(**A**) Stand in front of the patient and place one arm under her shoulders and the other across her knees. Assist her to a sitting position. (**B**) Then place the patient's arms across your shoulders and place your arms around her waist. (**C**) If further assistance is needed, put your knees around the patient's, pivot with the patient, and seat her in the chair.

providing a secure stepping stool. Always stay at the patient's side in order to assist him.

5. The wheelchair must be close enough so that the patient can be seated in the chair with one pivot. Have the foot supports of the chair up and the wheels locked.
6. Stand in front of the patient, spread his feet for a broad sense of support, flex his knees, support the patient at his sides, pivot with the patient, and seat him in the chair.
7. The footrests on the wheelchair should then be put down and the wheels unlocked. A safety belt should be put across an unsteady patient.
8. A telescoping table must be placed in the lowest position before a patient is assisted to move onto it (Fig. 4–8).

The patient must be kept covered as much as possible during any move or transfer. He should never be transferred by gurney or wheelchair without being covered with a sheet or blanket.



Figure 4–8
Assisting a patient from a telescoping table.

When he is placed on a radiographic table, he must be covered with a protective sheet. He must not be allowed to become chilled.

A patient who has received a narcotic, hypnotic, or other type of psychoactive medication; a confused, disoriented, unconscious, or head-injured person; or a child must never be left alone on a radiographic table or a gurney. If the patient's behavior cannot be predicted, or if he is in a wheelchair, he should be carefully observed. A soft immobilizer belt should be placed over any patient on a gurney or in a wheelchair. The side rails of the gurney must always be up (Fig. 4–9).

Using a Gait or Transfer Belt

In some institutions, a transfer or gait belt is required when moving or walking with a disabled patient. In others, it is a matter of choice. The radiographer must learn the policy of the institution in which he is working.

A transfer or gait belt is a belt made of a sturdy material, either leather or a heavy fabric that is



Figure 4–9
Keep the side rails of the gurney up and the safety strap attached.

about 54 to 60 inches long. Its purpose is to assist in stabilizing the patient during a move from one surface to another or during ambulation. It is placed around the waist of the patient to be transferred when he is in a sitting position and fastened securely. Some of these belts have a hand grip for the health care worker to grasp at the back as they are assisting the patient.

1. Before applying the belt, explain its use to the patient and inform him that it will be worn for a very brief time.
2. Be certain that the belt is positioned at waist



Figure 4–10
Place fingers through the back of the belt in an underhand grasp.

level and is not resting on bare skin. Be certain that it is not placed over an open wound, an operative site, a colostomy, or a patient's breast tissue. The belt should be secured so that there is only enough space for your fingers to slip through it in the rear.

3. After the belt is in place, place your fingers through the back of the belt in an underhand grasp (Fig. 4–10). Then support the patient during the move by holding him by the belt.

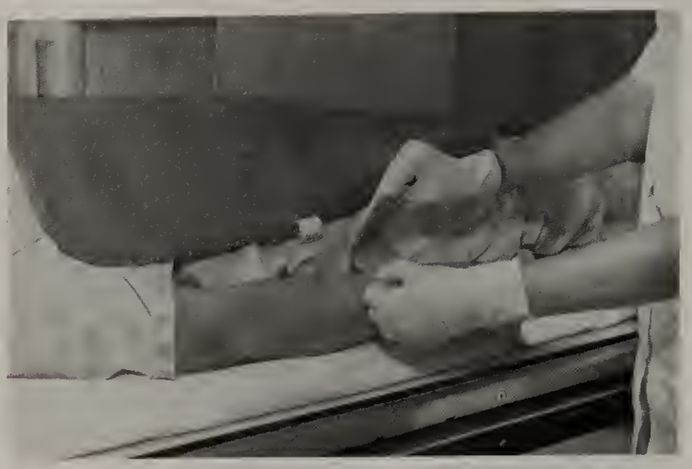


Figure 4–11
Velcro strap immobilizer.

Use of Immobilizers

The ethical and legal restrictions concerning use of immobilizers in patient care are discussed in Chapter 1. The radiographer must remember that the use of immobilizers must be ordered by the physician in charge of the patient's care and applied in compliance with institutional policy.

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) states that immobilizers should be used only after less restrictive measures have been attempted and have proven ineffective in protecting the patient. The radiographer must remember this and use his critical thinking skills to avoid the use of immobilizers if at all possible. Immobilizers are defined as any manual method or physical or mechanical device, material, or equipment attached or adjacent to the person's body that the person cannot remove easily that restricts freedom of movement or normal access to one's body (Omnibus Reconciliation Act, 1989).

The most effective method for avoiding the need to restrain an adult patient is the use of therapeutic communication to explore the patient's fears. If a patient seems fearful or is striking out or moving in an unsafe manner, the radiographer should assure him that the procedure will be done quickly and in a manner that keeps him as comfortable as possible. If this does not reassure the patient, other, less restrictive devices, such as soft velcro straps, sandbags, and sponges, may be used to remind the patient to refrain from moving (Figs. 4–11 and 4–12).

If immobilizers are to be used, the radiographer must be certain that they are being used to protect the patient's safety and that their use is the only alternative.

There are various types of restraining devices that may be used for adult patients. Immobilizers for use with children will be discussed in Chapter 8. Reasons for application of immobilizers in the care of an adult patient include the following:

1. To control movement of an extremity when an intravenous infusion or diagnostic catheter is in place.
2. To remind a patient who is sedated and having difficulty remembering to remain in a particular position.
3. To prevent a patient who is unconscious, delirious, cognitively impaired, or confused from falling from an examination table or a gurney; from removing a tube or dressing that may be life sustaining; or from injuring himself by impact with diagnostic imaging equipment.

When the radiographer is caring for a patient who has been restrained, the reason for the use of immobilizers must be explained to the patient and any persons who may accompany him. After immobilizers are applied, the patient must not be left unattended, and the radiographer should inform

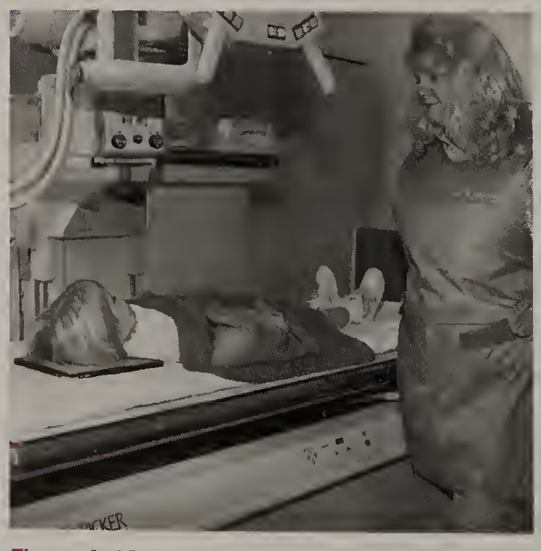


Figure 4–12
Sandbags used to immobilize a child.

the patient that he is not alone and is not being punished. A calm, reassuring manner often soothes an agitated or confused patient who has been immobilized. Patients in this state need repeated orientation by the radiographer and an explanation of what is being done. The radiographer must work quietly and quickly to complete the procedure and return the patient to his room or wherever he is to be taken on completion of the radiographs.

Immobilizers (or restraints, as they are often called) must always be applied carefully and in the manner prescribed by the manufacturer of the device. The type of immobilizer to be used is dictated by need. All radiographers must document application of immobilizers as explained in Chapter 1. Rules for application of immobilizers follow:

1. The patient must be allowed as much mobility as is safely possible.
2. The areas of the body where immobilizers are applied must be padded to prevent injury to the skin beneath the device.
3. Normal anatomic position must be maintained.
4. Knots that will not become tighter with movement must be used (a half-knot is recommended (Fig. 4–13).
5. The immobilizer must be easy to remove quickly, if this is necessary.
6. Neither circulation nor respiration must be impaired by the immobilizer
7. If leg immobilizers are necessary, wrist immobilizers must also be applied to prevent the patient from either unfastening the device or, in an attempt to leave the examination table or gurney, accidentally hang himself.

Although the radiographer is not usually the health care worker who applies immobilizers or who monitors a patient in immobilizers for long periods of time, he must understand that immobilizers must be removed at least every 2 hours. After removal, the joints affected by the immobilizer must be put through range of motion. It may be necessary to remove one immobilizer at a time; reapply one before releasing another. Immobilizers must always be applied to the frame of the gurney, bed, or table, not to a moveable part of the equipment. Any use of immobilizers requires documentation of the type of immobilizer used, the time it was applied and removed, the reason for its application, and an assessment of the patient at each stage.

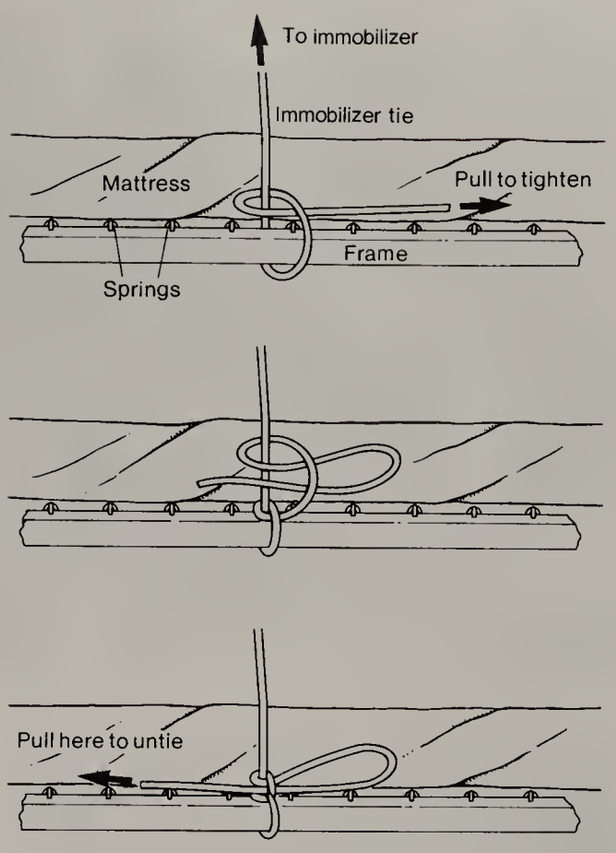


Figure 4–13
Following this sequence will result in tying a half-bow knot. The knot will remain secure until the free end is pulled. It is a safe knot that can be quickly released.

There are various types of immobilizers that may be used. They include the following:

1. Limb holders or four-point restraints (Fig. 4–14*A*).
2. Ankle or wrist immobilizers (see Fig. 4–14*B*).
3. Immobilizing vest for keeping a patient in a wheelchair (see Fig. 4–14*C*).
4. Waist immobilizer, which keeps the patient safe on an examining table or in bed, but allows him to change position (see Fig. 4–14*D*).

At times, a patient who is aggressive and delusional may need to have waist, wrist, and ankle immobilizers that are stronger than those shown in Figure 4–14 *B*, *C*, and *D*. Immobilizers of this type also have locks. If this type of immobilizer is necessary, one or more security officers should be called to assist with application. A radiographer alone or with only the assistance of one other radiographer must never attempt to apply immobilizers to an extremely aggressive or combative patient. Persons who have been trained to deal with this type of patient problem must do this. When this type of immobilization is necessary, the rules of immobilizer application still apply.



A



B

Figure 4–14
(**A**) Limb holders restrain this patient's arms and legs. (**B**) This type of immobilizer may be used for the ankle or wrist. It is soft and padded to prevent injury to the patient's skin. (**C**) An immobilizing vest prevents the patient from leaving the wheelchair and helps support him. The waist belt on this immobilizer adjusts to fit the size of the patient without restricting his breathing. (**D**) *Left:* This waist immobilizer is effective for keeping the patient in bed, while still allowing her to turn from side to side and to sit up in bed. *Right:* This safety belt allows freedom to move but not to fall from the bed.

Positioning the Patient for Diagnostic Imaging Examinations

When a patient must spend long periods of time in the diagnostic imaging department, it is the radiographer's duty to assist him to maintain his body in normal alignment for comfort and to maintain normal physiologic functioning. There are several protective positions that the body may assume or be assisted to assume for comfort. There are also several positions that the patient may be requested to assume to facilitate diagnosis or treatment. The radiographer must familiarize himself with all these positions and the problems that may be encountered with each in order to assist the patient as the need arises.

The positions are as follows:

Supine or dorsal recumbent position—patient is flat on his back. The feet and the neck will need to be protected when the patient is lying in this position. A pillow may be placed under the head to tilt it forward. The feet should be supported to prevent plantar flexion or footdrop (Fig. 4–15*A*).

Lateral recumbent position—patient is on the right or the left side with both knees flexed. This position relieves pressure on most bony prominences. The patient may be supported with pillows or sandbags to maintain the position (see Fig. 4–15*B*).

Prone position—patient lies face down. A small pillow should support the head to prevent flexion of the cervical spine. The patient may be moved down on the table so that his feet drop over the edge, or a pillow may be placed under the lower legs at the ankles to prevent footdrop (see Fig. 4–15*C*).

High Fowler's position—patient semi-sits with head raised at an angle of from 45° to 90° off the table. This position is used for patients in respiratory distress (see Fig. 4–15*D*).



C



D



Figure 4–14 ***(Continued)***

Semi-Fowler's position—patient's head is raised at an angle of from 15° to 30° off the table. The arms must be supported to prevent pull on the shoulders and the feet must be supported to prevent plantar flexion or footdrop. Pillows or blocks under knees must be removed after a brief time (15 to 20 min) to prevent circulatory impairment (se Fig. 4–15*E*).

Sims' position—patient lies on either his left or right side with the forward arm flexed and the posterior arm extended behind his body. The body is inclined slightly forward with the top knee bent sharply and the bottom knee slightly bent. This position is frequently used for diagnostic imaging of the lower bowel (see Fig. 4–15*F*).

Trendelenburg position—the table or bed is inclined with the patient's head lower than the rest of the body. Patients are occasionally placed in this position during diagnostic imaging proce-

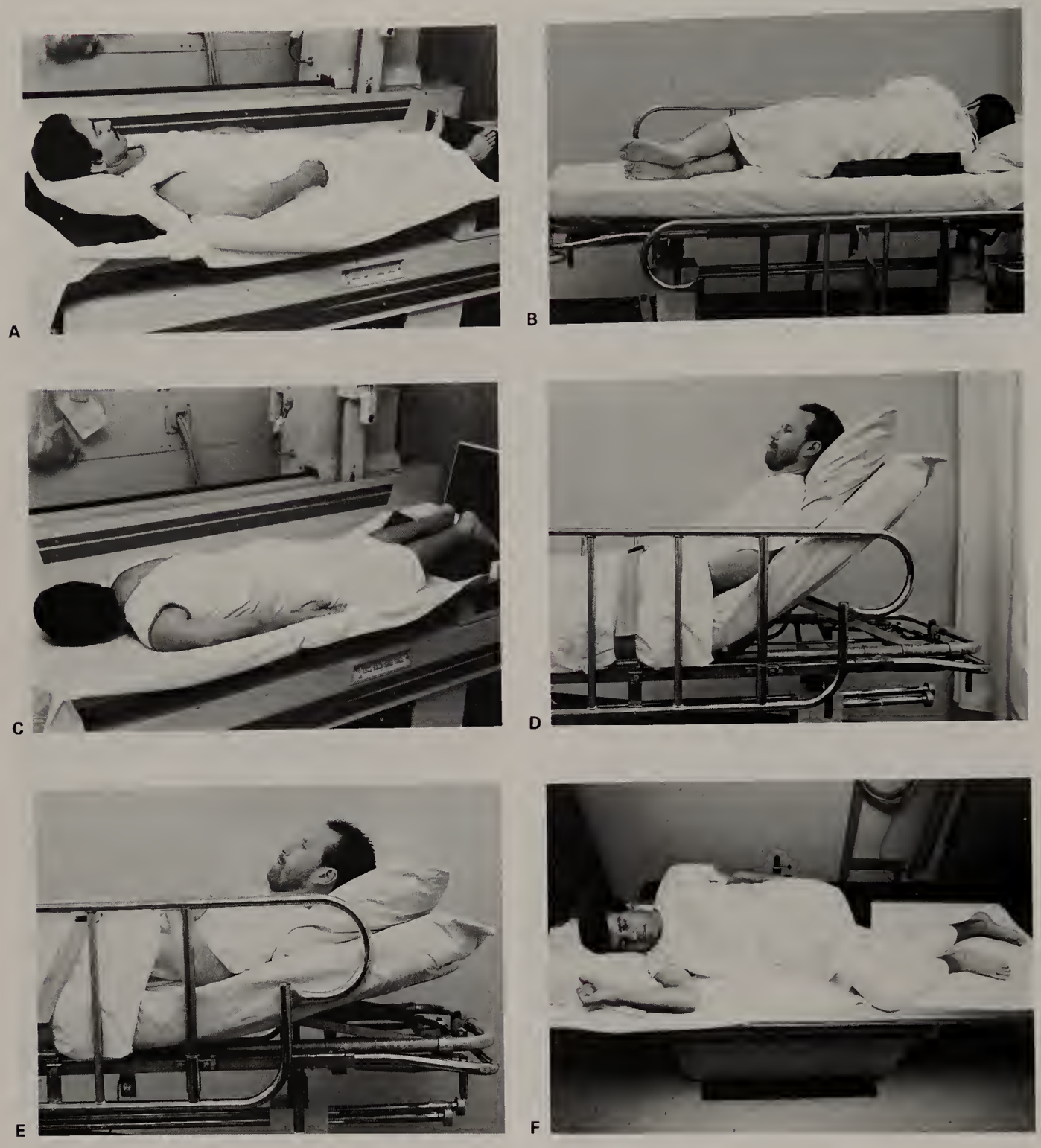


Figure 4–15
(**A**) Supine position. (**B**) Lateral recumbent position. (**C**) Prone position. (**D**) High Fowler's position. (**E**) Semi-Fowler's position. (**F**) Sims' position.

dures and for promotion of venous return in patients with inadequate peripheral perfusion caused by disease.

Patients in respiratory distress or who have chronic obstructive pulmonary disease must not be left in a prone, supine, or Sims' position for more than brief periods of time to avoid becoming increasingly dyspneic.

Assisting the Patient to Dress and Undress

The patient may arrive in the diagnostic imaging department alone if he comes from outside the hospital. As the radiographer is making an initial assessment of the patient's condition, he may ob-

serve that the patient will need help in removing his clothing. This assistance may be necessary if the patient is in a cast or a brace, is very young, or is in too weakened a condition to help himself. He may have a contracture of an extremity. His eyesight may be poor. Whatever the problem, if the radiographer senses that the patient will have difficulty undressing if left alone, he should offer assistance and stay near the dressing room in order to provide help when it is needed.

If a trauma patient is brought to the diagnostic imaging department from the emergency unit, removing his clothing in the conventional manner may cause further injury or pain. The radiographer may consider cutting away garments that interfere with acceptable radiographs; however, clothing must not be cut without the patient's consent except in extreme emergencies. If the patient is unable to give consent, a member of his family should do so in writing for the radiographer's protection.

1. If the patient is very young and is accompanied by a familiar adult, he will be more relaxed and cooperative if the adult helps him to dress and undress. Explain to the adult how the child should be dressed for the examination, arrange a meeting place, and leave them alone.
2. If you must assist a patient who has a disability of the lower extremities, the clothing should be removed from the top part of the body first.
3. Place a long examining gown on the patient. Instruct him to loosen belt buckles, buttons, or hooks around the waist and slip his trousers over his hips. If he cannot do this for himself, reach under the gown and pull the trousers down over the hips.
4. Have the patient sit down. You may have to squat in front of the patient and gently pull the clothing over his legs and feet to remove it (Fig. 4–16). If the patient is not able to help, an assistant should be called.

Some dresses may be removed in the same way. If this method is not practical, however, and the dress must be pulled over the woman's head, proceed as follows:

1. Place a draw sheet over the patient and then help her to remove her slip and brassiere.
2. Help her to put on an examining gown, then remove the draw sheet.

The following are steps to re-dress a patient with a paralyzed leg, a leg injury, a cast, or a brace:



Figure 4–16
Squat in front of the patient and remove the clothing over the feet and legs.

1. Slide the clothing (pants or skirt) over the feet or legs as far as the hips while the patient is sitting and still wearing an examining gown.
2. Have him stand, and pull the clothing over the hips if he can tolerate it.
3. If the patient is not able to pull his clothing over his hips by himself, have an assistant raise him off the chair so that you may slip the clothing over the hips and waist.
4. Remove the patient's arms from the sleeves of the gown. Have him hold the gown over his chest, and carefully pull the shirt over his head, or put it on him one sleeve at a time.
5. When the outside items of clothing are on the patient, remove the gown from under the clothes.

THE DISABLED PATIENT

If a patient is on a gurney or the radiographic table and the radiographer must change his clothing, this will be most easily accomplished with the patient in a supine position.

1. Cover him with a draw sheet and have an examining gown ready. Explain what is to be done and ask the patient to help if he is able.

If he is paralyzed or unconscious, summon help before beginning the procedure.

2. Remove the clothing from the less affected side first. Then remove the clothing from the more affected side and place the clean gown on that side, making sure to keep the patient covered with the draw sheet.
3. Next place the clean gown on the unaffected side and tie the gown at the back, if practical (Fig. 4–17).
4. If the patient is wearing an article of clothing that must be pulled over his head, roll the garment up above the waist. Then remove the patient's arms from the clothing, first from the unaffected side and then from the affected side.
5. Next, gently lift the clothing over the patient's head. One person alone should not attempt to undress a disabled patient; to do so may cause further injury or discomfort.
6. To remove trousers, loosen buckles and buttons and have the patient raise his buttocks as you slip the trousers over the hips. If the patient is unable to help, have an assistant stand at the opposite side of the table. After the trousers have been loosened, have the assistant pull the patient toward him, then slide the trousers off one side of the hip. Next, draw the patient toward you and have the assistant slide the trousers off the other hip.
7. Slip the trousers below the knees and off (Fig. 4–18).
8. Fold the clothing and place it in a paper bag on which the patient's name has been printed. If the patient is accompanied by a relative or a friend, ask that person to keep the patient's clothing. If the patient is alone, you will be responsible for caring for the clothing.

When a patient's gown becomes wet or soiled in the radiology department, it is your duty to change it. If a patient is allowed to remain in a wet or soiled gown, his skin may become damaged, or he may become chilled.



Figure 4–17
Place the clean gown on the unaffected side, then tie it behind the patient's neck.



Figure 4–18
Place the immobile patient on his side to begin removing his trousers.

When changing the gown of a patient who has an injury or is paralyzed on one side, remove the gown from the unaffected side first. Then, with the patient covered by the soiled gown, place the clean gown first on the affected side and then on the unaffected side. Pull the soiled gown from under the clean one.

THE PATIENT WITH AN INTRAVENOUS INFUSION

Frequently, patients are taken to the diagnostic imaging department with an intravenous (IV) infusion in place.

1. If the patient's gown must be changed, the clothing should be slipped off the unaffected side first.
2. Carefully slide the sleeve of the unaffected side over the IV tubing and catheter, then over the container of fluid. For this step, the container must be removed from the standard.
3. When replacing the soiled gown with a clean one, first place the sleeve on the affected side over the container of fluid, then over the tubing and onto the arm with the venous catheter in place (Fig. 4–19). Rehang the bottle of fluid and complete the change.
4. When moving the arm of a patient who has an IV catheter in place, support the arm firmly so that the catheter does not become dislodged. Remember to keep the bottle of fluid above the infusion site in order to prevent blood from flowing into the tubing.



Figure 4–19
Place soiled gown to one side of the table or on top of the IV pump. Do not disengage the tubing from the IV infusion.

If the intravenous infusion is being controlled by a pump and the patient's gown becomes wet or soiled and must be changed, do not attempt to disengage the IV tubing from the pump. In this case, you should:

1. Remove the gown from the unaffected arm, and place the soiled gown to one side of the table until the nurse in charge of monitoring the infusion can remove it.
2. Then replace the soiled gown with a clean gown over the unaffected side and the chest only.

Skin Care

The radiographer is responsible for the care of his patient's skin or integumentary system while he is in the diagnostic imaging department. Skin breakdown can occur in a brief period of time (1 to 2 hours) and result in a decubitus ulcer that may take weeks or months to heal. Mechanical factors that may predispose the skin to breakdown are immobility, pressure, and shearing force.

Immobilizing a patient in one position for an extended period of time creates pressure on the skin bearing the patient's weight. This, in turn, restricts capillary blood flow to that area and can result in tissue necrosis.

Moving a patient to or from a diagnostic imaging table too rapidly or without adequately protecting his skin may damage the external skin or the underlying tissues, as they are pulled over each other creating a shearing force. This, too, may lead to tissue necrosis.

Another factor that contributes to skin breakdown is friction caused by movement back and forth on a rough or uneven surface such as a wrinkled bed sheet. Allowing a patient to lie on a damp sheet or remain in a wet gown may lead to skin damage. Similarly, urine or fecal material that is allowed to remain on the skin acts as an irritant and is damaging to the skin.

Early signs that indicate imminent skin breakdown are blanching and a feeling of coldness over pressure areas. This condition is called *ischemia*. Ischemia is followed by heat and redness in the area as the blood rushes there in an attempt to provide the traumatized skin with nourishment. This pro-

cess is called *reactive hyperemia*. If, at the time of reactive hyperemia, the pressure on the threatened area is not relieved, the tissues begin to necrose, and a small ulceration is soon visible. Ischemia and reactive hyperemia are difficult to visualize in patients who are dark skinned. In these cases, the radiographer must feel the skin to assess for threat of skin damage.

A shearing injury to the skin may cause it to appear bluish and bruised. If such an area is not cared for, necrosis and ulceration will occur.

Persons who are most prone to skin breakdown include the malnourished, the elderly, and the chronically ill. A patient who is elderly or who is in poor health may have dehydrated skin, an accumulation of fluid in the tissues (edema), increased or decreased skin temperature, or a loss of subcutaneous fat that acts to protect the skin. Any of these factors will contribute to the potential for skin breakdown, and the radiographer must be particularly cautious when moving or caring for this type of patient.

PREVENTING DECUBITUS ULCERS

Protection of the integumentary system must always be a consideration when caring for patients in the diagnostic imaging department. The tables on which the patients must be placed for care are hard, and often the surface is unprotected. The areas most susceptible to decubitus ulcers are the scapulae, the sacrum, the trochanters, the knees, and the heels of the feet.

The radiographer should assist the patient who is on a gurney or diagnostic imaging table for long periods of time to change his position, or change it for him if he is unable to do so. Pressure should be kept off hips, knees, and heels. This can be done by placing a pillow or soft blanket under the patient or by turning him to a different position whenever possible. This is done in the usual hospital situation every 2 hours. If the patient is lying on a hard surface, it should be done every 30 minutes. If a patient is perspiring profusely or is incontinent of urine or feces, the radiographer should make certain that he is kept clean and dry, and precautions must be taken when moving the patient to prevent skin abrasions.

Special precautions should be taken to protect the patient's feet and lower legs during a position change or transfer. The feet should be protected by shoes, and care should be taken to prevent bruising as the move is made. Circulatory impairment in the lower extremities is common, and the slightest bump may be the beginning of an ulceration.

Cast Care and Traction

Radiographic exposures of fractures that have been casted are often needed to determine correct positioning of musculoskeletal tissues. Casts may be made of plaster (gypsum), fiberglass, plastic, or cast-tape materials. The material used is dependent upon the type of injury, the length of time needed for immobilization, and the physician's preference.

The radiographer often cares for the patient who has a newly applied cast. Some of the materials used, particularly plaster, contain water and can accidentally be compressed. Compression of a cast may produce pressure on the patient's skin under the cast and this, in turn, may lead to the formation of a decubitus ulcer at the site of cast compression.

A cast that becomes too tight may cause circulatory impairment or nerve compression. To prevent these complications, the radiographer must be able to assess the patient for circulatory or neurologic impairment and must learn to move a cast with care.

When moving a patient who is wearing a cast, the radiographer should slide his opened, flattened hands under the cast. He should avoid grasping the cast with the fingers as this may cause indentations if the cast material is still damp. A cast must be supported at the joints when it is moved. A casted extremity must be moved as a unit with flat hands supporting it at the joints (Fig. 4–20). When moving a patient who has an abduction bar placed between the legs of a spica cast, it is imperative that the abduction bar not be used as a moving or turning device.



Figure 4–20
Support a cast at the joints when moving it.

In order to position a patient who is in a cast, the radiographer will need to have bolsters or sandbags on hand so that the cast can be well supported. A recently casted limb should usually be kept elevated. If a cast is allowed to put pressure on the skin in any area, it may impede circulation or damage underlying nerves.

A patient with a cast who is in the diagnostic imaging department for any length of time should be assessed for signs of impaired circulation or nerve compression every 15 minutes. A cast applied to an arm may cause a circulatory disturbance in the hand; a leg or body cast may affect circulation in the feet, toes, or lower leg. Signs of impaired circulation or nerve compression that the radiographer may easily detect are as follows:

Pain: Pain that is sudden in onset or that increases with passive motion may indicate nerve damage.

Coldness: Fingers or toes distal to a cast should feel warm.

Numbness: Cast that is too tight may cause numbness, another sign of nerve damage.

Burning or tingling of fingers or toes: These symptoms may indicate circulatory impairment.

Swelling: Indicative of edema, swelling may result in circulatory impairment or nerve compression.

Skin color changes (to a pale or bluish color): Skin should remain pink and warm. In dark-skinned persons, temperature and comparison with the normal extremity are evaluated.

Inability to move fingers or toes: All fingers and toes should be able to be moved, fully extended, and flexed.

Decrease in or absence of pulses: These changes may indicate circulatory impairment.

If any of these changes are observed, the radiographer must notify the physician in charge of the patient immediately. The physician may order a change in the patient's position in an attempt to relieve pressure.

If the patient in a body cast or a spica cast reports difficult respirations or nausea, or is vomiting, the physician must be notified as this may indicate abdominal distress that requires immediate treatment.

The radiographer who is called on to take radiographic films of patients who are in traction will need to use a portable machine. The radiographer working with a patient in a traction device must never remove the traction apparatus or relieve the pull of the traction. To do so may cause a reduced fracture to become misaligned. If the radiographer is unable to complete the assignment because of a traction apparatus, he may have to enlist the help of the nurse in charge of the patient.

Assisting the Patient With a Bedpan or Urinal

A patient may spend several hours in the diagnostic imaging department; often he is not able to postpone urination or defecation. He may be embarrassed about making the request and will wait until the last possible moment to do so. When such a request is made, the radiographer should respond quickly yet treat it in a matter-of-fact manner.

1. If possible, help the patient to reach the lavatory near his examining room; this is the most desirable way to handle the situation. However, do not allow the patient to go to the toilet without assistance. Help him to put on his slippers or shoes, and wrap the draw sheet around him if no robe is available. Help him off the radiographic table or out of his wheelchair, and lead him to the lavatory. A patient may have been fasting, or he may have been given drugs that make him very unsteady; therefore, it is not safe to leave him unattended.
2. If the patient can help himself in the lavatory, close the door and tell him that you will be just outside in case he needs you. Each lavatory should be equipped with an emergency call button, and you should explain its use to the patient. If there is no emergency call button, check on the patient at frequent intervals in order to be certain that his condition is stable.
3. After the patient has finished using the lavatory, help him to wash his hands if he cannot do so himself.
4. Then accompany him back to the examination area.
5. Cover him and make him comfortable.
6. Return to the lavatory and make certain that it is clean.
7. Wash your hands.

THE BEDPAN

The patient who is unable to get to the lavatory must be offered a bedpan or urinal. In the diagnostic imaging department, clean bedpans and urinals are usually stored in a specific place. The radiographer is charged with ascertaining that the bedpan or urinal to be used has been sterilized between uses.

There are two types of bedpan. The standard bedpan is made of metal or plastic and is approximately 4 inches high (Fig. 4–21). It can be used by most patients. However, a patient may have a fracture or another disability that makes it impossible for him to use a pan of this height. For these patients, the fracture pan is used. All diagnostic imaging departments should have these pans available (Fig. 4–22).



Figure 4–22
A fracture pan.

1. Before assisting the patient, wash your hands and then obtain tissue and a bedpan with a cover. If the pan is cold, run warm water over it, then dry it. If possible, close the examining room door, or screen the patient to ensure privacy. Always place a sheet over the patient while helping him onto the bedpan.
2. Next, approach the patient. Remove the bedpan cover, and place it at the end of the table. If the patient is able to move himself, place one hand under his lower back, and ask him to raise his hips.
3. Place the pan under the hips (Fig. 4–23). Be sure he is covered with a sheet. If he is able to sit up, assist him to a sitting position. Do not leave a patient sitting on a bedpan—he is poorly balanced and may fall.
4. If you cannot stay with the patient, or if the patient is not able to sit up, place two or three pillows behind his shoulders and head so that he is comfortable. Leave the toilet tissue where he can reach it. Let the patient be alone, but remain nearby so that when he has finished you are on hand to assist him.
5. When the patient has finished using the bedpan, don clean, disposable gloves and help him off the pan. Have the patient lie back, place one of your hands under the lumbar area, and have him raise his hips.
6. Remove the pan, cover it, and empty it in the designated area. Then rinse it clean with cold water and return it to the area where used equipment is placed.
7. Offer the patient a wet paper towel or washcloth to wash his hands and a dry paper towel to dry them.
8. Remove your gloves as described in Chapter 3 and wash your hands.

If a patient is unable to assist in getting himself onto and off a bedpan, do not attempt to help him



Figure 4–21
A standard bedpan.



Figure 4–23
Place one hand under the patient's lower back and ask him to raise his hips so you may place the pan.

alone. Enlist the aid of another team member. Have that person stand at the opposite side of the table. With the assistance of the second radiographer, turn the patient to a side-lying position. Place the pan against the patient's hips, then turn him back to a supine position while holding the pan in place. Be certain that his hips are in good alignment on the pan. Place pillows under the patient's shoulders and head and stay nearby. When he has finished using the pan, put on clean gloves and reverse the procedure in order to remove the pan.

If the patient is not able to clean the perineal area himself, you will have to assist him. Wear clean, disposable gloves to do this.

1. Take several thicknesses of tissue and fold them into a pad. Wipe the patient's perineum from front to back, then drop the tissue into the pan; if necessary, repeat the procedure until the perineum is clean and dry.
2. Cover the pan and empty it and place it in the soiled equipment area for resterilization.
3. Remove your gloves correctly and wash your hands.

If a patient has difficulty in moving or adjusting to the height of a regular bedpan, follow the same procedure using the fracture pan. The end with the lip is the back of the pan.

THE MALE URINAL

The male urinal is made of plastic or metal and is so shaped that it can be used by a patient who is supine, lying on his right or left side, or in Fowler's position (Fig. 4–24). The urinal may be offered to the male patient who is unable to get off of the gurney or examining table to go to the lavatory.

1. If the patient is unable to help himself, simply hand him an aseptic urinal and allow him to use it, providing privacy whenever possible.
2. When he has finished, put on clean, disposable gloves, remove the urinal, empty it, and rinse it with cold water. Then place it with the soiled supplies to be resterilized.
3. Offer the patient a washcloth with which to cleanse his hands.
4. Remove gloves and wash your own hands.

If a patient is unable to assist himself in using the urinal, the radiographer must position the urinal for him.



Figure 4–24
Male urinal

1. Don clean, disposable gloves; raise the cover sheet sufficiently to permit adequate visibility, but do not expose the patient unduly.
2. Spread the patient's legs and put the urinal between them.
3. Put the penis into the urinal far enough so that it does not slip out, and hold the urinal in place by the handle until the patient finishes voiding.
4. Remove the urinal, empty it, replace it, remove your gloves, and wash your hands.

Departmental Safety

Prevention of patient and personnel injury is the responsibility of all health care workers. It is the radiographer's responsibility to practice safety in all aspects of his work. This includes fire and electrical safety; prevention of patient or staff falls; prevention of poisoning; and safe disposal of hazardous waste and toxic chemicals.

There are institutional, local, state, and federal agencies that regulate safety in health care institutions and there are safety committees in all JCAHO-accredited health care agencies. There are fire departments in all cities that routinely evaluate the fire safety of health care and community institutions. There are poison control centers that advise health care institutions if poisoning is possible. There is the Nuclear Regulatory Commission (NRC), which enforces radiation safety and nuclear medicine standards. The Environmental Protection Agency (EPA) establishes guidelines for the disposal of radioactive waste.

FIRE SAFETY

It is the radiographer's obligation to learn the fire-containment guidelines in any institution in which he works as a student or as an employee. He must know the following:

1. The telephone number in the institution for reporting a fire. The number must be posted in a clearly visible location next to the telephone.
2. The agency's fire drill and fire evacuation plan.
3. The location of the fire alarms.
4. The routes of evacuation in case of fire.
5. The locations of fire extinguishers and the correct type for each type of fire.
   Carbon dioxide extinguisher—grease or electrical fire
   Soda and acid (water extinguisher)—paper and wood fire
   Dry chemical extinguisher—rubbish or electrical fire
   Water pump—rubbish or wood fire
   Antifreeze or water—rubbish, wood, grease, or anesthetic fire
6. A fire must be reported before an attempt is made to extinguish it, regardless of the size.
7. Hallways must be kept free of unnecessary equipment and furniture.
8. Fire hoses must be kept clear at all times.
9. Fire extinguishers must be inspected at regular intervals. Fire drills must be regularly scheduled for agency personnel.
10. Warning signs must be posted that state that, in case of fire, elevators are not to be used and stairways must be used instead.

If fire should occur, the correct procedure for patient safety must be followed:

1. Persons in imminent danger are to be moved out of the area first.
2. Windows and doors are to be closed.
3. If oxygen is in use, it must be turned off.
4. Patient and staff evacuation procedures must be followed.

General rules for the prevention of accidents involving electrical equipment should include the following:

1. Use only grounded electrical plugs (three pronged) inserted into a grounded outlet.
2. Do not use electrical equipment when hands or feet are wet or when standing in water because water conducts electricity.
3. When removing an electrical plug from an outlet, grasp the plug at its base. Do not pull on the electrical cord.
4. Electric cords must be unkinked and unfrayed. If they are not, they must not be used.
5. Any electrical equipment must be in sound working order to be used for patient care. If it is not, the equipment must be returned to the manufacturer or to the area designated for repair service.
6. All electrical equipment must be tested before it is used for patient care.
7. Report any shocks experienced and do not use equipment if a patient reports that it gives a tingling feeling or a shock.
8. Do not use a piece of electrical equipment that you do not understand.
9. To prevent falls, do not use extension cords that are not grounded and secured to the floor with electrical tape.

PREVENTION OF FALLS

Patient falls are one of the most common hospital accidents. The radiographer must always be on guard to prevent falls. No patient should be allowed to get out of a wheelchair or off of a gurney or radiographic table without assistance from the radiographer or his designee.

The patients most prone to falls are the frail elderly, persons with neurologic deficits, persons who are weak and debilitated due to prolonged illness or lengthy preparation for procedures, persons with head trauma, persons with sensory deprivations, persons who have been medicated with sedating or psychoactive drugs, and confused patients.

The radiographer must adhere to the following rules:

1. Learn the condition of your patient and determine whether he is safely able to enter, remain in, or leave the diagnostic imaging department without assistance.
2. Keep floors clear of objects that may obstruct pathways.

3. Keep equipment such as gurneys, portable radiographic machines, and wheelchairs in areas where they do not obstruct passageways.
4. Side rails must always be up when a patient is on a gurney.
5. A wheelchair must be locked if a patient is in it; a soft restraint may be needed if the patient is not reliable and may try to get up without assistance.

POISONING AND DEPOSITION OF HAZARDOUS WASTE MATERIALS

The number of the nearest Poison Control Center must be posted near department telephones. The radiographer must adhere to the following:

1. Any toxic chemical or agent that may poison patients or staff must be clearly labeled as such.
2. These substances must be stored in a safe area designated for them.
3. Emergency instructions to be followed in case of poisoning must be conspicuously posted in the diagnostic imaging department.
4. Chemicals must remain in their own containers marked as toxic substances.
5. Chemical and toxic substances must be disposed of according to federal mandates and institutional policy.
6. Restrictions for disposal of hazardous materials must be posted in a conspicuous area and followed by all in the department.
7. Contrast agents and other drugs must be kept in safe storage areas where access to them is not available to anyone not designated to use them.
8. All containers of hazardous substances must be clearly marked with the name of the substance, a hazard warning, and the name and address of the manufacturer.
9. Hazardous substances may be labeled with a color code that designates the hazard category, for instance, *health, flammability,* or *reactivity.*

The radiographer must read and fully understand all hazard warnings before using any product and follow the guidelines as stated on the label. If there is no label, or the label is unclear, the product must not be used.

If an accidental spill of a hazardous substance occurs, first aid guidelines are as follows:

Eye contact: Flush eyes with water for 15 minutes or until irritation subsides. Consult a physician immediately.

Skin contact: Remove any affected clothing; wash skin thoroughly with gentle soap and water.

Inhalation: Remove from exposure; if breathing has stopped, begin CPR; call emergency number and a physician.

Ingestion: Do not induce vomiting; call emergency number and Poison Control.

Diagnostic imaging personnel must understand the potential hazards of scalds or burns that may occur in their department. Although heating pads and hydrotherapy are not commonly dealt with by radiographers, they must be aware of their potential hazards and refer use of this type of equipment to nurses and those instructed to handle them safely.

Hot beverages must be kept away from children. Coffee and tea equipment used in staff lounges must be kept in safe working order and deactivated when empty or not in use. If a patient is offered a hot beverage, it should be at a temperature that will not scald him should it accidentally be spilled.

RADIATION SAFETY

It is the radiographer's responsibility to protect himself, the patient, his coworkers, and any person in the vicinity from radiation exposure. While the benefit of rapid medical diagnosis by exposure of the patient to radiation outweighs the associated risks, it is the radiographer's aim to use, consistently, the least amount of exposure necessary to achieve this diagnostic end.

Ionizing radiation in excessive amounts or in amounts above the accepted level in a brief time period can result in either illness to the recipient or a potential genetic disturbance to the descendants of the recipient. Other factors that can increase the risk of suffering the adverse effects of ionizing radiation are the patient's age at exposure, sensitivity of exposed cells, and the portion of the body exposed. The very young, the very old, and pregnant women are the most vulnerable to adverse effects of radiation.

The goal of the radiographer must be to limit the amount of ionizing radiation to acceptable limits in the patient, others in the vicinity, and himself.

To do this, the following precautions must be followed:

1. Maintain exposure to a level *as low as reasonably achievable* (ALARA).
2. Minimize the length of time the patient or others in the vicinity are placed in the path of the x-ray beam.
3. Maximize the distance between the source of the ionizing radiation and the person exposed to it.
4. Maximize the shielding from exposure of the patient and others in the vicinity of the radiation.

Time: Use the shortest exposure time possible. Remember that radiation dosage increases with fluoroscopic imaging.

Distance: The closer one is to the radiation beam, the greater the exposure. The larger the field of radiation, the greater the risk of scattering the ionizing radiation and the greater the exposure risk. Increasing distance from the source greatly reduces the exposure risk of the radiographer and others in the vicinity.

Shielding: Shielding persons who are unable to reduce their exposure either by limiting time or increasing distance is the third alternative for protection from ionizing radiation. Shielding may be done by setting up a protective barrier, usually lead or an equivalent, between the source of the ionizing radiation and the subject involved, be it the patient or others in the vicinity. There are primary and secondary barriers. Primary barriers are usually made of lead or similar material; they are designed to withstand being struck by the beam exiting the x-ray tube without allowing passage of ionizing radiation. Secondary barriers are designed to prevent passage of scatter and leakage, rather than direct, radiation.

It is the radiographer's obligation to ascertain that all persons who are involved in, or who are in the vicinity of, a radiographic procedure are provided with appropriate protective apparel to shield them from ionizing radiation. This includes the patient, the physician, nurses, observers, and radiographers. Shielding can include a lead apron, lead gloves, a gonadal shield, a thyroid shield, and lead goggles (Fig. 4–25).

Use of gonadal shielding to protect male and female reproductive organs (ovaries and testes) is of vital importance. This is of particular importance if the patient is a child or an adult of childbearing age. There are several types of gonadal shields including flat and molded contact shields (Fig. 4–26).



Figure 4–25
Lead apron, thyroid shield, lead goggles, and film badge.

The radiographer must also use his technical expertise to minimize patient exposure to radiation. This includes beam limitation, technique selection, filtration, intensifying screens, and grids. Explanations of these techniques are beyond the scope of this text, and their use will be discussed in detail in other radiologic technology courses.

It is the radiographer's responsibility to understand the technical aspects of the profession in order to minimize the number of repeat radiographs necessary to achieve a diagnostic purpose. The need to frequently repeat exposures should influence the radiographer to employ his critical thinking skills to assess and solve the problems he is encountering. He must assess his ability to clearly communicate with the patient as well as keep pace with the necessary technical knowledge.

Estimates of patient exposure to ionizing radiation must be made available in the radiographic imaging department. These estimates denote the amount of radiation an average patient undergoing a given procedure would expect based on standard technique charts. The amount of exposure



Figure 4–26
Flat gonadal shield.

actually received is then compared to these estimates. All radiographic imaging equipment must also be inspected for radiation safety at regularly scheduled times.

Lead aprons and other protective apparel must be inspected periodically for quality control purposes. This apparel must be hung carefully over a wide bar or on special hangers when not in use. To fold or drop them may jeopardize their integrity.

Any health care worker, including the radiographer who works in constant contact with ionizing radiation, must be monitored to assess the amount of his exposure to it. This may be done by wearing a film badge sensitive to low radiation doses. The badge worn by the radiographer is processed and analyzed at regular time periods. Two other devices that monitor radiation exposure are the thermoluminscent dosimeter and a pocket dosimeter. The thermoluminiscent dosimeter is a plastic holder that contains crystals that absorb energy from radiation exposure. The pocket dosimeter is shaped like a penlight and contains a metal electrode surrounded by air. The air, if exposed to ionizing radiation, is ionized and neutralized by the electrode.

Special precautions must be taken to prevent exposing pregnant patients and pregnant health care workers to ionizing radiation. This is particularly true during the early weeks of pregnancy, when particular fetal tissues are especially sensitive to radiation. There is a rule called "the 10-day guideline rule" that states that any female in her childbearing years who is fertile should limit elective abdominal radiographs to the 10-day period following onset of menstruation. Since this is not a simple rule to follow, it may be used at the discretion of the physician in charge of the patient. Pregnant radiographers must limit their amount of exposure to radiation. The recommended dose limit (not to include medical exposure) for a fetus should not exceed 0.5 rem during the entire period of gestation, and the limit should not exceed 0.05 rem in any month.

To minimize their radiation exposure, radiographers should not hold patients who cannot maintain a particular position during a radiographic procedure. If a position cannot be maintained by a patient, bolsters or sandbags can be used. If this is not feasible, a relative or a person who is not working regularly in radiography should be requested to assist.

Summary

When a patient from outside the hospital arrives in the diagnostic imaging department, it is often necessary that he undress entirely or partially for the diagnostic examination or treatment. The radiographer should always show the patient where and how to do so in a sensitive manner in order to spare the patient embarrassment.

It is also the radiographer's responsibility to provide the patient with a safe place for his personal belongings. Remember that an article that may not seem valuable to the radiographer may be treasured by the patient. Everything that belongs to the patient must be treated as if it were of value.

Radiographers must always use correct body mechanics, beginning with good posture. When moving or lifting in the workplace, the weight must be kept close to the body and a firm base of body support maintained. This is accomplished by having the feet slightly spread and the knees flexed. The body should never be twisted or bent at the waist when lifting a heavy load. Weight should be pulled, not pushed. Arm and leg muscles, not the spine, should be used for lifting.

The three ways of moving patients are by gurney, by wheelchair, or by ambulation. When moving and lifting patients, the radiographer must assess the patient and resolve potential problems before beginning the transfer. The plan for moving the patient should be explained to him, and his help should be enlisted before beginning. The radiographer must always notify the ward personnel when taking a patient to or from his room in the hospital.

When a patient is on the radiographic table or on a gurney in the diagnostic imaging department, his body must be in good alignment. If he is moved to a particular position for an examination, correct body alignment must be restored as soon as possible.

There are times when immobilizers must be used for the safety of the adult patient. When immobilizers are required, they must be applied according to manufacturer's directions and the policy of the institution. Radiographers must not immobilize a patient without an order by a physician. When a patient is immobilized, he must be attended at all times and restraints must be released at least every 2 hours. The correct manner of documenting restraints must be followed.

Care must be taken to prevent the patient's skin from being damaged while he is being cared for in the diagnostic imaging department. This can be done by preventing injury that may come from immobility, pressure, shearing force, or friction. Patients most susceptible to skin breakdown are the malnourished, the elderly, and the chronically ill. Special care must be taken to protect these patients from injuries to their integumentary system, because it may result in a decubitus ulcer that can take months to heal. The radiographer must also take extra precautions when caring for a patient who is wearing a plaster cast or who is in traction. The extremities must be observed for evidence of neurocirculatory impairment that may result from the pressure of a cast on the skin. Some symptoms of neurocirculatory impairment that are easily detected are pain, coldness, numbness, burning or tingling of fingers or toes, swelling, color changes of the skin, or an inability to move fingers or toes. If these symptoms are noted, the radiographer must change the patient's position and report the problem to the physician immediately. A traction apparatus must not be released while taking a radiographic image. If the radiographer cannot complete a procedure because of this, he must request assistance from the nurse in charge of the patient.

If a patient cannot help himself to undress, the radiographer must offer assistance. This assistance should be given in a matter-of-fact manner that does not violate the patient's privacy.

Patients must be kept clean and dry while in the diagnostic imaging department. It will be the radiographer's duty to change the disabled patient's gown and covering if they become wet or soiled. This must be done in a prescribed manner to ensure privacy, safety, and comfort.

Some examinations done in the diagnostic imaging department are long and tedious. They often stimulate peristalsis and a need to defecate or urinate. Meeting these needs cannot be postponed. The radiographer must be prepared to assist with the bedpan or urinal if necessary. This should be done in a way that assures the patient as much privacy as possible.

Infection-control measures must be taken by the radiographer as he assists with bedpans or urinals. These items must be used for one patient only and then taken to an area for resterilization. The radiographer must don clean, disposable gloves when assisting with the patient's elimination needs, and he must wash his hands following removal of the gloves. The patient must not be left unattended while on a bedpan, on a gurney, or on a diagnostic imaging table. Patients must never be allowed to get on or off an examining table or out of a wheelchair without assistance. They must also be carefully attended on trips to the lavatory and in a dressing area following an examination or treatment.

The radiographer must be constantly on guard to protect patients and other staff members from accidents. Falls are the most common accident in hospitals. If the radiographer is knowledgeable about his patients' condition and attends to them carefully when they are in his care, most falls can be prevented.

The radiographer must understand the precautions that must be taken routinely to prevent fire and the correct procedures to follow should a fire occur. Prevention of accidents due to faulty electrical equipment, poisoning, and correct use and disposal of hazardous materials is also his professional obligation.

The radiographer must protect himself, the patient, and his coworkers from unnecessary exposure to ionizing radiation as excessive amounts, or amounts above the accepted level, may adversely affect the individual or his descendants. The very young, the very old, and pregnant women are particularly susceptible to adverse effects of ionizing radiation. Precautions to prevent excessive exposure involve knowledge, technical expertise, and constant vigilance as the radiographer works.

Chapter 4, Pre–Post Test

____ **1.** When admitting a patient to the diagnostic imaging department, the radiographer should
- **a.** Take the patient to the dressing area and explain in some detail how the patient should dress (or undress) for the procedure
- **b.** Give the patient directions concerning how to care for purses or valuables brought to the department
- **c.** Assist any patient who appears to need assistance with preparation for an examination
- **d.** a and b
- **e.** a, b, and c

____ **2.** The most effective means of reducing friction when moving a patient is by
- **a.** Placing the patient's arms across his chest and using a pull sheet
- **b.** Pushing rather than pulling the patient
- **c.** Rolling the patient to a prone position
- **d.** Asking the patient to cooperate with you

____ **3.** When transporting a patient back to his hospital room, some safety measures to be used are
- **a.** Place the side rails up, the bed in "low" position, and the call bell at hand
- **b.** Inform the nurse in charge of the patient that the patient has been returned to his room
- **c.** Give the patient something to eat or drink
- **d.** a and b
- **e.** a, b, and c

____ **4.** List seven potential problems that the radiographer must consider when assessing a patient's ability to move.

____ **5.** The following procedure(s) must be observed when assisting a patient with a bedpan:
- **a.** The patient's privacy must be respected
- **b.** Assistance should be sought for an immobile patient
- **c.** Clean gloves are worn to remove the bedpan
- **d.** a and c
- **e.** a, b, and c

____ **6.** Match the following patient positions with the correct definition:
1. Patient on side with forward arm flexed and top knee flexed
2. Semisitting with head raised 45° to 60°
3. Patient lying flat on back
4. Patient on back with head lower than extremities
5. Patient on back with head raised 15° to 30°

- **a.** Fowler's position ____
- **b.** Supine position 3
- **c.** Semi-Fowler's position ____
- **d.** Trendelenburg position ____
- **e.** Sims' position 1

____ **7.** Contributing factor(s) to skin breakdown are
- **a.** Turning every 1 to 2 hours
- **b.** Friction and pressure
- **c.** Frequent diagnostic imaging procedures
- **d.** An unstable environment

8. Two convenient and safe methods of moving a patient from a radiographic table to a gurney are _____ and _____.

9. Describe three legitimate reasons for application of immobilizers to an adult patient.

10. List seven rules to be followed if immobilizers are to be used during patient care in the diagnostic imaging department.

____ 11. If a patient who has a cast in place complains of pain that is sudden in onset and increases in intensity when the patient's affected limb is moved, the radiographer should
   a. Complete the procedure and discharge the patient
   b. Elevate the affected limb
   c. Notify a physician immediately
   d. Find a nurse to administer pain medication

12. When caring for a patient who has a new cast applied to an extremity, the radiographer must remember to
   a. Hold the cast firmly at a position between the joints when moving it
   b. Observe for signs of impaired circulation
   c. Support the cast with bolsters and sandbags
   d. a, b, and c
   e. b and c

13. When caring for a patient who is disabled and difficult to move, the radiographer must remember that it is essential to
   a. Keep the patient as quiet as possible
   b. Work quickly
   c. Obtain as much help as necessary to avoid injury to the patient and the radiographer
   d. Move the patient by gurney

14. List four signs of circulatory impairment if a patient is wearing a plaster cast.

15. The leading cause of work-related injuries in the field of health care is
   a. Bumping into misplaced equipment
   b. Overexposure to radiation
   c. Poor hand-washing techniques
   d. Abuse of the spine when moving and lifting patients

16. List five general rules for correct upright posture.

17. It is within the radiographer's scope of practice to release a traction apparatus if he sees fit to do so.
   a. True
   b. False

18. When moving a heavy object, the radiographer should _____ the weight, not _____ it.

19. List eight fire-prevention and containment guidelines the radiographer must learn and use routinely.

20. List the rules to be followed concerning toxic chemicals in the diagnostic imaging department.

21. Explain the first aid precautions to be used in event of eye or skin contact, inhalation, or ingestion of a toxic chemical.

22. List four precautions that the radiographer must use to protect himself and others from overexposure to ionizing radiation.

____ 23. When moving a patient into an unnatural position for a radiographic examination, the patient should maintain that position
   a. Until he asks to be moved

b. Until the film is developed and approved by the radiologist
c. Only for the time it takes to make the exposure
d. a and b
e. b and c

24. List the four areas of the body that are most susceptible to skin breakdown.

25. Patients most prone to falls are
a. The frail elderly
b. The person who is confused
c. Persons who have been given a psychoactive drug
d. Persons with sensory deficits
e. a, b, c, and d

26. A student radiographer must take repeat radiographs on his patients several times due to their poor quality. The student must question
a. His technical knowledge
b. His lack of concern for the patient
c. His communication skills
d. a and b
e. a and c

27. Explain precautions to be taken by the radiographer who is 8 weeks pregnant.

28. A 4-year-old girl is in the diagnostic imaging department for skull radiographs after falling out of a grocery cart. She is accompanied by her mother. The child is screaming and flailing about. You are assigned to her care and are concerned that you will be unable to obtain satisfactory radiographs. Her radiographs are important to her diagnosis because skull fracture is suspected; however, she is in danger of falling from the table in her agitated state. Your best approach to this problem would be to
a. Put on a lead apron and lead gloves and hold her yourself while another radiographer takes the radiographs
b. Ask another radiographer to hold the child
c. Send the child home until she is more tranquil
d. Ask her mother to hold the child
e. Sedate her and then proceed

○ *Laboratory Reinforcement*

1. A patient who is totally paralyzed on her right side comes to the radiology department from a hospital ward. Her gown has become wet and must be changed. Demonstrate, in the school laboratory, how you will perform this task.

2. The paralyzed patient in situation 1 must use the bedpan for urination. Demonstrate in the laboratory the proper way to assist her.

3. In the school laboratory, using a fellow student as a patient, demonstrate the following:
A. A sheet transfer from a hospital bed to a gurney
B. A log-roll move
C. The proper method of assisting a disabled patient from the radiographic table to a wheelchair
D. The proper method of positioning a patient in the prone position
E. The proper method of assisting a patient from a supine position to a sitting position

4. In the school laboratory, practice application of limb immobilizers, ankle or wrist immobilizers, an immobilizing vest, and a waist immobilizer.

5. In the school laboratory, practice tying a half-knot.

Critical Thinking Problems

1. Mary Sleepless had knee replacement surgery 6 days ago. She is about to be discharged from the hospital following an uneventful postoperative course. Her physician has ordered radiographs of the affected knee prior to discharge. The doctor's orders for this patient are that she may be up on crutches with no weight bearing on the affected knee. There are no telescoping radiographic tables in the diagnostic imaging department in which you work. How will you transport this patient and move her on and off of the radiographic table?

2. Janice Smiley is an 85-year-old Caucasian female who is 5 feet tall and weighs 200 pounds. She was admitted to the acute care unit in the hospital in which you are working for dyspnea related to chronic obstructive pulmonary disease. She is to have a portable chest radiograph. When you arrive in Ms. Smiley's room, you find that she is in severe respiratory distress and is unable to move herself in bed. How will you proceed with your assignment?

5

Surgical Asepsis

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Gowning
Gloving
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Taking Radiographic Films in the Operating Room
Skin Preparation for Sterile Procedures
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Changing Dressings
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Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Define the term *surgical asepsis* and differentiate between *medical asepsis* and *surgical asepsis*.
2. Explain the radiographer's responsibility for maintaining surgical aseptic technique when it is a required part of patient care.
3. Differentiate between disinfection and sterilization.
4. List and define methods of sterilization and disinfection.
5. List the rules for surgical asepsis.
6. Demonstrate the correct method of opening a sterile pack and of placing a sterile object on a sterile field.
7. Demonstrate the correct method of putting on a sterile gown and sterile gloves.
8. Demonstrate skin preparation for a sterile procedure.
9. Demonstrate the correct method of removing and reapplying a sterile dressing.

Glossary

Antimicrobial: any substance or procedure that kills microorganisms or suppresses their multiplication or growth
Antiseptic: any substance that inhibits the growth of bacteria
Barriers: a covering used to prevent contact with body fluids
Breaches: breaks in technique
Contamination: the act of soiling or making inferior by contact or mixing, as by introducing organisms into a wound
Disinfectant: an agent that destroys infection-producing organism
Dominant: exerting a ruling or controlling influence
Drape: to cover
Fenestrated: having one or more openings
Fluoroscopy: an examination in which the patient is positioned so that the part to be viewed is placed between the x-ray tube and the fluorescent screen
Germicide: an agent that kills bacteria outright

Invasive: involving puncture or incision of the skin or insertion of an instrument or injection of foreign material into the body; used in describing diagnostic technique
Laminar air flow: filtered air moving along separate parallel flow planes to various areas
Microwaves: a wave typical of electromagnetic radiation for infrared radio waves
Parenteral: by subcutaneous, intramuscular, intrasternal, or intravenous injection
Ratchet: the section of the forceps that allows an instrument to remain closed and firmly locked until released
Spores: the refractive, oval body formed within bacteria, regarded as a resting stage during the life history of a cell
Sporicide: an agent that kills spores
Sterile field: an area protected from microorganisms, usually by a sterile sheet or covering onto which only sterile objects may be placed
Sterile pack: a package wrapped to maintain sterility and in which all items for a particular medical or surgical procedure are contained
Sterilization: ridding instruments, dressings, etc., of all microorganisms and their pathogenic products
Thermal: pertaining to heat
Umbilicus: the depressed scar marking the site of entry of the umbilical cord in the fetus; also called *navel*
Vermin: an external animal parasite

Surgical asepsis differs from medical asepsis. In Chapter 3, medical asepsis is defined as any practice that helps reduce the number and spread of microorganisms. The term *surgical asepsis* is defined as the complete removal of microorganisms and their spores from the surface of an object. The practice of surgical asepsis begins with cleaning the object in question using the principles of medical asepsis. This is followed by a sterilizing process using the technique recommended for that item. Various applications of heat or chemical action accomplish total removal of microorganisms and spores.

Any medical procedure that involves penetration of body tissues (an invasive procedure) requires the use of surgical aseptic technique. This includes major and minor surgical procedures, administration of parenteral medications, invasive radiographic imaging procedures, catheterization of the urinary bladder, tracheostomy care, and dressing changes.

The radiographer is frequently required to go to the operating room (also called the OR or surgical suite) to perform diagnostic radiography during surgical procedures. Because this technique is also routinely practiced in the special procedures areas of the radiographic imaging department, the radiographer must be familiar with the required procedures.

Before any invasive procedure can be performed, the skin must be prepared (skin prep). The purpose of a skin prep is to remove oils, dirt, and as many microorganisms as possible prior to the procedure. This prevents contamination of the operative site, thereby reducing chances of infection. Hair is considered to be a contaminant and is frequently removed from the skin surrounding the operative site. Because the radiographer may be responsible for the skin prep in his own department, he must learn to perform this procedure effectively.

Occasionally, a physician may request that a patient's dressing be removed or a simple sterile dressing be reapplied by the radiographer. If not performed correctly, this procedure is another potential source of contamination for the patient or the radiographer.

Breaches in aseptic technique must be recognized by the radiographer, who must also be able to remedy the problem quickly. If not, contamination will go unrecognized and infection may result. It is the duty of all health care workers who participate in procedures requiring the use of surgical asepsis to be able to maintain strict surgical aseptic technique at all times because the patient's well-being is at stake.

The Environment and Surgical Asepsis

The means of transmission of microorganisms are discussed in Chapter 3. To review, the methods of transmission are by direct and indirect contact, by droplet, by vehicle, and by airborne route. Every possible effort is made in the surgical suite and in special procedures areas to protect the patient from infection. This is done by creating an environment that establishes barriers that limit the sources of contamination. All persons who enter the surgical suite are expected to follow the rules established to maintain these barriers.

Surgical departments have dress and behavior protocols that are strictly enforced. The radiographer who is assigned to work in this area is expected to follow these protocols. Comfortable, supportive shoes must be worn. Clogs, sandals, and cloth shoes are prohibited for reasons of safety. Meticulous personal hygiene is required. A shower should be taken shortly before reporting

for work in the OR. Jewelry and nail polish are prohibited because they harbor microorganisms. Any health care worker who has an acute infection or open skin lesion must not work in the surgical suite or special procedures area. All persons working in the OR must change their outer clothing and don special cotton garments called scrub suits before entering the suite. Shoe covers are required in some institutions.

If the radiographer must leave the surgical suite to develop films and then return, he must either change his scrub suit or place a protective gown over it; this gown is discarded before he re-enters the surgical suite. Hair must be completely covered with a surgical cap or hood at all times in the OR. Hands and arms are scrubbed as described for medical asepsis before entering a surgical suite, a special procedures room, or a neonatal intensive care unit.

A clean surgical mask is worn over the mouth and nose when an invasive procedure is in progress. The radiographer who must use radiographic equipment in the OR must clean it with a disinfectant solution before bringing it into the area. Many hospitals have radiographic equipment that is never removed from the surgical suite, and it is routinely cleaned by the house-cleaning department before and after every use.

Hands and forearms are scrubbed in a specified manner (called a surgical scrub) by persons participating in invasive surgical procedures. When this is completed, they dry their hands with a sterile towel, dress in a sterile gown, and put on sterile gloves. Medical personnel dressed in sterile attire prepared to participate in an invasive procedure are said to be "scrubbed" or "sterile." After a person is scrubbed, he may not touch anything that is not sterile. If he does so inadvertently, he is considered to be contaminated and must remedy this immediately.

Not all persons present during a surgical procedure are dressed in sterile gowns and gloves; however, they must all be dressed in a scrub suit, have their hair covered by a cap or hood, and wear a mask over the mouth. It is thought that the bare skin may shed microorganisms. In some surgical suites, persons in the operating room who are not in sterile gown and gloves must wear a scrub jacket to help prevent shedding from bare arms.

These sterile personnel are the only surgical attendants permitted to touch the sterile field, an area that has been prepared to receive sterile equipment. The circulating nurse monitors the sterile field and counts the sponges, needles, and instruments before and after each surgical procedure, because all of these must be accounted for.

Sterile linens and other equipment and supplies used for sterile procedures must be packaged in a particular manner to be considered safe for use. They must also be stored in a manner that protects them from contamination.

Any break in sterile technique increases the patient's susceptibility to infection. Those involved in carrying out a sterile procedure must constantly be aware of which areas and articles are sterile. If a sterile article is touched by an unsterile one, it must be replaced by an article that is sterile. A contaminated area must be made sterile again. Correct sterilization techniques must be learned and followed. Correct methods of opening sterile packs and donning sterile gown and gloves must also be learned and used without fail.

The use of contaminated instruments or gloves, a wet or damp sterile field, and microorganisms blown onto a surgical site are the most common causes of contamination. Ventilating ducts must have special filters in order to prevent dust particles from entering the room. Laminar air flow may be used to prevent drafts that transport dirt particles and microbes into the OR. Doors must always be kept closed during surgical procedures.

The radiographer whose work involves sterile procedures must develop a sense of responsibility and maintain the highest standards possible when practicing surgical asepsis. The patient's welfare depends on this.

The Surgical Team

The surgical team consists of a variety of staff members who serve the patient during surgery. They are as follows:

Surgeon: the physician who plans and performs the surgical procedure and makes the surgical decisions.

Surgical assistant: usually another surgeon, who may be a resident physician. There may be several assistants if the patient's surgical needs require this.

Anesthesiologist: a physician with special education in anesthesiology who makes the decisions concerning type of anesthesia required.

Nurse anesthetist: a registered nurse who has had special education in anesthesiology who administers anesthesia and monitors the anesthetized patient under the supervision of the anesthesiologist.

Circulating nurse: a registered nurse who coordinates the patient's care during the surgical procedure. This person does not don sterile garments but assists the team performing the surgery. The duties of the circulating nurse are as follows:

- Sets up the operating room and obtains all special equipment needed
- Greets the patient; interviews and prepares him for the procedure
- Performs the skin prep and, after the patient is anesthetized, assists in positioning him for the procedure
- Maintains sterility of the sterile field during the procedure; maintains other aspects of patient safety
- Assesses blood and urine loss of patient during procedure; documents pertinent care
- Is responsible for instrument, needle, and sponge count

Scrub nurse and surgical technologist: dresses in sterile gown and gloves; sets up the sterile field; assists with placing sterile drapes; passes instruments to the surgeon; and assists the circulating nurse with maintaining an accurate instrument, sponge, and needle count.

Radiologic technologist: assists with fluoroscopy as needed or takes radiographs to obtain diagnostic data. The radiographer may need to be present for an entire surgical procedure or may only be needed briefly. Although the radiographer is not required to don sterile garments, he must wear a scrub suit, cap, and mask while in the surgical suite, and scrub as for medical asepsis.

There are many other members of the surgical team who work behind the scenes to prepare surgical packs; procure, clean, and repair instruments; and limit contamination of the surgical suite.

Methods of Sterilization

Removal of microorganisms and their spores must be complete, or the article is not sterile. The method used to attain sterilization depends on the nature of the item to be sterilized. All effective methods of sterilization have advantages and disadvantages. The methods currently used include:

1. Steam under pressure
2. Gas
3. Chemicals
4. Dry heat
5. Ionizing radiation
6. Microwaves/nonionizing radiation

STEAM UNDER PRESSURE

Using steam under pressure is an effective and convenient means of sterilization for items that can withstand high temperatures and moisture. It is fast, convenient, and economical. Steam that is not pressurized cannot reach temperatures high enough to kill all microorganisms and their spores. Pressure is attained in a chamber called an *autoclave.*

There are several types of autoclave designed to sterilize with steam under pressure. Whatever type is chosen must allow the steam to penetrate every fiber of the article in order to accomplish its purpose. Some bacterial spores continue to live for longer than 3 hours in temperatures as high as 240°F (115°C), but none can live if the temperature is raised to 250°F (121°C) for longer than 15 minutes, so the temperature within the autoclave must reach this range for this period of time on every fiber to be sterilized. The time required to do this depends upon the contents of the pack and the temperature in the autoclave.

Indicators are placed in the center and outside of each pack to be sterilized. When the indicator changes color, it is proof that the contents of the pack have been exposed to steam sufficiently to change the color of the indicator, but it does not guarantee the sterility of the pack. There are variations among indicators used, and the radiographer must familiarize himself with the types used in his place of employment.

GAS

Sterilization by gas is the method of choice for items that cannot withstand moisture and high temperatures. A mixture of ethylene oxide and carbon dioxide or fluorinated hydrocarbon is used because ethylene oxide gas alone is flammable and explosive.

Gas sterilizers are heated from 120°F to 140°F (49°C to 60°C) with a humidity of 40% to 80%. This humidity is lower than is achieved with steam under pressure. The items to be sterilized, size, gas concentration, and temperature dictate time needed for sterilization to be achieved.

Gas sterilization should not be used for items that can be sterilized with steam. Glass ampules of

medication with rubber stoppers should not be gas-sterilized, because the gas may penetrate through the rubber stopper and change the chemical composition of the solution.

CHEMICALS

Chemical sterilization is used when an item cannot withstand heat, when gas sterilization is not available, or when the aeration time is lengthy. The only chemicals that may be used for sterilization purposes are those registered as sterilants by the United States Environmental Protection Agency and used as directed by the manufacturer. The chemical solution of choice at present is 2% activated, buffered alkaline glutaraldehyde, which is sporicidal on items immersed in solution for 6 to 10 hours.

DRY HEAT

Dry heat is used to sterilize anhydrous oils (oils containing no water), petroleum products, and bulk powders. It may also be used to sterilize some delicate cutting instruments that may be corroded or discolored by other methods of sterilization. It is a slow, uneven method rarely used in hospitals. The time it takes to sterilize with dry heat varies from 1 to 6 hours.

IONIZING RADIATION

Ionizing radiation is not used in institutions, but it is used in commercial sterilization. Cobalt-60 is the most common source of radiation sterilization. Ionic energy is converted to thermal energy during this process and causes the death of microorganisms and their spores.

MICROWAVES (NONIONIZING RADIATION)

This method of sterilization uses low-pressure steam and the nonionizing radiation of microwaves to produce heat that destroys microbes. It is a rapid method of sterilizing metal instruments, but has not yet been developed to obtain its maximum potential.

Disinfection

All items that penetrate the skin or mucous membranes must be sterile. Articles or surfaces that cannot be sterilized in the OR or special procedures area must be disinfected. Tables, floors, walls, and equipment used in areas where the patient is to have an invasive procedure are included in this category. Skin around the area to be penetrated is also disinfected. When skin is disinfected, the solutions used are called *antiseptics*. The term *disinfection* means that as many microorganisms as possible are eliminated from the surfaces by physical or chemical means. Spores are often not destroyed by disinfection.

Chemical disinfectants are numerous and vary in their effectiveness for destroying microorganisms. The nature of the contamination and the area or object to be disinfected are also taken into consideration when a disinfectant is selected for use. The manufacturer's directions must be followed carefully when using any chemical.

Physical methods of disinfecting are boiling in water and ultraviolet irradiation. Boiling may be used as a means of disinfection if no other method is available; however, many spores are able to resist the heat of boiling (212°F or 100°C) for many hours.

In order to increase the effectiveness of boiling, sodium carbonate may be added to the water in quantity to make a 2% solution. It should not be added if the material being boiled is made of rubber, because sodium carbonate will destroy the rubber. If an object is to be disinfected by boiling and sodium carbonate is added to the water, it should be boiled for 15 minutes. If sodium carbonate has not been added, boiling time should be 30 minutes.

Ultraviolet rays kill microorganisms when they come into direct contact with them. This is not a practical means of disinfecting for hospital use because there is no assurance that the ultraviolet has actually come into contact with microbes, which are in a constantly mobile state because of air currents.

Packing and Storing Sterile Supplies

There are several acceptable materials that can be used for packaging items that are to be sterilized. They are cloth, nonwoven fabrics, paper, and plastic. Whichever material is chosen for use, the following restrictions must be considered:

1. The sterilizing agent must be able to penetrate the material.
2. The sterilizing agent must be able to escape at the end of the sterilizing procedure.

3. Items packaged must be covered completely by the wrapper and securely fastened with tape or a heat seal that does not lend itself to reuse.

4. Pins, staples, or other sharp, penetrating objects must not be used to fasten packages, because they allow a port for contaminants to enter the pack when removed.

5. Contents must be identifiable, and evidence of exposure to the sterilizing agent must be present. Indicator tape with stripes that change color when exposed to the sterilizing agent is the most frequently used.

6. Packaging must be impermeable to dust, microbes, and moisture and must be able to maintain the sterility of the contents until opened.

7. The wrapper must be strong enough to remain damage free.

8. Items must be wrapped to allow opening and removing them without contamination.

9. The wrapping material must be free of toxic ingredients and dyes and be economical.

A special area is designated in hospitals for the preparation of sterile supplies by a method that is followed at all times. Cloth wrappers are made of muslin of a specified weight. If this material is used for wrapping, it must be used in quadruple thickness, usually accomplished by using two double-thickness wrappers together. Nonwoven fabrics are available in three thicknesses: light, medium, and heavy. Lightweight nonwoven fabrics must be used in four thicknesses and mediumweight in double thickness. Heavyweight nonwoven material is usually used for surgical drapes in single thickness.

All sterile items are stored in the same place, separate from nonsterile items. A sterile package must have an expiration date printed on it. The radiographer must check the sterilization date carefully to be certain that the shelf life (the time that the package may be considered sterile while being stored) has not been exceeded. If there is no date on the package, it must be considered unsterile.

All storage areas for sterile materials must be clean, dust-free, vermin-free, and draft-free. Generally speaking, items that have been sterilized in the hospital and wrapped in cloth or paper wrappers are considered sterile for 30 days if they are in a closed cupboard. If they are on an open shelf, they are considered sterile for 21 days. Extremes of temperature and humidity must be avoided, and traffic in the storage area should be light. Items sealed in plastic bags immediately after sterilization are considered sterile for 6 to 12 months, provided the seal is not broken.

Commercially packaged sterilized items are considered sterile until the seal is broken or the package has been damaged or until the expiration date on the package has passed.

Rules for Surgical Asepsis

The basic rules for surgical aseptic technique apply whenever and wherever the sterile procedure is done. The radiographer must commit these rules to memory and use them in his own department and in the OR. They are as follows:

1. Know which areas and objects are sterile and which are not.

2. If the sterility of an object is questionable, it is not to be considered sterile.

3. Sterile objects and persons must be kept separate from those that are unsterile.

4. When any item that must be sterile becomes contaminated, the contamination must be remedied immediately.

5. When tabletops are to be used as areas for creating a sterile field, they must be clean, and a sterile drape must be placed over them.

6. Personnel must be clothed in a sterile gown and gloves if they are to be considered sterile.

7. Any sterile instrument or sterile area that is touched by an unsterile object or person is considered contaminated by microorganisms.

8. A contaminated area on a sterile field must be covered by a folded sterile towel or a drape of double thickness.

9. If a sterile person's gown or gloves become contaminated, they must be changed.

10. A sterile field must be created just prior to its use.

11. Once a sterile field has been prepared, it must not be left unattended, because it may become contaminated accidently and be presumed to be sterile.

12. An unsterile person does not reach across a sterile field.

13. A sterile person does not lean over an unsterile area.

14. A sterile field ends at the level of the tabletop or at the waist of the sterile person's gown.

15. Anything that drops below the tabletop or a sterile person's waistline is no longer sterile. The only parts of a sterile gown considered sterile are the areas from the waist to the shoulders in front and the sleeves.

16. The edges of a sterile wrapper are not considered sterile and must not touch a sterile object.

17. Any part of a sterile drape that falls below the tabletop is considered unsterile and is not brought up to table level.

18. Sterile drapes are placed by a sterile person who drapes the area closest to him first to protect his sterile gown.

19. A sterile person must remain within the sterile area. He does not lean on tables or against the wall.

20. If one sterile person must pass another, they must pass each other back-to-back.

21. The sterile person faces the sterile field and keeps his sterile gloved hands above his waist and in front of his chest. He avoids touching any area of his body.

22. Any sterile material or pack that becomes dampened or wet is considered unsterile.

23. Any objects that are wet with sporicidal solution and are placed on the sterile field must be placed on a folded sterile towel in order for the moisture to be absorbed.

24. A wet area on a sterile field must be covered with several thicknesses of sterile toweling or an impervious drape.

25. All areas that are used for sterile procedures, including floors, should be well cleaned with disinfectant solution after each procedure. Mops used should be disposable and used only one time.

26. Air conditioning units must be kept clean, and filters should be changed frequently to prevent their blowing bacteria on sterile fields.

27. Ventilation ducts must have special filters in order to prevent particles from entering the OR or special procedures room.

28. When pouring a sterile solution, place the lid face upward and do not touch the inside of the lid or the lip of the flask. Pour off a small amount of solution before the remainder is poured into the sterile container.

29. When a sterile solution is to be poured into a container on a sterile field, the container is placed at the edge of the sterile field by the sterile person (Fig. 5–1).

COMMERCIAL PACKS

Commercial packs are usually wrapped in paper or plastic wrappers. They are frequently sealed in plastic to ensure prolonged sterility. Directions for opening the containers in such a way that there is no contamination are printed on the pack and should be read before opening. The most common type of pack is sealed at the edges. The seal can be separated at the top and peeled back until the sterile article is exposed. The pack can either be opened completely and the contents made available for the sterile person to pick up, or the contents can be dropped onto the sterile field. Packs must never be cut open or pierced with a knife or sharp object. Do not tear packs open, and do not allow the contents to slide over the edges of the pack. They should be flipped or lifted out.



Figure 5–1
Place container at edge of sterile field and pour from a distance that prevents contamination.

Opening Sterile Packs

The radiographer must be prepared to open sterile packs and either place their contents on the sterile field or hand them to the sterile person without contaminating them. There is a standard method for this procedure, which can be done without difficulty after it is practiced.

CLOTH-WRAPPED PACKS

The radiographer should already have washed his hands. When a request for a sterile item is re-

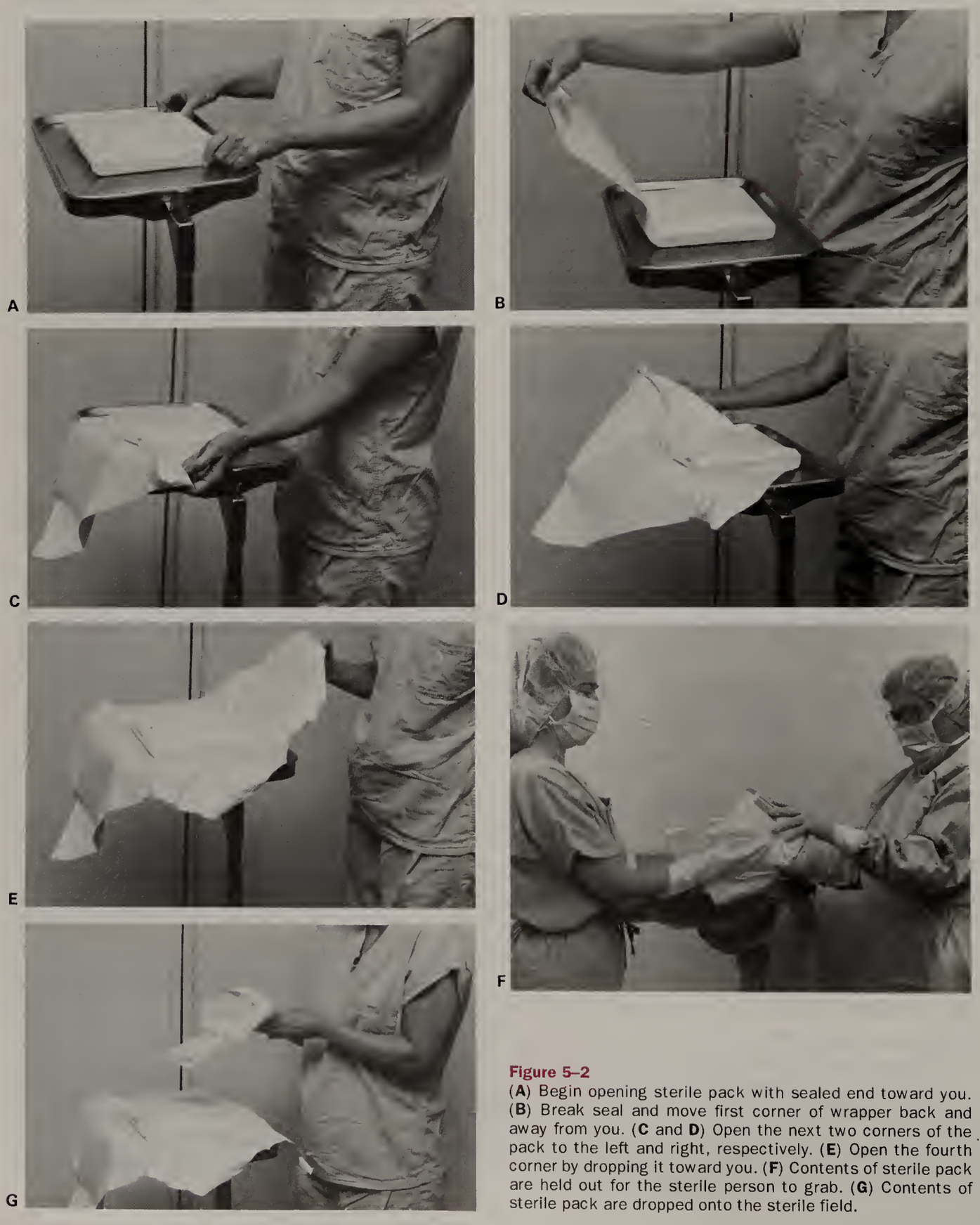


Figure 5–2
(**A**) Begin opening sterile pack with sealed end toward you. (**B**) Break seal and move first corner of wrapper back and away from you. (**C** and **D**) Open the next two corners of the pack to the left and right, respectively. (**E**) Open the fourth corner by dropping it toward you. (**F**) Contents of sterile pack are held out for the sterile person to grab. (**G**) Contents of sterile pack are dropped onto the sterile field.

ceived, the radiographer obtains the correct pack and returns it to the procedure room. A cloth-wrapped pack will be sealed with indicator tape. The lines in the tape will be dark gray if the pack has been correctly sterilized.

The pack is placed on a clean tabletop with the sealed end toward the radiographer (Fig. 5–2*A*). Opening a sterile pack involves the following steps:

1. Remove the tape and discard it.
2. Open corner 1 back and away from the pack (see Fig. 5–2*B*).
3. Next, open corners 2 and 3 (see Figs. 5–2*C* and *D*).
4. Then open corner 4 and drop it toward your body (see Fig. 5–2*E*).
5. Do not touch the sterile contents of the pack. This can now become a sterile field, and more sterile items may be placed in the center of the drape, or the sterile contents of the pack can now be placed on another sterile field.
6. To move the contents to another sterile field, grasp the underside of the wrapper and let the edges fall over your hand.
7. Hold the contents forward for the sterile person to grasp (see Fig. 5–2*F*). If it is preferable that you place the contents on the sterile field, you must grasp the corners of the wrapper with the other hand so that they do not brush the field.
8. Reach slightly over the sterile field and several inches above it and drop the contents of the pack onto the field (see Fig. 5–2*G*).

STERILE FORCEPS

A sterile forceps—usually a large, serrated ring forceps with ratchet closures—may be used to transfer objects from one sterile area to another. It is packaged in a sterile wrapper. The package should be opened so that there is a sterile surface on which to place the forceps when it is not in use. Only the tips of the forceps are sterile.

When an object is to be transferred with a sterile forceps, the procedure is as follows:

1. Open the sterile pack.
2. Grasp the forceps by the handle, open the ratchet, and grasp the object to be transferred.
3. Close the ratchet around the object.
4. Transfer the object to the new location.



Figure 5–3
You may place sterile forceps on the sterile wrapper with contaminated handles away from the center.

5. Open the ratchet and drop the sterile object onto the sterile field.
6. Replace the forceps on its sterile wrapper with the handles away from the center of the wrapper (Fig. 5–3).

The forceps must not be used for more than one procedure. If it is not kept in constant sight of the person using it, it should not be considered sterile and another must be obtained for use.

The Surgical Scrub

Although the radiographer is not often the "sterile person" in the OR or special procedures room, he must be able to perform this function if the situation calls for it. To begin, regular exterior clothing is changed for a scrub suit, and shoe covers are placed over the shoes. The shoe covers are made of heavy paper and have a built-in conductive strip that prevents the production of static electricity. A surgical cap or hood is then put on to cover all hair. Hoods are used if the person has a beard. All jewelry is removed. If pierced ear studs are worn, they must be covered by the cap.

If the procedure to be performed in the OR or special procedures room involves fluoroscopy, or if the team is unable to protect themselves while radiographic exposures are being taken, protective lead garments must be worn over the scrub suit and under the sterile gown. These protective gar-

ments, which should include a lead apron, a thyroid shield, and special glasses, should be put on before the surgical scrub is begun.

A face mask is removed from the container. This mask should be handled by the ties only. The mask is placed on the face so that it covers the nose and mouth (Fig. 5–4). It is tied at the back of the head and neck and checked for comfort and security. The mask must never be touched after it is in place, because it quickly becomes contaminated. Masks must be changed between each procedure and are never to be worn around the neck to be pulled up again over the face.

At this point, the procedure will vary with the OR assignment. If the radiographer is to take radiographic exposures, he should scrub for 3 minutes with an antiseptic soap, dry his hands with paper towels, and proceed to his position in the OR. If he is to put on a sterile gown and gloves, he must do a surgical scrub.

The procedure for the surgical scrub varies from hospital to hospital, but either the timed method or the brush count method is used. Some institutions require an initial 10-minute scrub and subsequent 5-minute or reduced brush stroke scrubs for each case following the initial scrub during a 24-hour period. The antimicrobial agents most commonly used for surgical scrub at this time are an iodine complex and detergent (Iodophors), chlorhexidine gluconate in 4% solution, and, in cases of allergy to other agents, hexachlorophene or triclosan.



Figure 5–4
The mask must cover both nose and mouth.

The surgical scrub is performed to remove as many microorganisms as possible from the skin of the hands and lower arms by mechanical and chemical means prior to a sterile procedure. The arms should be bare to at least 4 inches above the elbows. The procedure for the timed or stroke method surgical scrub is as follows:

1. Approach the sink. Adjust the water temperature and pressure. Most surgical scrub areas have knee or foot regulators for water faucets. If they do not, the faucet handles should be turned on, adjusted, and not touched again.

2. Obtain a scrub brush. Brushes must be single use and disposable. Combination sponge-brushes with the antimicrobial agent permeated through them are most commonly used. Wet the hands and forearms to approximately 2 inches from the elbow. Hold the hands up and allow the water to flow downward toward the elbows from the cleanest area to the least clean area and apply the antimicrobial agent (Fig. 5–5*A*).

3. Scrub hands and arms using a firm rotary motion. Fingers, hands, and arms should be considered to have four sides, all of which must be thoroughly cleaned. An anatomical pattern should be followed, beginning with the thumb and proceeding to each finger. Next do the dorsal surface of the hand, the palm, and up the wrist, ending 2 inches above the elbow. Wash all four sides of the arm. Scrubbing for the OR always begins with the hands because they are in direct contact with the sterile field (see Fig. 5–5*B*).

4. A nail cleaner is included with the scrub brush. After the first hand and arm scrub, clean under each fingernail with this nail cleaner and dispose of it. (see Fig. 5–5*C*). Rinse hands and arms, and rescrub in the same pattern until all brush strokes are complete or until the time is up (see Fig. 5–5*D*).

5. When the scrub is complete, drop the brush into the sink or a receptacle prepared to receive the used brushes. Do not touch the sink or the receptacle. Remember to hold the hands up above the waist and higher than the elbows during and after the surgical scrub.

6. Proceed to the area where a sterile towel, sterile gown, and sterile gloves have been prepared for you.



Figure 5–5
(**A**) Hold hands upward during surgical scrub and allow water to flow towards the elbows. (**B**) Begin surgical scrub by washing all sides of the hands. (**C**) Clean under each fingernail with nail cleaner in package. (**D**) Rinse hands and arms beginning with the hands. *(continued)*



Figure 5–5 ***(Continued)***
(**E**) Pick up sterile towel and allow it to unfold, but do not allow it to touch your clothing. (**F**) Drop towel when drying is complete.

7. Pick up the sterile towel, which is folded on top of the sterile gown, by one corner and let it unfold in front of you at waist level. Do not let the towel touch your scrub suit (see Fig. 5–5*E*).
8. Dry one hand and one arm with each end of the towel. Do not go back over areas already dried.
9. When hands and arms are thoroughly dry, drop the towel to the floor or into a receptacle for this purpose, being careful to keep hands held up above the waist (see Fig. 5–5*F*).

Sterile Gowning and Gloving

If the radiographer must open his own sterile gown and glove packs, he must do so before the surgical scrub. Usually an assistant is on hand to do this for the person who is scrubbing.

GOWNING

The sterile gown is made of either a synthetic nonwoven material or of cloth. To don it, the radiographer follows these simple steps:

1. Grasp the gown and remove it from the table.
2. Step away from the table. The gown will be folded inside out.
3. Hold the gown away from your body and allow it to unfold lengthwise without touching the floor (Fig. 5–6*A*).
4. Open the gown and hold it by the shoulder seams. Place both arms into the arm holes of the gown and wait for assistance (see Fig. 5–6*B*).
5. Your assistant or the circulating nurse will place his hands into the inside of the gown at the shoulders and pull the gown over the shoulders and arms until the hands are exposed if open-gloving technique is to be used. If closed-gloving technique is to be used, the cuffs of the gown sleeves will be left to cover the hands (see Fig. 5–6*C*).

GLOVING

There are two methods of gloving for sterile procedures: open and closed. For the radiographer's purposes, the open method is more practical. Setting up for a sterile procedure, as well as performing certain minor sterile procedures, requires the use of sterile gloves, but not a sterile gown. If this is the case, the radiographer should wash his hands according to the rules of medical sepsis described in Chapter 3 and proceed with gloving by the open method.

The glove wrapper is opened, and the gloves are exposed. Sterile gloves are always packaged folded down at the cuff and powdered so that they may be put on more easily.



Figure 5–6
(**A**) Pick up the sterile gown by holding it at the shoulder seams and then allow it to unfold in front of you. (**B**) Place both arms into the arm holes and wait for assistance. (**C**) Cuffs of gown sleeves are left covering the hands if closed-gloving technique is to be used.

1. Glove the dominant hand first. Assuming that the right is your dominant hand, pick up the right glove with the left hand at the folded cuff. Slide the right hand into the glove, leaving the cuff of the glove folded down.
2. When it is over the hand, leave it and pick up the left glove with the gloved right hand under the fold (Fig. 5–7*A*). Pull the glove over the hand and over the cuff of the gown in one motion (see Fig. 5–7*B*).
3. Then place the fingers of the gloved left hand under the cuff of the right glove and pull it over the cuff of the gown. After the cuffs of the gloves cover the cuffs of the sterile gown, the gloves can be adjusted.

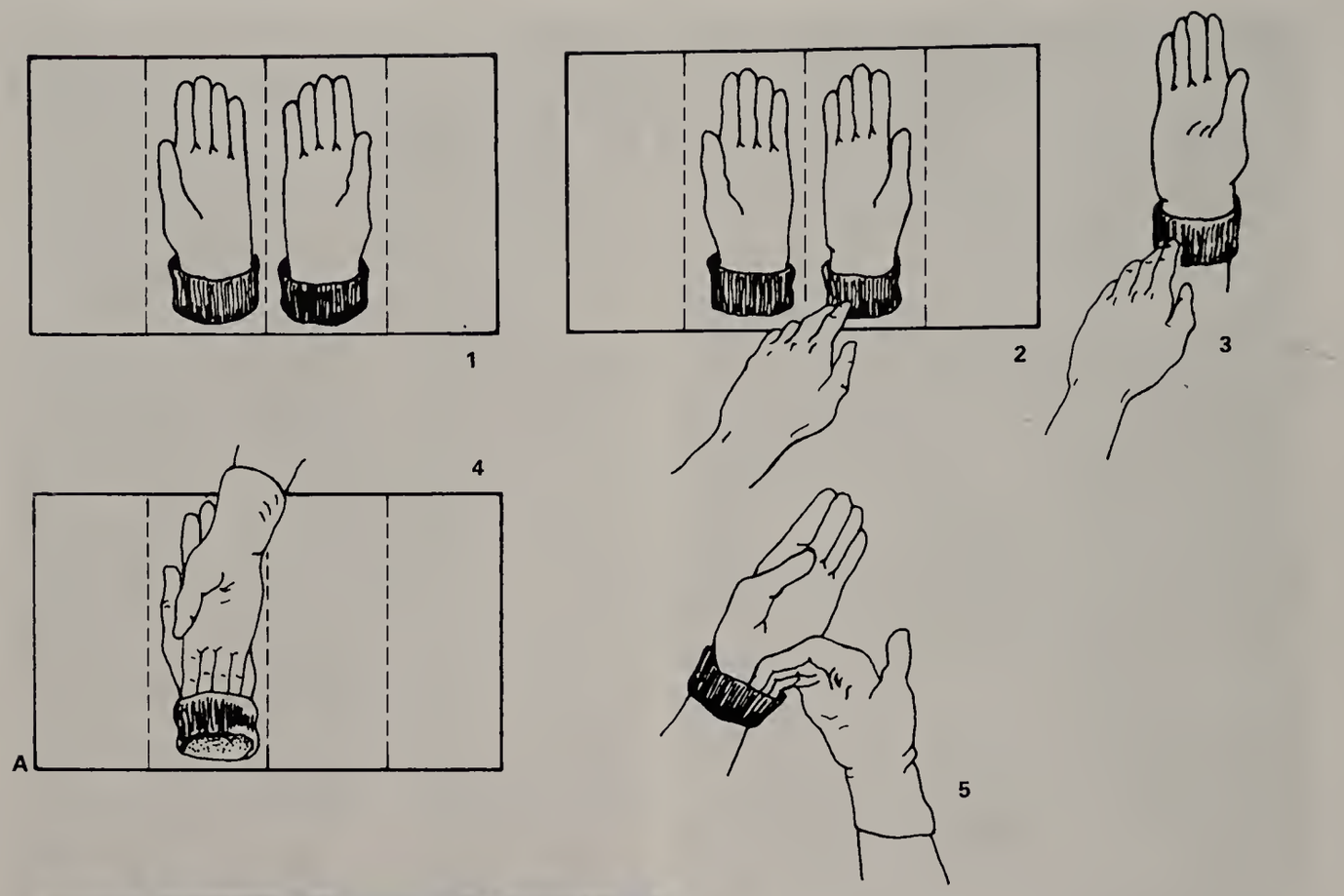


Figure 5–7
(**A**) Open gloving. (**B**) To complete open gloving, pull the glove over the hand and the cuff of the gown in one motion.

Closed Gloving

This procedure must be practiced several times before it is perfected. The radiographer must not be discouraged if he contaminates his gloves the first few times that he puts them on. The important thing is to notice when the gloves become contaminated and to ask for another pair.

The closed method is restricted to use when a sterile gown has been donned and the hands remain enclosed within the cuffs of the gown. The

sterile glove pack is opened before the procedure begins.

1. With the left hand (or nondominant hand) covered by the gown sleeve cuff, pick up the right glove and place it palm-side down on the palm of the right hand, which is also covered by the cuff of the second sleeve. The fingers of the glove should be pointing toward the elbow (Figs. 5–8*A* and *B*).
2. Grasp the cuff of the glove through the gown with the right hand. The covered left hand pulls the glove over the right hand, gently in-

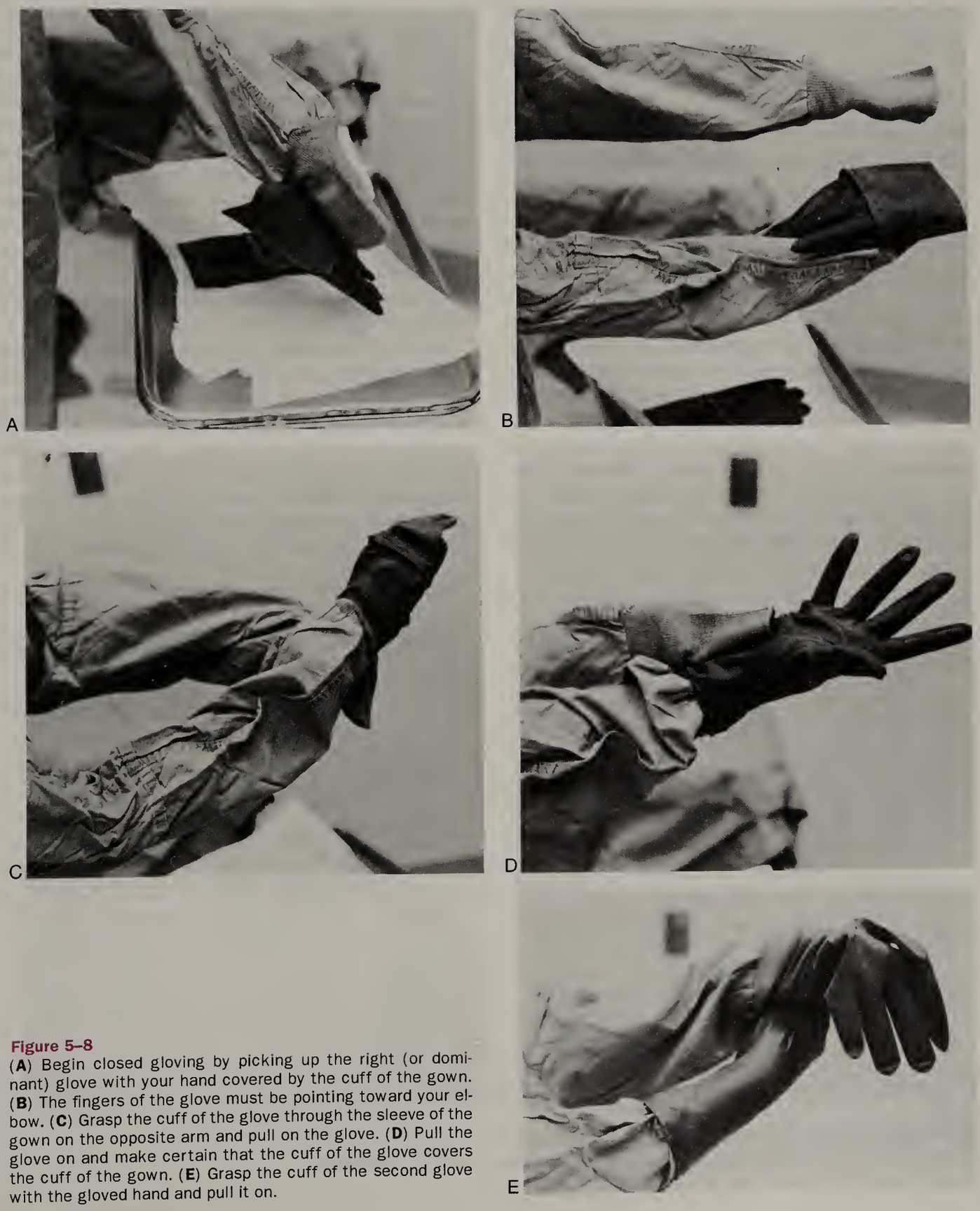


Figure 5–8
(**A**) Begin closed gloving by picking up the right (or dominant) glove with your hand covered by the cuff of the gown. (**B**) The fingers of the glove must be pointing toward your elbow. (**C**) Grasp the cuff of the glove through the sleeve of the gown on the opposite arm and pull on the glove. (**D**) Pull the glove on and make certain that the cuff of the glove covers the cuff of the gown. (**E**) Grasp the cuff of the second glove with the gloved hand and pull it on.

serting the fingers into the finger spaces of the glove. Be certain that the cuff of the glove covers the cuff of the gown (see Figs. 5–8*C* and *D*).

3. With the gloved right (or dominant) hand, pick up the next glove and place it on the palm of the left hand with the fingers pointing to the elbow.

4. Grasp the cuff of the glove through the sleeve cuff; with the gloved right hand, pull the second glove into place (see Fig. 5–8*E*).

Taking Radiographic Films in the Operating Room

When the radiographer is called to the OR, he must know what equipment the institution has available for taking radiographic films there. In many hospitals, radiographic equipment remains in the operating suite at all times. In smaller institutions, the radiographer will have to transfer a portable radiographic machine from his own department.

The radiographer is also responsible for protecting himself and the persons in the OR from radiation. He must know if the institution in which he is employed has protective lead garments available at all times in the OR suite or if he must transport them along with the portable machine for his own use and the use of the OR team.

The radiographer must clean the portable radiographic machine and the cassettes that will be used with a disinfectant solution before he transfers them into the operating room where he will be working. All necessary equipment must be prepared and cleaned before the radiographer changes into a scrub suit and scrubs.

Frequently, the need for a radiographic film or fluoroscopy is anticipated, and cassettes may be placed before the surgical procedure begins. At other times, the need is not anticipated, and the radiographer will have to place the machine and cassettes after the sterile field has been created and the surgery begun. If this is the case, the cassette may be passed to the scrub nurse by the radiographer. The scrub nurse receives it in a sterile plastic bag and places it at the radiographer's direction. The radiographer places the cassette in the bag carefully to avoid contaminating the outside of the bag and the scrub nurse's gloves (Fig. 5–9*A*).

If the radiographer must place the cassette himself, the OR team will make room for him. He can direct the team to stand behind plastic screens placed to protect them from radiation while he makes the necessary exposures. Care must be taken to prevent contamination of the surgical field. The radiographer will approach the operating table and place the cassette by lifting the surgical drapes from the bottom underside only (see Fig. 5–9*B*).



Figure 5–9
(**A**) Place the cassette in the protective bag, being careful not to contaminate the outside or the scrub nurse's gloves. (**B**) Place the cassette by lifting the underside of the sterile drapes.

Skin Preparation for Sterile Procedures

The radiographer is often called upon to do the skin prep in the special procedures area.

MECHANICAL METHODS OF SKIN PREPARATION

The mechanical method of skin preparation includes the removal of hair as necessary and a friction scrub with antiseptic soap and water. Hair removal can break or injure the skin and should be done only when it is essential to prevent infection. It must be done only with an order from the physician in charge of the patient and as close to the time of the procedure as possible.

If hair removal is ordered, the radiographer should wash his hands and obtain a prep set that includes a small basin, a sponge permeated with antiseptic soap, one or two disposable razors, a sponge for rinsing, and a towel. Clean gloves are worn by the radiographer for this procedure. The procedure is explained to the patient, who is then placed in a comfortable position. Before any skin preparation with antiseptics, the radiographer must ask the patient if he is allergic to iodine or any other antiseptic solutions. If the answer is positive, he must inform the physician, who will choose a substitute.

1. Fill the basin with warm water, don the clean gloves, wet the soap sponge, and soak and soap thoroughly the area to be shaved.

2. Shave the skin using short, firm strokes. Hold the skin taut and shave in the direction of hair growth. Remove only as much hair as necessary.

3. After all unwanted hair has been removed, rinse the area with sterile water and dry it with the towel.

4. Drape the area with towels in order to designate the upper and lower limits of the area to be prepped. The radiologist will explain how large an area must be prepared. Usually it will be an area of approximately 6 to 10 inches in diameter around the puncture area.

   Often, prepackaged prep trays are available that contain two small basins (one for sterile water and one for antiseptic), a set of large sponges, sterile towels, sterile gloves, and the antiseptic detergent solution. A flask of sterile water must also be on hand. The water should be no colder than room temperature. If the umbilicus is in the area to be prepared, four sterile applicators should be included. If the area to be prepared includes the vagina, a long sponge holder and eight to ten gauze sponges should be added. The physician will do the vaginal prep. The antiseptic detergent solutions most commonly used for skin preparation are iodophors, chlorhexidine gluconate, and, in special circumstances, hexachlorophene or triclosan.

5. After all of the necessary equipment has been assembled and the patient has been prepared, open the sterile pack.

6. Pour sterile water into one of the basins. If the antiseptic agent is not in the sterile set, pour it into the other sterile basin.

7. Then put on the sterile gloves using the open-gloving technique.

8. Wet a sponge with water and then with soap solution and begin scrubbing in the center of the area to be prepared, working slowly outward in a circular motion. Use a firm stroke—friction is as important in the removal of microorganisms as is the antiseptic. Do not rewash the skin that has already been scrubbed with this sponge. When you reach the edges of the area being scrubbed, remove the sponge from the sterile field, discard it, and obtain another one. Repeat the procedure using the other sponge (Fig. 5–10). If the umbilicus is to be prepared, clean it with cotton applicators soaked in the antiseptic detergent.

9. This scrubbing procedure should last from 3 to 10 minutes. The skin must then be rinsed well with sterile water, or the lather may be wiped away without rinsing. The routine varies depending upon the procedure, the antiseptic used, and the policy of the institution.

10. Carefully inspect the patient's skin during the skin prep. If it shows any sign of irritation or rash, the procedure should be stopped and the antiseptic thoroughly rinsed off with sterile water. The physician should then be notified of the patient's sensitivity so that another chemical may be chosen that is not harmful to him.

11. Do not allow solution to drain off the area being prepped and pool under the patient



Figure 5–10
Repeat the scrub, beginning again in the center of the area to be prepared for the sterile procedure.

during the procedure, because this may burn the skin.

CHEMICAL METHODS OF SKIN PREPARATION

After the mechanical aspects of the skin prep are complete, the skin around the area to be penetrated is often painted with an antiseptic solution. This destroys some of the remaining microbes and acts as a deterrent to further microbial growth (is bacteriostatic) for a brief period of time. Agents commonly used include povidone-iodine, chlorhexidine, alcohol, and hexachlorophene. The choice of solution depends on the institutional policy and the patient's tolerance of the product. Alcohol must never be used on mucous membranes or on an open wound, because it coagulates protein and therefore may cause harm.

If the skin is to be painted with antiseptic after the scrub, it should be done with a circular motion, beginning at the center of the area to be prepped and working outward (Fig. 5–11). Many special procedure sets have long-handled sponges and a receptacle for this purpose.

1. Use the antiseptic of your institution's choice and follow the directions listed in the previous paragraph.
2. If there are no special skin-prep sponges, gauze sponges folded and grasped in a sterile ring forceps and dipped into a small sterile container of disinfectant may be used.



Figure 5–11
Begin at the center of the area being prepared and work outward in a circular motion.

Draping

After the skin has been mechanically and chemically prepared and allowed to dry, sterile drapes may be applied. They are placed around the area of skin that has been prepared. The type of sterile drape used differs with each procedure. In the diagnostic imaging department, the drapes are usually a single-thickness, impermeable material that is disposable. A fenestrated drape is often used. If this is the case, the drape should be applied in such a way that the opening leaves only the operative site exposed.

If sterile towels are used, they should be placed so that they are well within the limits of the area prepared, and they should be folded and placed so that they overlap and the folds face the operative site (Fig. 5–12*A*).

Usually, the physician places the sterile drapes after he has donned sterile gloves for the procedure. The radiographer must have the sterile pack that contains the drapes open and ready. Many prepackaged procedure sets contain sterile drapes. If the radiographer is to place the sterile drapes, he must first open a set of sterile gloves for himself. Then the pack containing the drapes is opened. The sterile gloves are then donned, and the drapes are placed. The part of the drape closest to the radiographer is placed first so that the sterility of his gloves is maintained, or he holds the drape to protect his gloves (see Fig. 5–12*B*). Once the drape is



Figure 5–12
(**A**) The part of the drape closest to you is placed first. (**B**) Sterile towels should overlap and the folds must face the operative side.

in place, it may not be moved, because the underside of the drape would then be contaminated by touching the patient's skin.

A plastic adhesive drape may be chosen for use. This type of drape adheres to the patient's skin and will not slip as the procedure progresses. This drape is placed by the scrub nurse and the surgeon or his assistant after the usual skin prep. After it is in place, the incision is made through the drape. Removal of this type of drape requires care to prevent injury to the patient's skin as it is pulled away.

Changing Dressings

The radiographer must not remove or reapply dressings unless there is an order from the physician caring for the patient to do so. When the physician requests that a dressing be removed for a procedure in the diagnostic imaging department, the radiographer must be able to remove it without contaminating the wound or himself in the process.

All dressings must be treated as if they are contaminated, because drainage from wounds may harbor pathogenic microorganisms. Before removing or replacing a dressing, the following materials must be obtained:

Clean gloves

A bag for infectious waste and a bag closure

When these items have been prepared, the following procedure should follow:

1. Wash your hands as for a medical aseptic procedure.

2. Place the patient in a comfortable position and explain the procedure.

3. Provide privacy for the patient by closing the door and keeping all of his body covered except the area where the dressing is in place.

4. Before donning the clean gloves, loosen the tape holding the dressing in place. It is difficult to manage tape while wearing gloves. Remove the tape with care; if it adheres to the skin and the patient complains of pain, use a commercial tape remover. Pull the tape off toward the wound while supporting the skin with the nondominant hand.

5. Put on the clean gloves and remove the dressing carefully (Fig. 5–13*A*). Be cautious when removing the dressing as it may be adherent to the wound or there may be a drain in place. If the dressing is adherent to the wound, stop the procedure and inform the physician. Do not forcefully remove a dressing. To do so may damage the tissues around the wound or dislodge a tissue drain.
6. Assess the soiled dressing for drainage or blood. Inform the physician if there is a large amount of either on the dressing.
7. Place the soiled dressing into the bag prepared for it (see Fig. 5–13*B*). Remove the gloves correctly.
8. Place your hands under the cuff in the bag and unfold it upward; close the bag with a closure and place it into a receptacle for contaminated waste (see Fig. 5–13*C*).
9. Wash your hands.

When a dressing is reapplied, sterile technique must be used. The procedure is as follows:

1. Assemble the necessary equipment and wash your hands. Equipment needed will be:
   A sterile towel or small sterile drape
   Sterile gauze dressings of the appropriate size
   Tape
   A refuse bag and closure
   Sterile gloves

   If the area around the wound is soiled or the wound is draining, additional sterile gauze sponges, a sterile forceps, and sterile normal saline solution may be needed to cleanse the skin around the wound. A small, sterile receptacle must be obtained in which to pour the normal saline solution. Do not cleanse the wound itself.
2. Approach the patient and explain what is to be done.

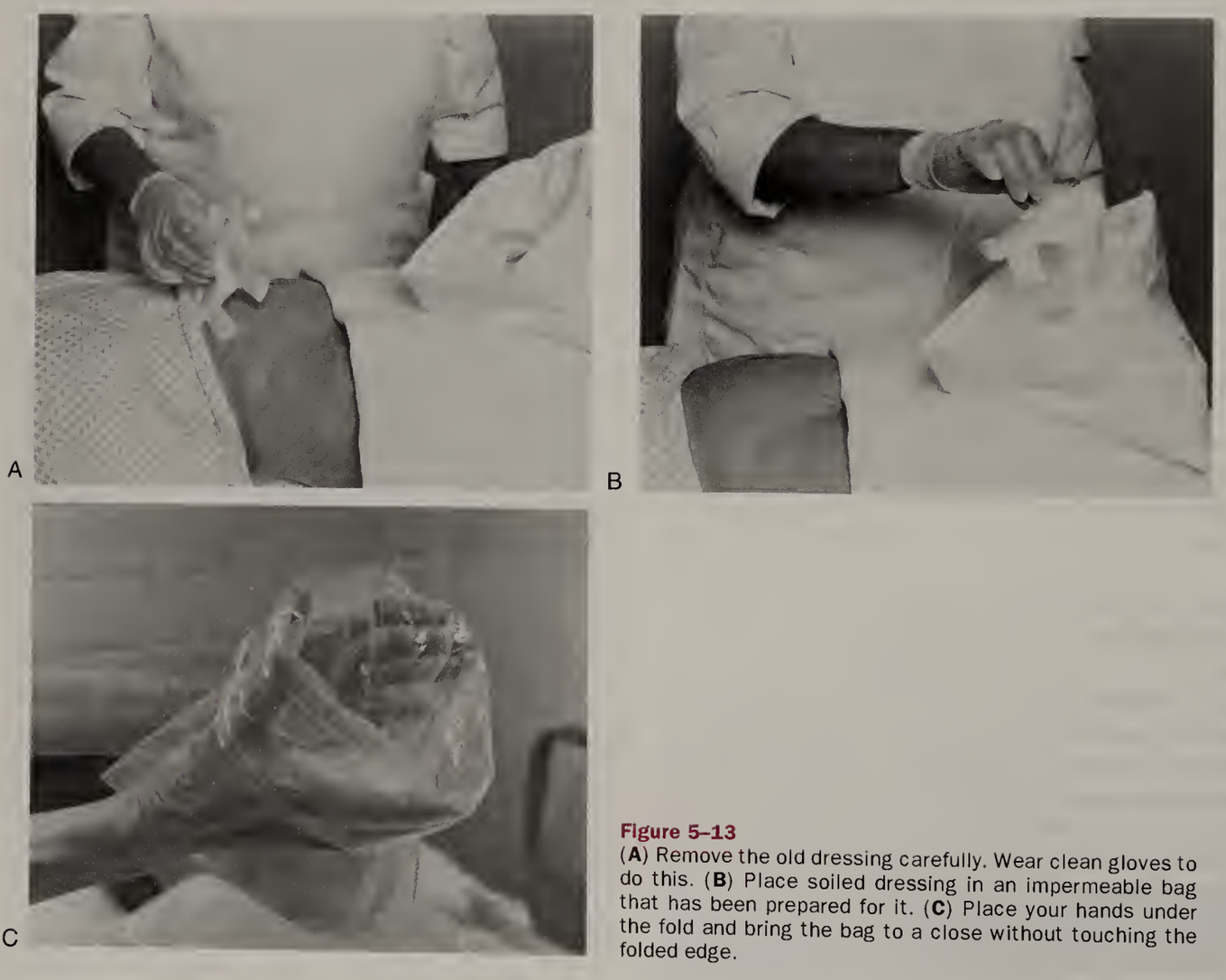


Figure 5–13
(**A**) Remove the old dressing carefully. Wear clean gloves to do this. (**B**) Place soiled dressing in an impermeable bag that has been prepared for it. (**C**) Place your hands under the fold and bring the bag to a close without touching the folded edge.

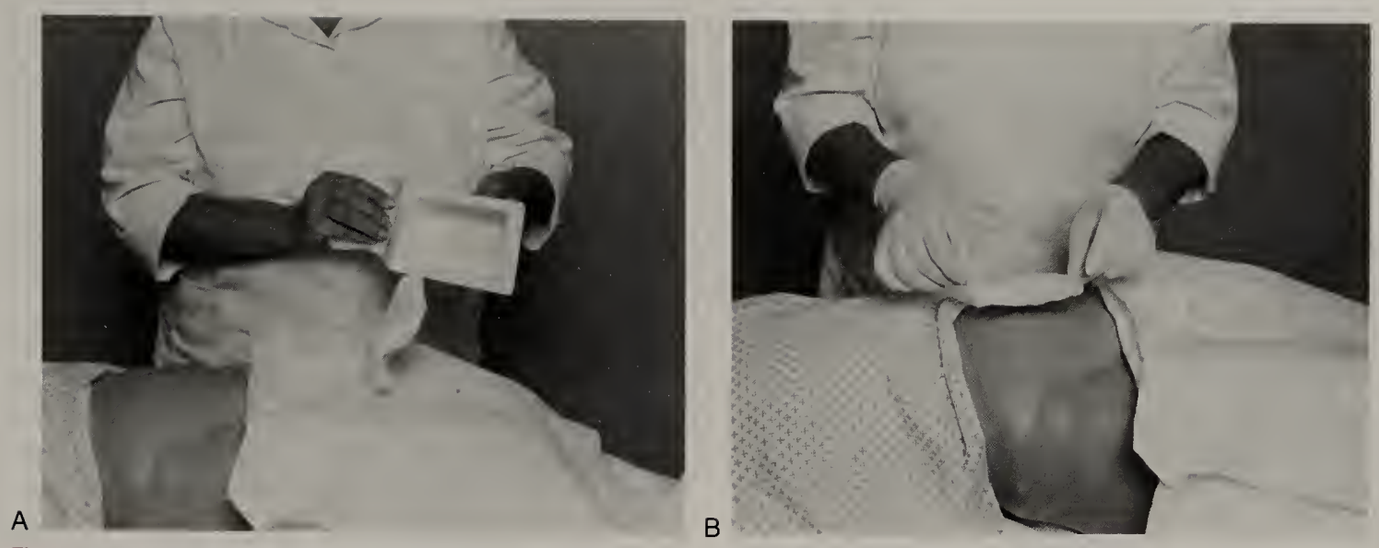


Figure 5–14
(**A**) Drop sterile dressings on sterile field without contaminating them. (**B**) Allow antiseptic to dry, then apply the new dressing.

3. If the soiled dressing has not been removed, remove it in the manner described above.
4. Open the sterile towel or drape to double thickness and use it as a sterile field on which to place the sterile dressings.
5. Open the dressings and drop them onto the sterile field without contaminating them (Fig. 5–14*A*).
6. Prepare the tape by having it cut or torn into the lengths needed to keep the fresh dressing in place. Place these lengths of tape in a convenient place away from the sterile field.
7. Cleanse the skin around the wound with sterile normal saline, if necessary, in the following manner:
   Pour normal saline into the sterile receptacle prepared for it.
   Moisten the gauze sponges with sterile normal saline and gently cleanse the skin, beginning in the area closest to the wound and moving outward.
   Drop the soiled sponges into the refuse bag, being careful not to contaminate your gloves. A sterile forceps may be used to hold the pads.
   Do not wash the wound itself and do not apply medication or antiseptics.
   Use as many pads as necessary to cleanse the skin.
8. Allow the skin to dry. Then apply the new sterile dressings (see Fig. 5–14*B*). If there is drainage, apply additional dressings to absorb the drainage.
9. Remove your gloves and drop them into the refuse bag. Apply tape to hold the dressing in place.
10. Cover the patient and make him comfortable.
11. Dispose of the waste material correctly and wash your hands.

Summary

The radiographer must participate in examinations that require use of sterile technique, both in the surgical suite and in his own department. Any health care worker who participates in sterile procedures must practice meticulous surgical asepsis in order to prevent contamination that may result in patient infection.

The most common means of spreading microorganisms in the OR or during special procedures are by use of contaminated instruments and gloves, by allowing a sterile field to become damp, or by failure to control air currents across sterile fields. All of these situations are avoidable.

There are several methods of rendering an article sterile, that is, completely removing microorganisms and their spores. They are steam under pressure, ethylene oxide gas, dry heat, chemicals, ionizing radiation, and nonionizing radiation (microwaves).

Sterilization indicators are used inside and outside packs before they are exposed to the sterilization process. They are an indication that the article

has been exposed to a particular sterilization process. The radiographer must be able to read and understand the indicators used in the institution in which he works.

Mechanical and chemical methods are used to disinfect objects and surfaces that cannot be sterilized. In order to ensure their effectiveness, the manufacturer's directions must be followed exactly.

Mechanical disinfecting methods are boiling and ultraviolet irradiation. Boiling is used as a means of disinfection only if no other method is available, because many microorganisms and their spores can withstand the boiling temperature for many hours. Ultraviolet rays kill microorganisms when they come into direct contact with them; however, it is an inefficient method of disinfection and is seldom used in hospitals.

The radiographer must learn the rules of surgical asepsis, because all invasive medical procedures require its use. He must learn to differentiate sterile objects from unsterile objects. He must learn to open sterile packs correctly to prevent contamination. When there is a question about the sterility of an item, it is always considered to be unsterile.

The surgical team is composed of the surgeon, the surgical assistant, the anesthesiologist, the nurse anesthetist, the circulating nurse, the scrub nurse or the surgical technologist, and the staff who prepares and maintains the surgical suite.

A surgical scrub is performed in the OR before a sterile gown and gloves are donned for a surgical procedure. The radiographer is not usually the sterile person in the OR because he will be there to take radiographic films or for operation of the fluoroscope. The radiographer is expected to assist with special procedures in his own department that require the use of surgical aseptic technique and, in some instances, a surgical scrub.

Preparation of the skin for surgical penetration involves removing as many microorganisms as possible from the operative site. This reduces the possibility of infection from the procedure. Mechanical and chemical methods are used to prepare the skin, followed by application of sterile drapes around the operative area.

The radiographer may be required to remove or reapply a dressing. These procedures should be performed using aseptic technique. Any dressing that is removed must be assumed to harbor pathogenic microorganisms. Soiled dressing must not be touched with bare hands. Gloves must be used. The soiled dressings must be wrapped in a waterproof bag and disposed of properly in order to prevent contamination.

When dressings are removed or reapplied, the patient must be protected from infection. The radiographer must also protect himself and others in his department. Use of aseptic technique and proper methods of waste disposal will accomplish these goals.

Chapter 5, Pre–Post Test

____ **1.** Which of the following is the best definition of surgical asepsis?
- **a.** Removing as many microorganisms as possible by mechanical and chemical methods
- **b.** Removing as many microorganisms and spores as possible by autoclaving
- **c.** Complete removal of microorganisms and spores
- **d.** Scrubbing, gowning, and gloving to prevent contamination

____ **2.** Which of the following procedures does not require the use of surgical aseptic technique?
- **a.** An intramuscular injection
- **b.** An intravenous injection
- **c.** An intrathecal procedure
- **d.** An arteriogram
- **e.** A gastrointestinal series

____ **3.** All items that penetrate the skin or mucous membrane must be
- **a.** Disinfected
- **b.** Sterile

_____ **4.** Methods of disinfection are
- **a.** Steam under pressure and ionizing radiation
- **b.** Boiling and ultraviolet light
- **c.** Dry heat
- **d.** Ethylene oxide gas

_____ **5.** You are the new radiographer in charge of maintaining a special procedures suite at the local community hospital. Since most procedures done in this suite demand sterile technique, you must consider
- **a.** The type of disinfectant solutions that the housekeepers will use to clean the area before and after each procedure
- **b.** How often the air filters are changed
- **c.** How sterile packs and instruments are packaged and stored
- **d.** a and b
- **e.** a, b, and c

_____ **6.** Any dressing removed in the diagnostic imaging department should be considered
- **a.** Sterile
- **b.** Surgically aseptic
- **c.** Contaminated
- **d.** Medically aseptic

_____ **7.** Sterile drapes are placed by the sterile person. They drape
- **a.** The area farthest away from them first
- **b.** The area nearest the invasive site first
- **c.** The area closest to them first

_____ **8.** The skin is disinfected before beginning all invasive procedures to
- **a.** Protect the sterile drapes from contamination
- **b.** Decrease the possibility of introducing microorganisms into the open wound
- **c.** Protect the health worker from infection
- **d.** Ensure the success of the procedure

_____ **9.** Removal of hair is done in preparation for an invasive procedure
- **a.** As close to the time of the invasive procedure as possible
- **b.** The night before the procedure
- **c.** Any time at all

_____ **10.** When preparing the skin for a sterile procedure, the radiographer should scrub
- **a.** From the outside inward
- **b.** In a back and forth motion
- **c.** In a circular motion from inside to outside

_____ **11.** Before the radiographer uses a sterile pack, he must check its
- **a.** Shelf life
- **b.** Expiration date
- **c.** List of contents
- **d.** Method of sterilization

_____ **12.** Boiling is an acceptable means of sterilization.
- **a.** True
- **b.** False

____ **13.** Common means of transmitting microorganisms in the OR or special procedures room include
- **a.** Use of contaminated gloves or instruments
- **b.** Allowing a sterile field to become wet or damp
- **c.** Allowing microorganisms to be blown onto a surgical suite
- **d.** None of the above
- **e.** a, b, and c

____ **14.** In order to maintain a sterile field, the person who has created it must never leave it unattended.
- **a.** True
- **b.** False

____ **15.** If an object on a sterile field drops below the "sterile person's" waistline, it may still be considered sterile.
- **a.** True
- **b.** False

____ **16.** The edges of a sterile wrapper may be considered sterile.
- **a.** True
- **b.** False

17. Match the following:

1. Surgeon	____
2. Scrub nurse	____
3. Radiographer	____
4. Nurse anesthetist	____
5. Circulating nurse	____

- **a.** Monitors the patient during anesthesia
- **b.** Ensures radiation safety in the OR
- **c.** Performs the surgical procedure
- **d.** Monitors the patient's safety in the OR
- **e.** Arranges the sterile field

○ *Laboratory Reinforcement*

1. Demonstrate in the school laboratory the proper techniques for scrubbing, gowning, and gloving for the OR or for special procedures.

2. Demonstrate in the school laboratory how to open a large sterile pack in such a way as to create a sterile field.

3. Demonstrate in the school laboratory how to prepare the skin for an examination that involves a puncture of the lumbar spine.

4. Demonstrate in the school laboratory how you would drape the skin for a sterile procedure.

Critical Thinking Problems

1. The radiologist is scrubbed and he asks the radiographer to get him a number 16 French catheter. Demonstrate in the school laboratory the placement of this catheter on the sterile field without causing contamination.

2. Mrs. Brown is in the diagnostic imaging department to have radiographic films taken of her ankle. There is an open wound on the ankle covered by a large dressing. The dressing must be removed for the procedure and reapplied after the exposures are completed. The physician asks the radiographer to do this. Demonstrate in the laboratory how you will remove and reapply the dressing.

6

Vital Signs and Oxygen Administration

Measuring Vital Signs
Body Temperature
Measuring Body Temperature
- The Tympanic Membrane Thermometer
- The Electronic Thermometer for Oral Temperature
- Oral Temperature, Glass Thermometer
- Taking an Axillary Temperature
- Taking a Rectal Temperature
- Other Instruments Used to Measure Body Temperature

Pulse
Assessment of the Pulse
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Blood Pressure
Equipment Needed to Measure Blood Pressure
Measuring Blood Pressure
Oxygen Therapy
Pulse Oximetry
Hazards of Oxygen Administration
Oxygen Delivery Systems
- Home Oxygen Delivery Systems
- Oxygen Delivery Equipment for the Imaging Department

Radiographic Examinations of the Chest
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Define the term *vital signs* and explain when the radiographer is responsible for their assessment.
2. List the rates of temperature, pulse, respiration, and blood pressure that are considered to be within normal limits for a child and for an adult male or female.
3. Identify sites and methods available for measuring body temperature and correctly read a clinical thermometer.
4. Accurately monitor pulse rate.
5. Accurately monitor respirations.
6. Accurately monitor blood pressure.
7. Identify the most common types of oxygen administration equipment and explain their potential hazards.
8. Describe the equipment that must be available and functional in all radiographic imaging departments to monitor blood pressure and to administer oxygen.
9. List the precautions that must be taken when oxygen is being administered.

Glossary

Alveolar: pertaining to air cells in the lungs (alveoli) where the gases of respiration are exchanged
Anterior: situated at or directed toward the front
Apical: pertaining to apex of heart
Arterial: pertaining to an artery; the type of blood vessels that carry oxygenated blood away from the heart to body organs and tissues
Assessment: an appraisal or evaluation
Atherosclerosis: a disorder in which the inner walls of the arteries develop a buildup of yellowish plaque that may eventually obstruct circulation of oxygenated blood
Bradycardia: abnormally slow heart beat (below 60 beats per minute)
Bronchiole: a small airway of the respiratory system that extends from the bronchi into the lobes of the lungs
Cardiopulmonary: pertaining to the heart and lungs
Cellular: pertaining to or made up of cells
Chemoreceptor: any of the special cells or organs adapted for excitation by chemical substances and located outside the central nervous system
Cyanosis: a bluish discoloration of the skin and mucous membranes due to lack of oxygen in the blood
Diencephalon: the posterior part of the forebrain
Diode: a low-pressure electron tube or a conductive device used to rectify alternating current
Doppler: a device used to measure heart sounds or other sounds using sound wave frequency and distance
Dyspnea: difficulty breathing resulting from insufficient air flow to the lungs
Enzymatic: relating to, caused by, or characteristic of an enzyme
Flank pain: pain on the side of the body between the ribs and the ilium
Hemodynamics: the study of the movement of the blood and the forces concerned therein
Hemoglobin: iron-containing pigment of red blood cells that carries oxygen to the tissues
Hemorrhoids: enlarged veins in the anal canal that bleed easily and are painful
Hypercapnia: increased amount of carbon dioxide in the blood
Hypothalamus: the portion of the diencephalon lying beneath the thalamus at the base of the cerebrum and forming the floor and part of the lateral wall of the third ventricle
Hypothermia: low body temperature
Hypoxia: reduction in the amount of cellular oxygen
Intra-arterial: within the artery
Invasive procedure: any medical treatment or examination that involves penetration of the body tissues or organs
Lateral: pertaining to the side
Oral: taken by mouth
Oximeter: a photoelectric device that measures oxygen saturation of the blood
Oxygenated: saturated with oxygen
Parenchyma: the functional elements of an organ as distinguished from its supporting or connective tissue
Pathological: the structural and functional manifestations of a disease
Peripheral: the outer portion or surface of the body
Pharynx: the throat
Posterior: directed toward or situated at the back
Pulmonary: involving the lungs
Pyrexia: a fever, or febrile condition
Radiolucent: permitting the passage of radiant energy such as x-ray, yet offering some resistance to it
Retraction: the act of drawing back or condition of being drawn back
Symmetry: correspondence in size, form, and arrangement of parts on opposite sides of a plane or around an axis
Systemic: affecting the body as a whole
Systemic vascular resistance: the resistance against which the left ventricle must eject blood at every systolic heart beat
Systole: the contraction of the heart that drives blood into the aorta and pulmonary arteries
Tachycardia: abnormally rapid heart beat (over 100 beats per minute)
Therapeutic: involving the science or art of healing; a scientific account of the treatment of disease
Thermostat: a device in a heating system by which temperature is automatically maintained between certain specified levels
Toxic: poisonous or acting as a poison
Tracheobronchitis: inflammation of the trachea and bronchi
Transtracheal: a technique of oxygen administration for the patient requiring chronic oxygen therapy; oxygen is administered by catheter into the trachea
Tympanic: Bell-like; resonance pertaining to tympanum
Viscosity: the thickness of a fluid
Volatile: easily vaporized or evaporated; unstable or explosive in nature

Taking a patient's vital signs (also called *cardinal signs*) is an important part of a physical assessment and includes measurement of body temperature, pulse, respiration, and blood pressure. The radiographer must know how to measure each vital sign to be prepared in the event that he encounters an emergency situation in which these skills are needed. It is also important to learn what the patient's vital signs are under normal circumstances because all persons have some variation from what is considered normal for their particular age group. Once the radiographer knows what the patient's usual, or baseline, vital signs are, he can judge whether his patient's vital signs are deviating from that baseline. Changes in vital signs can be an indication of a problem or a potential problem.

A patient's baseline vital signs cannot be established with one reading of pulse, respiration, or blood pressure because there are many variables that can make one reading unreliable. The radiographer must also measure the patient's vital signs

if the patient comes to the diagnostic imaging department for an extensive procedure or examination without a chart and there is no registered nurse available.

Oxygen is an essential physiologic need for survival. It comes from the environment to the lungs, then is transported to the bloodstream and body tissues. The human brain cannot function for longer than 4 to 5 minutes without an adequate oxygen supply. It is occasionally necessary to administer oxygen in the diagnostic imaging department, and the radiographer may be expected to assist in its administration. A patient receiving oxygen therapy in his hospital room may be unable to leave the room to go to the diagnostic imaging department for necessary procedures. In these instances, the radiographer will be required to make portable radiographic exposures at the bedside. Because oxygen is a potentially toxic and volatile substance, the radiographer must understand the precautions that are to be taken when assisting with its administration or when using radiographic equipment while oxygen is in use.

It is the radiographer's responsibility to make certain that there is a functioning sphygmomanometer, a stethoscope, and the equipment necessary to administer oxygen in each diagnostic imaging room at the beginning of each shift. Emergencies requiring these items arise and there is no time to look for this equipment.

Measuring Vital Signs

A physician's order is not required for vital signs to be measured. Unless there is a registered nurse present to do so, the radiographer should take vital signs when a patient is admitted to the diagnostic imaging department for any invasive diagnostic treatment or procedure, before and after the patient receives medication, any time the patient's general condition suddenly changes, or if the patient reports nonspecific symptoms of physical distress such as simply not feeling well or feeling "different."

*Base line before you start invasive procedure.

Body Temperature

Body temperature is the physiologic balance between heat produced in body tissues and heat lost to the environment. It must remain stable if the body's cellular and enzymatic activity are to function efficiently. Body temperature is controlled by a small structure in the basal region of the diencephalon of the brain called the *hypothalamus*, sometimes referred to as the body's thermostat.

Body heat is produced by chemical processes that result from metabolic activity. When the body's metabolism is increased, more heat is produced. When it is decreased, less is produced. Both normal and abnormal conditions in the body can produce changes in body temperature. The environment, time of day, age, weight, physical exercise, digestion of food, disease, and injury are some factors that influence body temperature. The body's cellular functions and cardiopulmonary demands change in proportion to temperature variations outside of normal limits.

When a patient's body temperature is elevated above normal limits, he is said to have a fever, or *pyrexia*. Fever indicates a disturbance in the heat-regulating centers of the body, usually as a result of a disease process. As body temperature increases, the body's demand for oxygen increases. A person with a body temperature below normal limits is said to have *hypothermia*, which may be indicative of a pathological process. Hypothermia may also be induced medically to reduce a person's need for oxygen. It is rare for a person with a body temperature of between 41°C (105.8°F) and 44°C (111.2°F) or below 34°C (93.2°F) to survive (Fig. 6–1).

A body temperature of 37°C or 98.6°F is considered to be average or normal. A variation of 0.5° to 1° above or below average is usually considered to be within normal limits.

The normal body temperature of infants and children up to 13 years of age varies somewhat from these readings. Average body thermometer in well children from ages 3 months to 3 years is from 99°F (37.2°C) to 99.7°F (37.7°C). From 5 years of age to 13 years the normal temperature is from 97.8°F (36.7°C) to 98.6°F (37°C). Symptoms of a fever are increased pulse and respiratory rate, general discomfort or aching, flushed dry skin that feels hot to the touch, chills (occasionally), and loss of appetite. Fevers that are allowed to remain very high for a prolonged period of time can cause irreparable damage to the central nervous system.

MEASURING BODY TEMPERATURE

There are four areas of the body in which temperature is usually measured: the oral site; the tympanic site; the rectal site; and the axillary site.

Oral temperature is taken by mouth, under the tongue; the average temperature reading here is

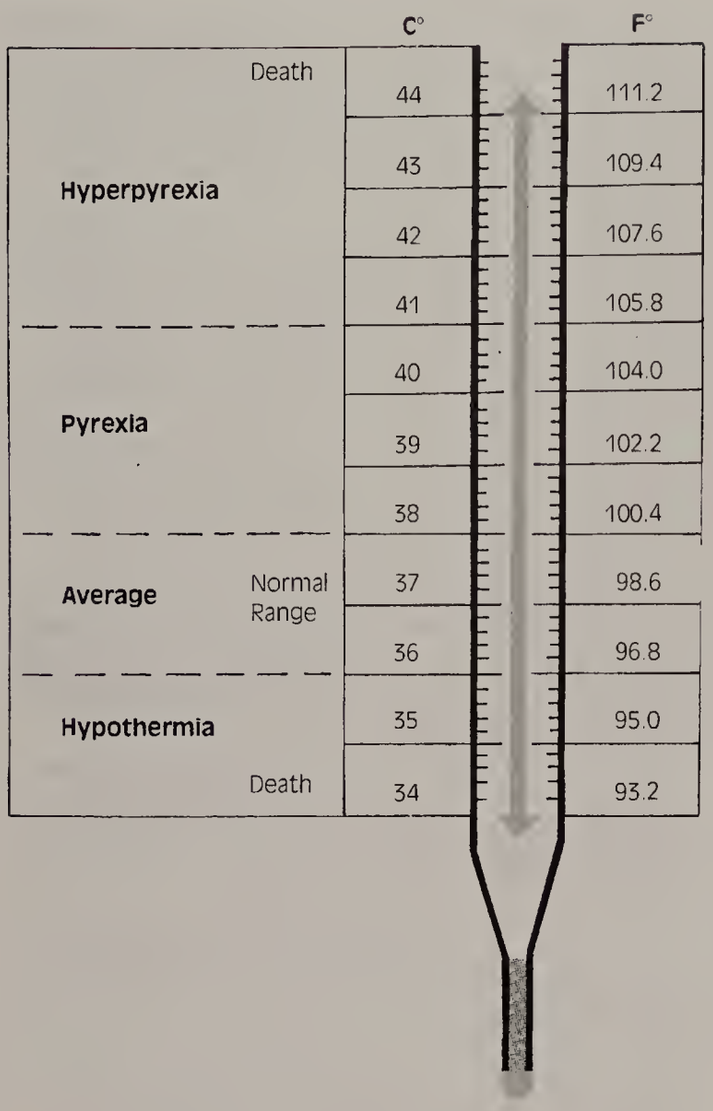


Figure 6–1
The range of human body temperature, as measured orally. (Taylor C, Lillis C, and LeMone P: Fundamentals of Nursing: The Art and Science of Nursing Care. Philadelphia, JB Lippincott, 1989.)

37°C (98.6°F). The axillary temperature is taken in the axilla or armpit. The average temperature here is 36.4°C to 36.7°C (97.6°F to 98°F). Rectal temperature is taken at the anal opening to the rectum. The average temperature here is 37.5°C (99.6°F).

The site selected for measuring body temperature must be chosen with care depending upon the patient's age, state of mind, and ability to cooperate in the procedure. Because the reading will vary depending on where it is measured, the site used must be specified when the reading is reported. Temperature readings are reported in most health care facilities as follows:

A rectal temperature of 99.6°F is written 99.6 R

An oral temperature of 98.6°F is written 98.6 O

An axillary temperature of 97.6°F is written 97.6 Ax.

A tympanic temperature of 97.6°F is written 97.6 T.

Whatever method of measuring body temperature is chosen, the radiographer must assemble the necessary equipment, wash his hands, put on clean gloves if contact with blood or body fluids is possible, and position the patient appropriately.

The Tympanic Membrane Thermometer

The tympanic membrane thermometer (also called an *aural thermometer*) is a small, hand-held device that measures the temperature of the blood vessels in the tympanic membrane of the ear. This provides a reading close to the core body temperature if correctly placed.

The procedure for its use is as follows:

1. Place a clean sheath on the probe that is to be inserted into the external auditory canal (Fig. 6–2). The patient may be sitting upright or in a supine position.
2. Place the probe into the external auditory canal and hold it firmly in place until the temperature registers automatically on the meter held in your nondominant hand.
3. Remove the probe and read the indicator.
4. Remove the probe cover and dispose of it correctly. Then remove your gloves and wash your hands.
5. Record the reading. Immediately report any abnormal temperature to the physician in charge of the patient.



Figure 6–2
Measuring temperature with a tympanic membrane thermometer. A clean sheath is placed on the probe and the probe is placed inside the external auditory canal.

The Electronic Thermometer for Oral Temperature

The procedure is the same as for the tympanic membrane thermometer except that the probe is placed under the patient's tongue and held in place until the instrument signals that it has registered a temperature (Fig. 6–3).

Oral Temperature, Glass Thermometer

The mouth is an accessible site for measuring body temperature if a tympanic membrane thermometer is not available. This site should not be used if the patient is apt to be injured during the procedure by biting down on the thermometer or if he is unable to hold the instrument under his tongue with lips closed for the specified period of time. Patients who fall into this category include those who are delusional, disoriented, or delirious; those who have facial injuries, or have had oral surgery; those with a history of convulsions; those unable to breathe with the mouth closed; and young children.

When measuring oral temperature with a glass clinical thermometer, the procedure is as follows:

1. Wash your hands.
2. Select a sterilized thermometer with an elongated tip.
3. Shake the thermometer down to a mercury reading of 35°C (96°F).
4. Approach the patient, explain the procedure, and place the thermometer tip under his tongue.
5. Have the patient close his lips over the tip of the thermometer and leave it in place for 3 to 5 minutes.
6. Remove the thermometer, wipe it with a tissue, read it, and place it with the soiled equipment.
7. Remove your gloves and wash your hands.

This type of thermometer must be held at eye level by the blunt end and turned until the mercury column can be seen and read. The point on the marked scale where the mercury stops indicates the temperature to be recorded. Each long line on the thermometer represents one full degree of body temperature and is numbered accordingly. The short lines each represent two tenths of one degree of body temperature; these lines are not numbered (Fig. 6–4).

After the thermometer has been read, report the temperature reading to the patient's physician and record it on the patient's chart.

Taking an Axillary Temperature

Use of this site is the safest method of measuring body temperature because it is a noninvasive procedure. It is particularly useful when measuring an infant's temperature. Unfortunately, the time and precision of placement needed to obtain an

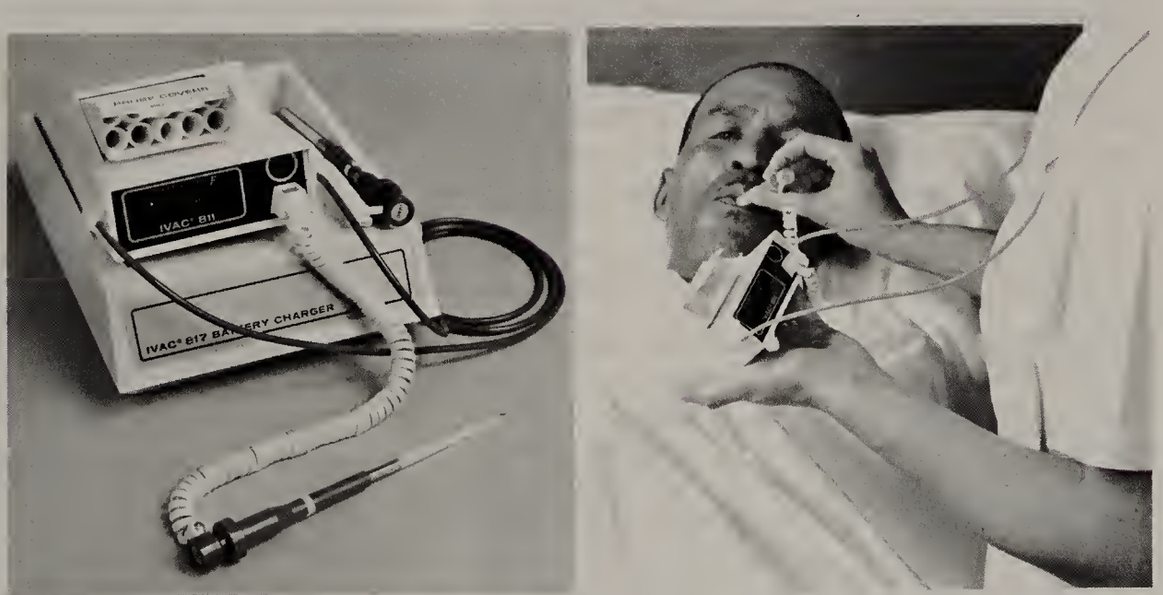


Figure 6–3
(***Left***) An electronic thermometer. There are interchangeable oral and rectal probes. The cylindrical objects near the top of this model are disposable plastic probe covers. (***Right***) The radiographer reads the thermometer on the clock-like face when the thermometer signals that peak temperature has been reached.

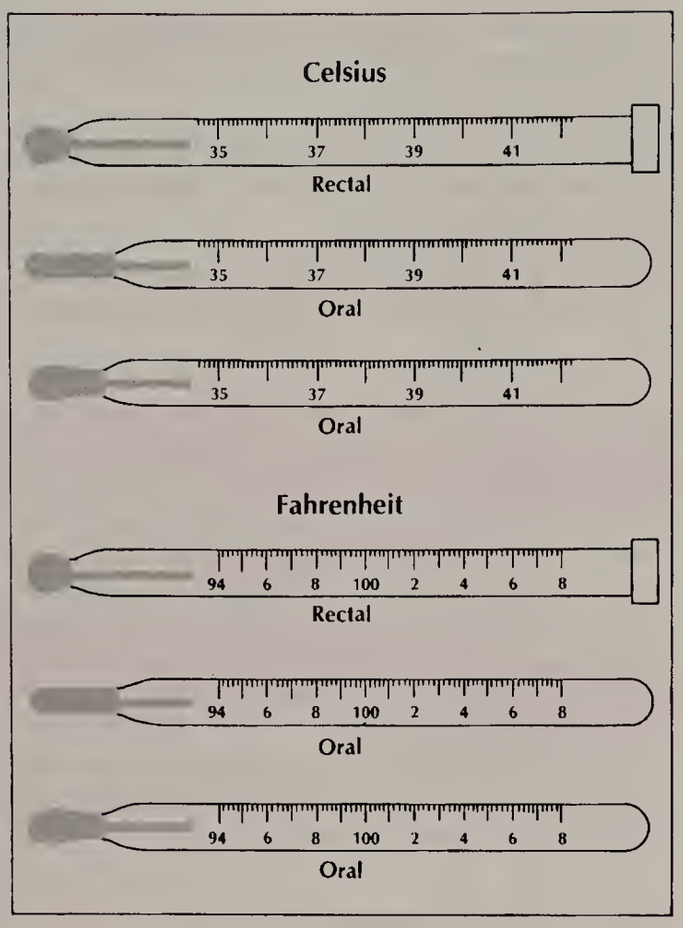


Figure 6–4
Glass clinical thermometers. (***Top***) These three thermometers are calibrated to measure degrees Celsius. (***Bottom***) These three measures are in the Fahrenheit scale. Those with blunt bulbs are rectal thermometers.

accurate reading make this method somewhat unreliable. When it is necessary to measure temperature using the axillary site, an electronic, a disposable, or a glass thermometer with a blunt tip may be used. The procedure is as follows:

1. Obtain the instrument to be used; if it is a glass thermometer, shake it down.
2. Wash your hands. Put on clean gloves.
3. Dry the patient's armpit with a paper towel or a dry washcloth.
4. Place the thermometer into the center of the armpit.
5. Place the patient's arm down tightly over the thermometer with the arm crossed over his chest. Gently hold the arm of a child or a restless adult in place until the thermometer has registered. A glass clinical thermometer must be held in place for 5 minutes, whereas electronic and disposable thermometers are held for 1 minute.
6. Remove it, and remove the probe cover, or wipe the glass thermometer.
7. Read the thermometer; report and record the reading.
8. Dispose of the thermometer as appropriate.

Taking a Rectal Temperature

This site is considered to provide the most reliable measurement of body temperature because factors that can alter the results are minimized. It is also in close proximity to the pelvic viscera or the "core" temperature of the body. Body temperature should not be measured rectally if the patient is restless or has rectal pathology such as tumors or hemorrhoids.

In order to take a rectal temperature, a thermometer with a blunt tip must be used. An oral thermometer, whether it is of the glass or electronic type, should never be used to take a rectal temperature. Probe covers are often colored red for rectal temperature. The procedure is as follows:

1. Wash your hands.
2. Obtain a thermometer with a blunt tip. If a probe cover is used, apply it.
3. Don clean gloves.
4. Ensure the patient's privacy. Place him in Sims' position and cover him with a drape sheet.
5. Expose the patient only as much as is necessary for clearly viewing the rectal area.
6. Lubricate the thermometer tip with lubricating jelly. If the tip is covered with a probe cover, apply lubricant over the cover.
7. Separate the patient's buttocks with the heel of your hand so that the rectum is clearly visible.
8. Gently insert the tip of the thermometer into the rectum about 1 to 1½ inches and hold it in place for 2 to 3 minutes. Do not leave a patient who has a rectal thermometer in place. The thermometer must be held.
9. When the time has passed, remove the thermometer and return the patient to a comfortable position.
10. Remove the probe cover or wipe the thermometer with a tissue. Read it and dispose of it as appropriate.
11. Remove your gloves in the specified manner and wash your hands.



Figure 6–5
Disposable thermometer.

12. Report the temperature reading and record it.

Other Instruments Used to Measure Body Temperature

There are temperature-sensitive patches available that can be placed on the abdomen or forehead of infants or children to measure temperature. If they indicate an abnormal temperature, another method should be used to ascertain the actual reading.

If a patient's behavior is unreliable or if resterilization of equipment is not convenient, an unbreakable, disposable, single-use thermometer can be used (Fig. 6–5). Gloves are worn as in previous descriptions. The thermometer is removed from its wrapper and the indicator end is placed under the patient's tongue for 1 minute. The beads change color, indicating the patient's temperature. After recording the temperature, the thermometer is discarded. The accuracy of these instruments is uncertain.

Pulse

As the heart beats, blood is pumped in a pulsating fashion into the arteries. This results in a throb, or pulsation, of the artery. At areas of the body where arteries are superficial, the pulse can be felt by holding the artery beneath the skin against a solid surface such as bone. The pulse can be detected most easily in the following areas of the body:

The apical pulse—over the apex of the heart (heard with a stethoscope) (Fig. 6–6A).

The radial pulse—over the radial artery at the wrist, at the base of the thumb (see Fig. 6–6B).

The carotid pulse—over the carotid artery, at the front of the neck (see Fig. 6–6C).

The femoral pulse–over the femoral artery, in the groin (see Fig. 6–6D).

The popliteal pulse—at the posterior surface of the knee (see Fig. 6–6E).

The temporal pulse—over the temporal artery in front of the ear (see Fig. 6–6F).

The dorsalis pedis pulse—at the top of the feet in line with the groove between the extensor tendons of the great and first toe (may be congenitally absent) (see Fig. 6–6G).

The posterior tibial pulse—on the inner side of the ankles (see Fig. 6–6H).

The brachial pulse—in the groove between the biceps and triceps muscles above the elbow at the antecubital fossa (see Fig. 6–6I).

Usually the pulse rate is rapid if the blood pressure is low and slower if the blood pressure is high. The patient who is losing blood has an unusually rapid pulse rate and a very low blood pressure. The average pulse rate in an adult man or woman is between 60 and 90 beats/min in a resting state. The average pulse rate for an infant is 120 beats/min. A child from 4 to 10 years of age has an average pulse rate of from 90 to 100 beats/min.

ASSESSMENT OF THE PULSE

The pulse rate is a rapid and relatively efficient means of assessing cardiovascular function. *Tachycardia* is the term used to describe an abnormally rapid heart rate (over 100 beats/min), and *bradycardia* is the term used to describe an abnormally slow heart rate (below 60 beats/min). The radiographer must be prepared to make this assessment prior to any invasive diagnostic imaging procedure to establish a baseline reading and to reassess it frequently until the procedure is complete and the patient leaves the department, if a registered nurse is not present to do so. The radial pulse is usually the most accessible and can be taken most conve-

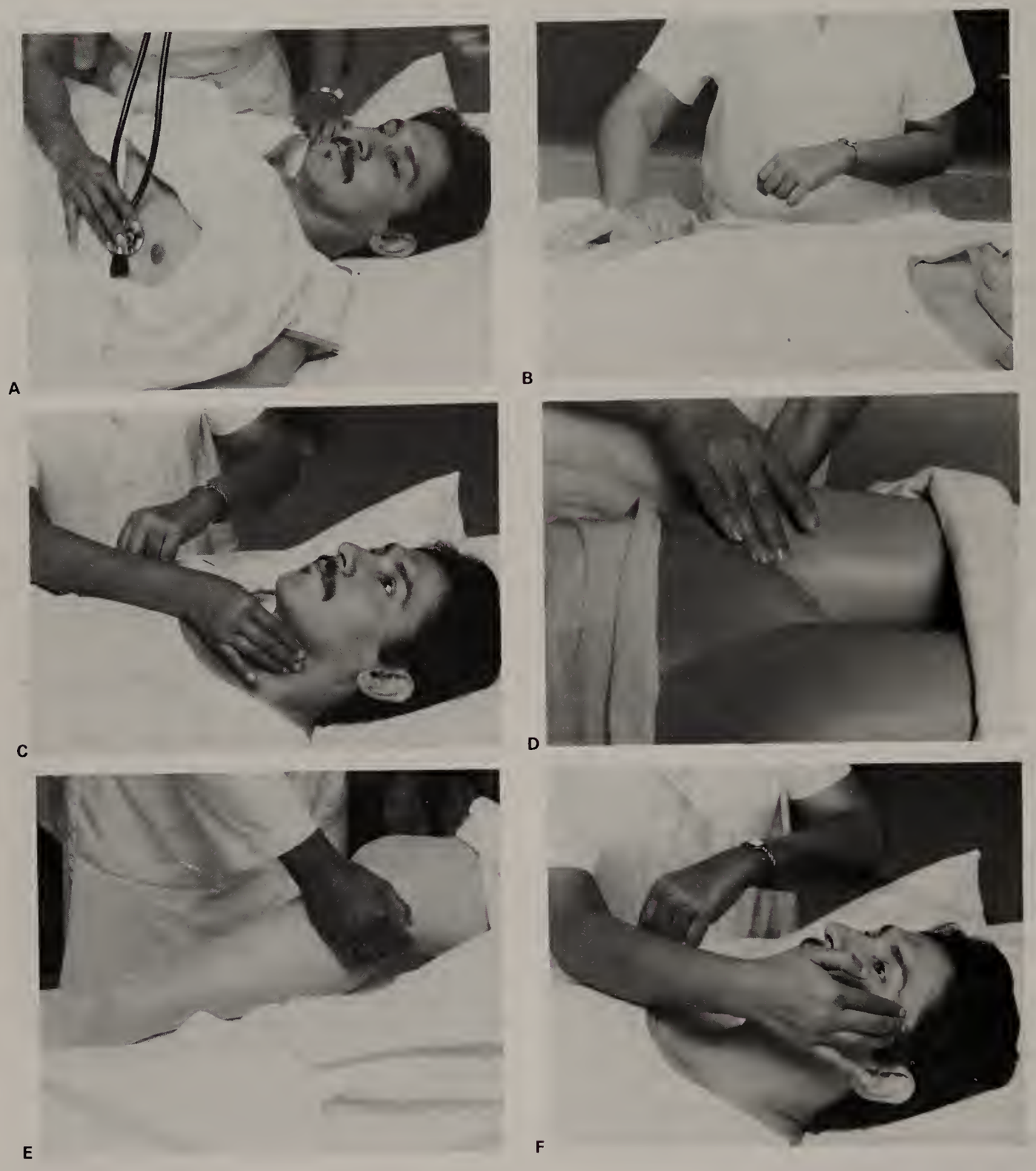


Figure 6–6
(**A**) Apical pulse. (**B**) Radial pulse. (**C**) Carotid pulse. (**D**) Femoral pulse. (**E**) Popliteal pulse. (**F**) Temporal pulse. (**G**) Dorsalis pedis pulse. (**H**) Posterior tibial pulse. (**I**) Brachial pulse.

niently on an adult patient. It should be counted for 1 full minute. If there is any irregularity of this pulse rate, the apical pulse must be taken. The apical pulse is also monitored if the radial pulse is inaccessible.

For infants and children, the apical pulse is the most accurate for cardiovascular assessment. The femoral, popliteal, and pedal pulses are assessed bilaterally if peripheral blood flow is to be assessed.

When pulse rate is being assessed, the strength and regularity of the beat as well as the number of beats per minute must be reported. The normal rhythm of the pulse beat is regular, with equal time intervals between beats. The pulse should not be obliterated by the pressure of the fingers. When



G



H



I

Figure 6–6 ***(Continued)***

it is, it is reported as weak or thready. If the beat is irregular, unusually rapid, unusually slow, or unusually weak, it must be reported to the physician in charge of the patient immediately. Changes in pulse rate during a procedure must also be reported.

In order to assess the pulse, one needs a watch with a second hand and a pad and pencil to record the findings. For monitoring apical pulse, a stethoscope is necessary, along with alcohol sponges for wiping the earpieces and the bladder of the instrument.

To assess radial, femoral, carotid, popliteal, pedal, and temporal pulses, observe the following guidelines:

1. Wash your hands, approach the patient, and lightly place your index finger and middle finger flat over the artery chosen for assessment. Do not press too hard, or your fingers will compress the artery and the beat will not be felt.
2. When the throbbing of the artery is felt, count the throbs for 1 minute. Do not use the thumb when counting the pulse rate, because it too has a pulse that may be mistaken for the patient's pulse.

The pedal, popliteal, and femoral pulses are often monitored during special diagnostic imaging procedures to ascertain that the patient's circulatory status in the lower extremities is satisfactory. When this is the case, they are not always counted. Instead, they are palpated and assessed as present and strong, weak, regular, or irregular. The areas where the pedal and popliteal pulses are palpated are sometimes indicated with a marker or a pen so that they may be easily found to be

checked as necessary. The radiographer must become proficient in finding and assessing these pulses.

Apical Pulse

To assess the apical pulse, the radiographer will need a stethoscope and alcohol wipes. The procedure is as follows:

1. Clean the earpieces and the bladder of the stethoscope with alcohol wipes. Wash your hands.
2. Approach the patient and place him in a semi-Fowler's or supine position.
3. Drape the patient so that the lower chest area is exposed.
4. Place the bladder of the stethoscope at the fifth intercostal space 5 cm from the left sternal margin (the nipple of the breast can be used as a landmark for 5 cm).
5. If the beat cannot be heard, move the stethoscope slightly in every direction until it can be heard.
6. Count the beats for 1 minute and assess the heart beats for regular rate and rhythm.
7. Remove the stethoscope; wipe the earpieces and bladder with alcohol. Cover the patient and make him comfortable.
8. Wash your hands. Report any irregularities to the physician and record the pulse rate.

When recording pulse rate, the abbreviation P for pulse is used. The apical pulse is recorded as AP. For example, P 80 equals a pulse rate of 80 beats/min. AP 88 equals an apical pulse rate of 88 beats/min. Any abnormalities noted should be reported to the patient's physician immediately and recorded, for example, *P 94, thready (or weak) and irregular.*

Respiration

The function of the respiratory system is to exchange oxygen and carbon dioxide between the external environment and the blood circulating in the body. Oxygen is taken into the lungs during inspiration. It passes through the bronchi, into the bronchioles, and then into the gas-exchange units of the lungs, the alveoli. Oxygen is transported to the body tissues by the arterial blood. Deoxygenated blood is returned to the right side of the heart through the venous system. It is then pumped into the right and left pulmonary arteries and reoxygenated by passing through the capillary network on the alveolar surfaces. The blood is then returned to the left side of the heart through the pulmonary veins for recirculation. During this process, carbon dioxide is also deposited in the alveoli and exhaled from the lungs during expiration.

The average rate of respiration (one inspiration and one expiration) for an adult man or woman is 10 to 20 breaths/min, and for an infant, 30 to 60 breaths/min. Respirations of fewer than 10 breaths/min for an adult may result in cyanosis, apprehension, restlessness, and a change in level of consciousness, because the supply of oxygen is inadequate to meet the needs of the body.

Normal respirations are quiet, effortless, and uniform. Medication, illness, exercise, or age may increase or decrease respirations, depending on the body's metabolic need for oxygen. When a patient is using more than the normal effort to breathe, he may be described as dyspneic or as having dyspnea.

ASSESSMENT OF RESPIRATION

As with other vital signs, it is important to establish a baseline respiratory rate because changes in respiration are often an early sign of a threatened physiologic state. When one assesses respiration, the rate, depth, quality, and pattern should be observed. The assessment procedure is as follows:

1. The patient remains in the position that he is in, either sitting or supine, for assessment of the pulse. He should be in a quiet state and not be aware that his respirations are being observed. If the patient is aware of the fact that his respirations are being assessed, he may consciously or unconsciously alter the pattern.
2. *Observe the chest wall for symmetry of movement.* There should be an even rise and fall of the chest with no involvement of muscles other than the diaphragm. In the adult patient, abdominal, intercostal, or neck muscle involvement in breathing is a sign of respiratory distress and should be noted. Other signs of respiratory distress in an adult patient include the following: the need to assume a sitting position, or the need to lean forward and

place the arms up over the back of a chair or on the knees in order to breathe easily.

3. *Observe skin color.* Cyanosis, or bluish discoloration, is easily observed around the mouth, in the gums, in nail beds, or in the earlobes. If present, it may be a sign of respiratory distress.

4. *Count the number of times the patient's chest rises and falls for one full minute.* The most convenient time to count respirations is immediately following the pulse count as you appear to be continuing to count the pulse rate but are observing respiratory movement instead. When recording respiration, use the abbreviation R. R 20 equals 20 rises and falls of the chest wall. Any abnormalities or deviations from the baseline should be reported to the physician in charge of the patient immediately and recorded, for instance, *R 28, shallow and labored.*

Blood Pressure

In general terms, pressure is defined as the product of flow times resistance. Blood pressure is the amount of blood flow ejected from the left ventricle of the heart during systole and the amount of resistance the blood meets due to systemic vascular resistance. Maintenance of blood pressure is dependent on peripheral resistance, pumping action of the heart, blood volume, blood viscosity, and the elasticity of the vessel walls.

If the volume of blood is decreased owing to hemorrhage or dehydration, the blood pressure falls because of a diminished amount of fluid in the arteries. Fluid or blood replacement will reverse this problem.

The viscosity of the blood is determined by the number of red blood cells in the blood plasma. If there are an increased number, the blood thickens or becomes more viscous and subsequently increases the blood pressure.

The arteries are normally elastic in nature; however, age or a build-up of atherosclerotic plaque reduces the flexibility of the arteries and increases blood pressure.

The peripheral blood vessels distribute blood ejected into the circulatory system to the various body organs. When the peripheral blood vessels are in a normal physiologic state, they are partially contracted. If this normal physiologic state is changed because of changes in environmental factors such as heat or cold, medication, disease, or other obstructive conditions, peripheral blood vessel resistance may increase, causing an increase in blood pressure, or may decline, causing a decrease in blood pressure.

Blood pressure normally varies with age, sex, physical development, body position, time of day, and health status. As a person ages, his blood pressure will usually increase as the body systems that control blood pressure deteriorate.

Blood pressure is usually lower in the morning following a night of sleep than it is later in the day following activity. Men usually have higher blood pressure than women. Blood pressure increases following a large intake of food. Emotions and strenuous activity usually cause systolic blood pressure to increase.

The instrument used to measure blood pressure is called a *sphygmomanometer.* Two numbers, read in millimeters of mercury (mm Hg), are recorded when reporting blood pressure: systolic pressure and diastolic pressure. The systolic reading is the highest point reached during contraction of the left ventricle of the heart as it pumps blood into the aorta. The diastolic pressure is the lowest point to which the pressure drops during relaxation of the ventricles and indicates the minimal pressure exerted against the arterial walls continuously.

Pulse pressure is the difference between the systolic and diastolic blood pressure and is an indicator of the stroke volume of the heart (the amount of blood ejected by the left ventricle during contraction). Pulse pressure decreases when a patient is in a state of hypovolemic shock.

Blood pressure readings vary with age, sex, physical development, and health status. The normal systolic pressure in men and women ranges from 110 to 140 mm Hg, and the normal diastolic pressure ranges from 60 to 80 mm Hg. Physiologic factors that may increase blood pressure are increased cardiac output, increased peripheral vascular resistance, increased blood volume, increased blood viscosity, and decreased arterial elasticity. Physiologic factors that decrease blood pressure are decreased cardiac output, decreased peripheral vascular resistance, decreased blood volume, decreased blood viscosity, and increased arterial elasticity.

The radiographer must have a baseline blood pressure reading so that he may evaluate his patient's blood pressure effectively if necessary. A patient is considered to be hypertensive if his systolic blood pressure is consistently greater than 140 mm Hg and if his diastolic blood pressure is consistently greater than 90 mm Hg. A patient is considered to be hypotensive if his systolic blood pressure is less than 90 mm Hg.

EQUIPMENT NEEDED TO MEASURE BLOOD PRESSURE

There are two types of sphygmomanometer, a mercury manometer and an aneroid manometer (Fig. 6–7). Each has a cloth cuff, which comes in a variety of sizes. Within the cuff is an inflatable bladder, which should be nearly long enough to encircle the arm. Each also has a pressure manometer, a thumb screw valve to maintain or release the pressure, a pressure bulb to inflate the bladder, and rubber tubings that lead to the gauge and to the pressure bulb. The bulb and the tubing must be free of leaks.

The mercury manometer is the more accurate of the two, but it is less convenient to use. The aneroid manometer needle should point to zero before the bladder of the cuff is inflated, and its calibration should be checked for accuracy and recalibrated by means of a perfectly accurate mercury manometer at least once each year.

The blood pressure cuff should be selected according to patient size. A cuff that is too large or too small for the patient's arm will give an incorrect reading.

A stethoscope that has a bladder and a bell, strong plastic or rubber tubing 12 to 18 inches (30 to 40 cm) in length that leads to firm but flexible binaurals (the metal tubings leading to the earpieces), and earpieces that fit snugly and securely into the ears should be chosen. Either the bladder or the bell of the stethoscope may be used for assessing blood pressure. The bell transmits low sounds and should be held lightly against the skin; the diaphragm transmits high-pitched sounds and is held firmly against the skin (Fig. 6–8).

There are many types of Doppler and electronic blood pressure monitoring devices used in clinical practice. Their methods of operation vary and will not be discussed in this chapter.

An automated vital sign monitor is used during special diagnostic imaging procedures when it is necessary to know the patient's circulatory status at all times. The pulse and blood pressure and mean arterial pressure are measured with this instrument.



Figure 6–7
Two types of sphygmomanometer. (***Left***) A mercury manometer. (***Right***) An aneroid manometer with self-securing cuffs. There are several varieties of aneroid manometer.

MEASURING BLOOD PRESSURE

The patient should be sitting in a chair with his arm supported or reclining in a supine position. Frequently during a physical assessment, blood pressure is measured in reclining, sitting, and standing positions; however, for the radiographer's purposes this is not indicated. The room should be as quiet as possible to facilitate hearing the pulsations. There should be no clothing between the blood pressure (BP) cuff and the skin. The bladder and bell of the stethoscope and the earpieces should be cleansed with alcohol sponges prior to and following each use to prevent passing infection indirectly from one person to another.

The procedure is as follows:

1. Roll up the patient's sleeve, if necessary. *The brachial artery must be free of clothing.*

2. Place the deflated sphygmomanometer cuff evenly around the patient's upper arm above the elbow; secure it so that it will not work loose.



Figure 6–8
Stethoscope.

3. Place the bladder or bell of the stethoscope over the brachial artery. This artery is located at the center of the anterior elbow and may be identified by feeling its pulsations. The instrument must be placed flat against the artery (Fig. 6–9). *Do not allow the stethoscope or the tubing to touch the patient's clothing as it will create sounds that may confuse your reading.*
4. Place the gauge of the sphygmomanometer on a flat surface so that it can be easily read.
5. Place the earpieces of the stethoscope in your ears. They must fit snugly.
6. Tighten the thumbscrew of the pressure bulb and pump the bulb until the indicator or mercury reaches 180 mm Hg or until you are no longer able to hear the pulse beat (Fig. 6–10).
7. Open the valve by slowly loosening the thumb screw. Allow the indicator to fall slowly as you listen for the first audible pulse beat. Listen carefully for the pulse beat to begin and take the reading on the gauge where it is first heard. *This first reading is the systolic blood pressure.*

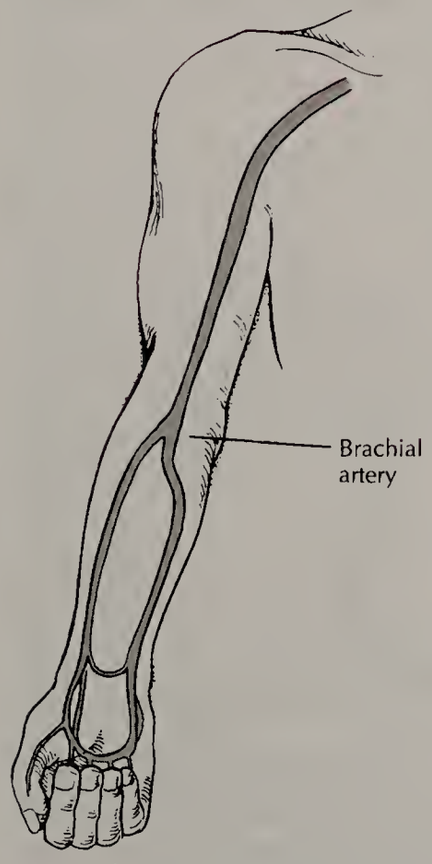


Figure 6–9
The bell or bladder of the stethoscope is placed over the brachial artery.



Figure 6–10
Measuring blood pressure.

8. Continue to listen to the pulsations until they become soft or the sound changes from loud to very soft or is inaudible. Note where the sound changes or is no longer heard. *This is the diastolic reading.*

Frequently, when one listens for the diastolic pressure, there is a detectable change in intensity of the sound before the sound is completely muffled. The point at which this softer sound is heard should be noted, and then the point at which no pulsation is heard should be noted. This reading is a more accurate indication of intra-arterial diastolic pressure. Both readings should be recorded, with the first, softer sound recorded first.

Blood pressure is recorded in the following manner: if the systolic reading is 120 and the diastolic reading is 80, it is written *BP 120/80* and is read "one twenty over eighty." If the diastolic reading is soft at 80 and then completely muffled at 60, it should be written *120/80/60.*

Blood pressure measurement for infants and small children is a more complex procedure. It should be performed by a physician or nurse educated in this skill. Usually a nurse is on hand to monitor the child when invasive diagnostic imaging procedures are to be done for patients in this age group.

Oxygen Therapy

An adequate oxygen supply is essential to life. Because oxygen cannot be stored in the body, the supply from the external environment must be constant. When a human being's oxygen supply is

suddenly interrupted or interfered with in any manner, it becomes an emergency that must be dealt with immediately to prevent a life-threatening situation. This type of emergency may occur in the diagnostic imaging department; therefore, the radiographer may be the first person to observe a problem. It will be his responsibility to ensure that the equipment needed to administer oxygen is available and in functioning condition in his work area at all times and to assist with oxygen administration in emergency situations. He must also become acquainted with the methods of oxygen administration that he may encounter in other areas of patient care.

The lungs supply oxygen and remove carbon dioxide from the body. Oxygen and carbon dioxide are carried to and from the various body systems in the blood. Only small amounts of oxygen are carried in solution in the blood. The major supply of oxygen is carried in chemical combination with hemoglobin. The oxygen capacity of the blood is expressed in percentage of the volume. The amount of oxygen in either air or blood is called the oxygen tension (partial pressure) and is written PO_2. Carbon dioxide is described similarly as PCO_2.

Carbon dioxide diffuses into the plasma of systemic capillary blood, but the major part enters the red blood cells. Carbon dioxide also is carried in combination with hemoglobin, which assists with its removal from the body. When there is an excessive build-up of carbon dioxide in the bloodstream, the pH (acidity or alkalinity) of the blood is changed, often with dire physiologic effects. Prevention of excessive acidity of the blood is achieved through the presence of a bicarbonate (HCO_3) buffer in the bloodstream.

The effectiveness of pulmonary function (the lungs' ability to exchange oxygen and carbon dioxide efficiently) is most accurately measured by laboratory testing of arterial blood for the concentrations of oxygen, carbon dioxide, bicarbonate, acidity, and the saturation of hemoglobin with oxygen (SaO_2). Laboratory values (called *arterial blood gases*) considered within normal limits are as follows:

pH: 7.35 to 7.45

$PaCO_2$: 32 to 45 mm Hg

PaO_2: 80 to 100 mm Hg

HCO_3: 20 to 26 mEq/L

SaO_2: 97%

When pulmonary function is disturbed, the level of oxygen in the arterial blood becomes inadequate to meet the patient's physiologic needs. This condition is referred to as *hypoxemia*. Carbon dioxide may be retained in the arterial blood, which results in a condition called *hypercapnea*. When the PaO_2 is below 60 mm Hg or the hemoglobin saturation is less than 90%, it can be assumed that adequate oxygenation of the blood is not taking place. The radiographer will usually rely on observation of physical symptoms of this problem, which will be discussed in Chapter 7, as this condition occasionally occurs with little warning, and there is no time for laboratory analysis of arterial blood gases.

PULSE OXIMETRY

A pulse oximeter is frequently used to monitor the oxygen saturation of hemoglobin (SaO_2). This is a fast, noninvasive method of monitoring the patient for sudden changes in oxygen saturation. A sensor is attached to a fingertip or an earlobe (Fig. 6–11). A photodetector attached to the sensor is able to distinguish between oxygenated and deoxygenated hemoglobin of the blood pulsing through the tissue at the location of the sensor. Normal values are 95% to 100%. Values of less than 85% indicate that the tissues are not receiving adequate oxygen. The pulse oximeter is used in all areas of acute health care as well as in the special procedures areas of radiographic imaging.

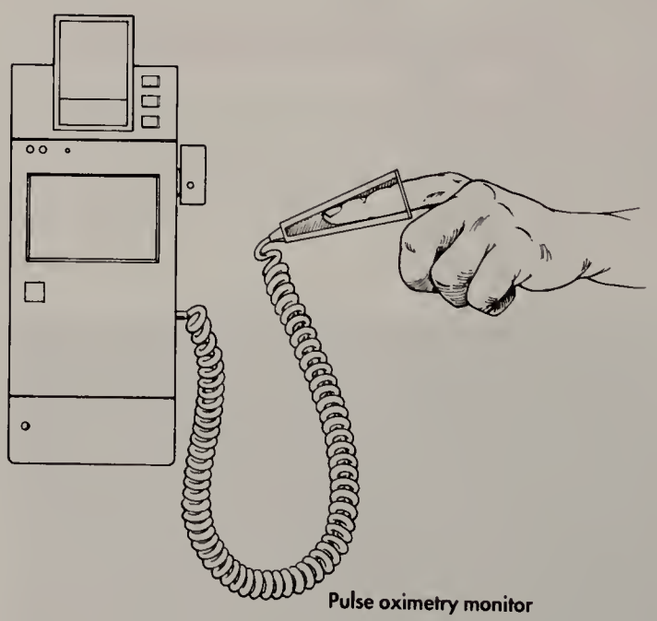


Figure 6–11
Pulse oximetry is an effective tool for measuring subtle changes in oxygen saturation (SaO_2). The finger, earlobe, or bridge of the nose can be used. A sensor detects changes in oxygen saturation levels in the blood pulsing through the tissue where the probe is attached. (Fuller J, Schaller-Ayers J. Health Assessment: A Nursing Approach, 2nd ed. Philadelphia, JB Lippincott, 1994.)

HAZARDS OF OXYGEN ADMINISTRATION

Oxygen is considered to be a medication and, like all other forms of medical therapy, must be prescribed by a physician. Excessive amounts of oxygen may produce toxic effects on the lungs and central nervous system or may depress ventilation.

Varying degrees of oxygen toxicity may result from inhalation of high concentrations of oxygen for more than brief periods of time. Mild oxygen toxicity may produce reversible tracheobronchitis. Severe oxygen toxicity may cause irreversible parenchymal lung injury. Because of the potential for adverse effects from excessive amounts of oxygen, it should be administered as prescribed and in the lowest possible amount to achieve adequate oxygenation.

Special care must be taken when oxygen is administered to patients with chronic lung disease. The radiographer must remember that if the patient has chronic lung disease, excessive oxygen in the blood may depress the respiratory drive and the patient may stop breathing. This occurs because patients with chronic lung disease have chemoreceptors that no longer respond to the stimulus of CO_2 to breathe, as occurs in a healthy individual. They must rely on hypoxia as a respiratory stimulus. If they receive an excessive amount of oxygen, hypoxia is no longer present and respiration ceases.

The equipment used to deliver oxygen is a potential source of infection to the patient. The radiographer must be certain that the tubing, cannulae, and masks for oxygen delivery are used for one patient only and then discarded. Oxygen supports combustion; therefore, care must be taken to prevent sparks or flames where oxygen is being administered. Smoking is prohibited in rooms where oxygen is in use, and anything that may produce sparks or flames must be used with extreme caution. The radiographer must take precautions when his equipment is to be used in the presence of pure oxygen to be certain that it will not produce sparks.

OXYGEN DELIVERY SYSTEMS

Oxygen is administered by artificial means when the patient is unable to obtain adequate amounts from the atmosphere to supply the needs of his body. If supplementary oxygen is required, it is delivered to the respiratory tract under pressure. When the flow rate is high, the oxygen is humidified to prevent excessive drying of the mucous membranes. This can be done by passing the oxygen through distilled water, because it is only slightly soluble in water. The procedure for moisturizing oxygen varies somewhat from one institution to another, but often the receptacle for distilled water is attached at the wall outlet, and the oxygen passes through the water and then into the delivery system.

In most hospitals, the oxygen is piped into hospital rooms, postanesthesia areas, emergency suites, and the diagnostic imaging department. Wall outlets make it readily available. Oxygen supplied in this fashion comes through pipes from a central source at 60 to 80 pounds of pressure per square inch. A flowmeter is attached to each wall outlet to regulate flow (Fig. 6–12).

If oxygen is not piped in through wall outlets, it is available compressed and dispensed in tanks of varying sizes. A full tank contains 2,000 pounds per square inch of pressure. These tanks have two regulator valves, one of which indicates how much oxygen is in the tank, and the other the rate

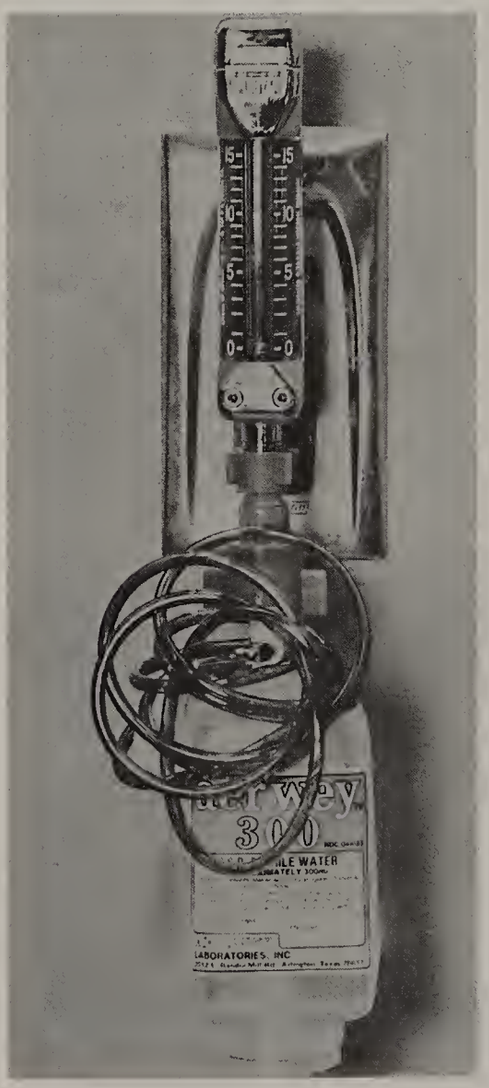


Figure 6–12
A wall oxygen outlet. The container above the outlet contains sterile water for humidifying the oxygen. The flow meter is located above the container.

of flow. If the radiographer must use this type of system, care must be taken not to allow the tank to fall or the regulator to become cracked (Fig. 6–13).

Twenty-one percent of the air we breathe normally is composed of oxygen. This is often abbreviated as FiO_2. This percentage of oxygen may need to be increased if a patient is in respiratory distress and unable to inspire enough room air to fulfill his body's oxygen needs.

There are many types of oxygen delivery systems that transport oxygen from wall outlets or tanks. The more complex systems deliver a controlled amount of premixed room air and oxygen. The simpler systems deliver a prescribed amount of oxygen mixed with room air, but the concentration varies as the patient's rate of respiration varies because they are not closed systems. The amount of oxygen that the patient needs and the type of delivery device needed are determined by the physician. The flow rate of oxygen is measured in liters per minute (LPM). There are several methods of oxygen delivery. The systems that the radiographer will be dealing with most commonly deliver low to moderate concentrations of O_2. They are as follows:

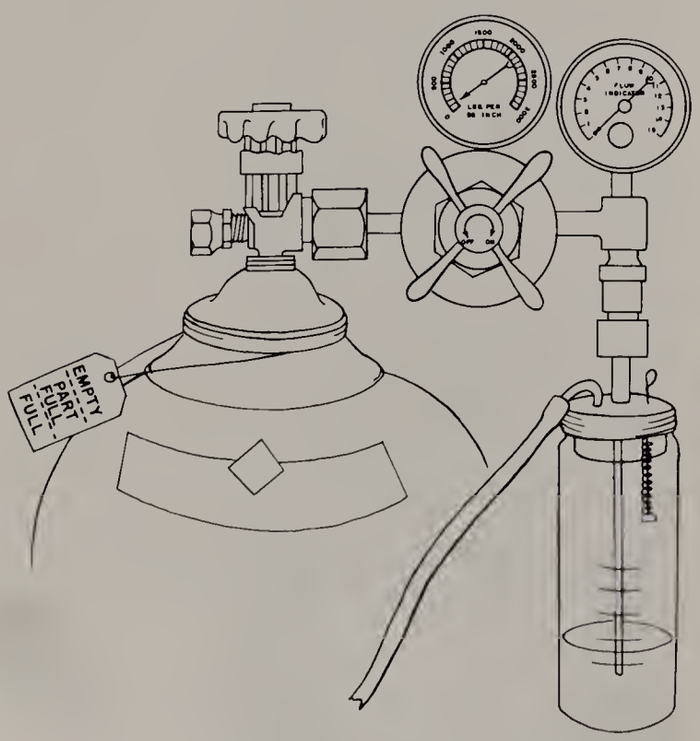


Figure 6–13
An oxygen tank. The regulator valve on top of the tank allows the oxygen to flow out of the tank. The valve to the right of the tank regulates the flow. The gauge on the left indicates the amount of oxygen in the tank; the one on the right indicates the rate of flow. The container to the right of the tank is a humdifier.

NASAL CANNULA The nasal cannula is a disposable plastic device with two hollow prongs that deliver oxygen into the nostrils (Fig. 6–14). The other end of the cannula is attached to the oxygen supply, which may or may not pass through a humidifier, and has a flow meter attached. The cannula is held in place by an elastic strap that fits over the ears and behind the patient's head.

The concentration of oxygen delivered by this method varies from 21% to 60% according to the amount of room air inspired by the patient. Oxygen delivery by nasal cannula is indicated for patients whose breathing rate and depth are normal and even. With this method, 1 to 4 LPM of oxygen is usually prescribed for adults. For children, the rate is much lower (1/4 to 1/2 LPM).

The radiographer must remember to have the oxygen turned on and flowing at the desired rate before placing any low-flow device on a patient. The nasal prongs must be kept in place in both nostrils.

NASAL CATHETER A nasal catheter is another means of low-flow delivery of oxygen. In this system, a French-tipped catheter is inserted into one nostril until it reaches the oral pharynx. It is used to deliver a moderate to high concentration of oxygen. As with the nasal cannula, the other end of the catheter is attached to the oxygen supply with a flow meter attached. The prescribed flow rate for this method of delivery is usually 1 to 5 LPM. The hazards of oxygen delivery by nasal catheter are that oxygen may be misdirected into the stomach, causing gastric distention, and that the mucous membranes may become dry, causing a sore throat. This method of oxygen delivery is used infrequently.



Figure 6–14
Nasal cannula.

FACE MASK A simple face mask is used to deliver oxygen for short periods of time. It, too, is attached to an oxygen supply and a flow meter. The mask is placed over the nose and mouth and attached over the ears and behind the head with an elastic band (Fig. 6–15). A mask is uncomfortable for long periods because the patient is unable to eat, drink, or talk with it in place. Moreover, the percentage of oxygen is so variable with the face mask that it is not the method of choice for long periods. When this type of delivery system is used, it should be run at no less than 5 LPM. This rate is needed in order to flush the CO_2 from the mask.

OTHER OXYGEN DELIVERY SYSTEMS Other face masks are usually used to administer more precise concentrations of oxygen. There are several masks available at present, and the physician will prescribe the one best suited to the patient's needs. The types of mask include a *nonrebreathing mask*, which, if correctly used, may supply 100% oxygen; a *partial rebreathing mask*, which may deliver 60% to 90% oxygen; a *Venturi mask*, which limits oxygen to 24% to 50%; and an *aerosol mask*, which provides 60% to 80% oxygen. If the high-flow mask has a reservoir bag attached, the bag fills with oxygen to provide a constant supply of oxygen. A valve prevents the exhaled gases from entering the reservoir bag and prevents rebreathing of exhaled gases (Fig. 6–16).

Persons who must have continuous O_2 therapy for long periods of time may have a *transtracheal delivery system*. This system has a catheter that is inserted into the trachea and tubing that is connected to a portable tank.

Patients in acute respiratory failure are often placed on *mechanical ventilators* that control or partially control inspiration and expiration and FiO_2. The radiographer will usually encounter these patients in the critical care units of the hospital. Before working with any patient who is on high-flow oxygen therapy or a mechanical ventilator, the radiographer must consult with the nurse in charge of the patient and plan his work carefully before beginning.

OXYGEN TENT Oxygen tents are used when there is a need for humidity and a higher concentration of oxygen than is present in the natural environment of the hospital room (Fig. 6–17). This method of delivery is rarely used for adults, but the radiographer may be called to the pediatric unit to attend a child in a tent. If this is the case, the radiographer may request that the oxygen be turned off for brief periods while he makes the required exposures. When finished, he must replace the tent, raise the side rails, and request that the nurse restart the oxygen and mist at the required concentration. The hazard of fire is especially great with an oxygen tent. Smoking is not permitted, nor is the use of any equipment that might generate sparks.

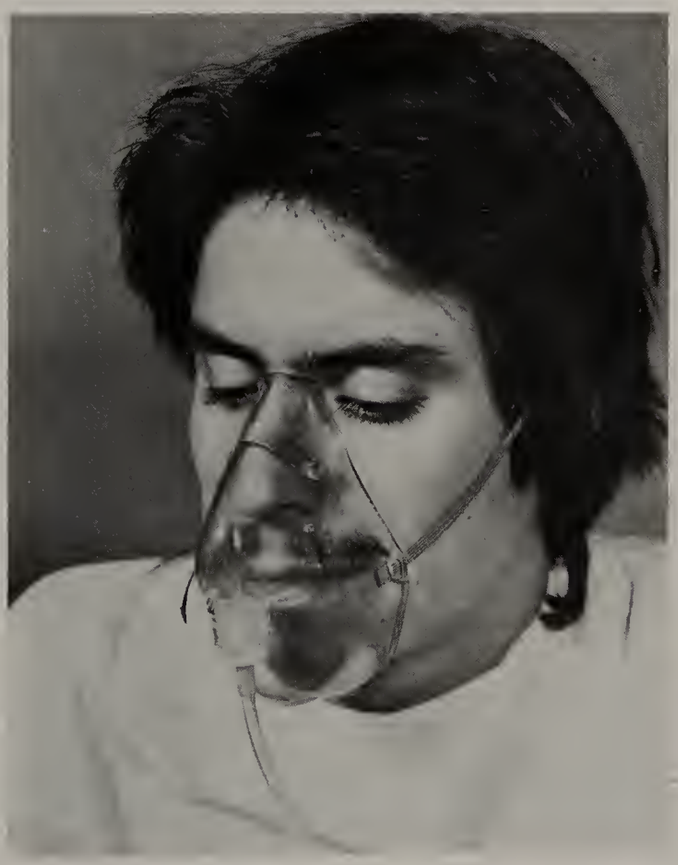


Figure 6–15
Simple oxygen face mask.



Figure 6–16
Rebreather mask.



Figure 6–17
Oxygen tent.

Home Oxygen Delivery Systems

The radiographer is sometimes assigned to take radiographs in the home of a patient who is unable to be transported to the health care facility. Oxygen is often used by these patients and may be delivered as a liquid, as compressed gas, or by means of an oxygen concentrator.

Compressed oxygen comes in tanks, usually smaller than the tanks used in the hospital; however, the principals of delivery are similar. Pure oxygen may be delivered by this method.

Liquid oxygen is a liquified gas that concentrates oxygen into a lightweight container the size of a thermos bottle. It is conveniently portable and lasts longer than other forms of oxygen. It is used by people who must take oxygen with them when they leave their homes. This is an expensive method, chiefly because the oxygen evaporates quickly.

The oxygen concentrator is economical and is an excellent source of oxygen. Oxygen is concentrated by means of an electric machine that removes the nitrogen, water vapor, and hydrocarbons from room air. Oxygen is delivered at 90% by this means.

Oxygen Delivery Equipment for the Imaging Department

A list of equipment that the radiographer will need to have on hand for oxygen administration in the diagnostic imaging department follows:

1. An oxygen source; either a piped-in source or a tank. If the source of oxygen is a tank, the tank must be checked daily to make certain that it is filled.
2. A sterile nasal cannula or simple face mask that is packaged and has not been used. These are disposable items.
3. Connecting tubing and an adapter to fit into a wall unit or tank, as required.
4. A humidifier, if indicated. Humidifiers are not always used for short-term oxygen administration.
5. A flow meter.
6. A "no smoking" sign.



Figure 6–18
Radiograph of congested lung.

Radiographic Examinations of the Chest

Normal lung tissue is radiolucent, therefore, pathological conditions that produce densities may be detected by radiographic imaging techniques (Fig. 6–18). Posterior/anterior and lateral radiographs are frequently ordered to diagnose pulmonary pathology and to determine placement of endotracheal tubes and hemodynamic devices. These radiographs are frequently taken at the patient's bedside because he is too ill to be moved. If this is the case, the radiographer must confer with the nurse in charge of the patient's care prior to beginning his assignment. Remember that the patient in respiratory distress will have difficulty complying with your needs and requests. Critical thinking and problem-solving skills will be needed to accomplish your task in a safe and efficient manner.

Summary

Body temperature is a physiologic balance between heat produced in body tissues and heat lost to the environment. Fever indicates a disturbance in the heat-regulating centers of the body. It can be detected by an elevation in body temperature, which can be measured by oral, tympanic, rectal, and axillary methods. The site and device selected to measure body temperature depend on the patient's age, as well as his mental and physical status. The reading varies depending on the site used for measurement. The body temperature of a normal adult man or woman is 36.7°C (97.6°F) axillary, 37°C (98.6°F) oral, and 38°C (99.6°F) rectal. These readings vary somewhat in infants and children. Time of day, age, exercise, environmental temperature, and disease alter body temperature.

The pulse is a reflection of the heartbeat, which sends blood to the arteries and causes them to throb. The areas where pulse can be measured best are at the radial artery (radial pulse), the temporal artery (temporal pulse), the carotid artery (carotid pulse), the femoral artery (femoral pulse), the apex of the heart (apical pulse), the dorsalis pedis artery (pedal pulse), the posterior tibial artery (posterior tibial pulse), and the popliteal artery (popliteal pulse). The apical pulse is measured by listening to it through a stethoscope. The average adult man or woman has a pulse rate of 60 to 90 beats/min. This rate varies in infants and children. The rate changes with age, exercise, time, and physiologic disturbances.

The exchange of oxygen and carbon dioxide between the atmosphere and the circulating blood is accomplished by respiration, which involves the inspiration of air containing oxygen and the expiration of air containing carbon dioxide. The rate of respiration for a normal adult male or female is from 12 to 20 breaths/min. This varies in infants and small children. Exercise, medication, age, or disease may change the respiratory rate.

Blood pressure is exerted by the blood on the walls of the blood vessels during the expulsion of blood from the heart and during the resting phase of the heart. It is measured with a sphygmomanometer and a stethoscope or with an electronic device. The most practical place to measure blood pressure is at the brachial artery, located at the center of the anterior elbow.

To record blood pressure, two or three readings are noted. The systolic reading is the highest point of pressure reached during a heart contraction. The diastolic reading is the lowest point to which the pressure drops during the relaxation of the ventricles and indicates the minimal pressure exerted against the arterial walls continuously. The diastolic reading may be heard first as a softening and then as a disappearance of sound, in which case both readings are recorded. Blood pressure readings are influenced by age, exercise, medication, disease, and time of day.

In order to determine critical changes in a patient's vital signs, the radiographer must know what the patient's usual or baseline vital sign readings are. If these are not available, he will have to rely on established norms to detect critical changes in the patient's vital signs.

Life cannot continue without oxygen, yet oxygen cannot be stored in the human body. When a disease that prevents the body from taking in enough oxygen is present, the necessary oxygen must be supplied by artificial means. Oxygen may be administered in the diagnostic imaging department in emergency situations and is frequently administered on hospital wards. Pure oxygen is a hazardous substance to be used only when prescribed by a physician. It supports combustion, so precautions must be taken when it is in use. No flames or machinery that might produce sparks may be used when oxygen therapy is in progress. It may also be toxic to lung tissues and produce other harmful physiologic effects if not cautiously used. No radiographic exposures should be made without consulting the nurse in charge of the patient first if a patient is receiving oxygen.

There are many types of oxygen delivery systems. These systems include nasal cannulas, catheters, face masks, nonrebreather masks, partial rebreather masks, and others. The rebreather masks deliver a controlled amount of oxygen mixed with room air. Patients who need continuous oxygen for long periods of time may have a transtracheal delivery system, while patients in acute respiratory failure may have oxygen delivered by mechanical ventilators.

The radiographer may be responsible for assisting with oxygen administration or for monitoring vital signs in emergency situations in the diagnostic imaging department. He must become proficient in these skills and must be certain that the equipment needed for these purposes is present at all times.

Chapter 6, Pre–Post Test

A 1. An essential part of the initial assessment of a patient who is in the diagnostic imaging department for an invasive procedure is measuring vital signs. Why is this initial assessment of vital signs important?
   a. It establishes a baseline for further assessments.
   b. It allows the radiographer to become acquainted with the patient.
   c. It allows the radiographer to know if the patient is hypertensive.
   d. It assists the physician.

____ 2. Systolic blood pressure can be defined as
   a. The lowest point to which the blood pressure drops during relaxation of the ventricles
   b. The highest point reached during contraction of the left ventricle
   c. The difference between the systolic and diastolic blood pressure
   d. The pressure in the pulmonary vein

____ 3. What range of breaths/min is the normal adult respiratory rate?
   a. 20 to 30
   b. 80 to 90
   c. 10 to 20
   d. 8 to 10

D 4. An adult patient is considered to be hypertensive or to have hypertension if his systolic blood pressure and diastolic blood pressure are consistently greater than
   a. 120 systolic and 80 diastolic
   b. 130 systolic and 86 diastolic
   c. 100 systolic and 60 diastolic
   d. 140 systolic and 90 diastolic

____ 5. Oxygen can be toxic to patients if it is incorrectly used. What must the radiographer remember?
   a. Oxygen can be administered prn.
   b. Oxygen administration must be ordered by the patient's physician.
   c. Oxygen is a vasodilator.
   d. Oxygen is inflammable.

D 6. One may say that the patient has tachycardia if his pulse rate is higher than
   a. 80 beats/min
   b. 90 beats/min
   c. 60 beats/min
   d. 100 beats/min

e 7. The radiographer must be certain that the following items are in his department, readily available, and in working order at all times.
   a. Catheterization sets
   b. Suture removal sets

c. Oxygen delivery equipment
d. Blood pressure monitoring equipment
e. c and d

b 8. Supplemental oxygen is part of many emergency treatment measures. It is within the scope of the radiographer's practice to begin oxygen administration on his own volition if he feels that it is called for.
a. True
b. False

e 9. The normal body temperature of a man or woman when taken orally is
a. 96.6°F
b. 38°C or 99.6°F
c. 37°C or 98.6°F
d. 37.7°C or 97.6°F

10. Match the following:
1. Sphygmomanometer c
2. Clinical thermometer d
3. Stethoscope b
4. Brachial artery a
5. Radial artery e

a. Point where the blood pressure is most often measured
b. Used to measure apical pulse
c. Used to measure blood pressure
d. Used to measure body temperature
e. Point where the pulse is most often measured

11. List four devices that might be used to deliver oxygen by the low-flow method.

12. List two hazards of which the radiographer must be aware when assisting with oxygen administration. Flammability

13. List the types of patient for whom it would be unsafe to measure body temperature by use of a glass clinical thermometer. disoriented, facial injury

14. List the sites available for measurement of body temperature.
oral, rectal, tympanic, axillary

Laboratory Reinforcement

1. In the school laboratory, measure the temperature, pulse, and respiration of several fellow students. Record the measurements on a sheet of paper. List other observations made when measuring pulse and respiration. Your instructor will check your readings.

2. In the school laboratory, measure the blood pressure of several fellow students. Then, with a double stethoscope, have your instructor check the blood pressure with you.

3. Demonstrate how to prepare for administering oxygen by mask with a wall attachment and with a tank attachment. If this equipment is not available in the school laboratory, do this in the radiology department of a hospital, with your instructor observing the demonstration.

Critical Thinking Problems

1. An 89-year-old, Caucasian female has come to the radiographic imaging department for an intravenous pyelogram (an examination of kidney function). The patient's skin is flushed and she is complaining of right flank pain. She does not respond appropriately to your directions and asks frequently where she is. The radiologist asks you to take her vital signs before the procedure is begun as there is no nurse avail-

able to do this. Explain the equipment you will need and how you will proceed.

2. You are requested to assist with a myelogram to be performed on a 38-year-old Hispanic female. You note that the patient's blood pressure has been recorded on her chart for the 3 days prior to this examination in the range of 110/72. You take her blood pressure as she is being assessed prior to this procedure and note that it is 160/90. How will you proceed?

7

Medical Emergencies in Radiographic Imaging

Assessment of Levels of Neurologic and Cognitive Functioning
Shock
Clinical Picture of Shock
Hypovolemic Shock
Cardiogenic Shock
Distributive Shock
Neurogenic Shock
Septic Shock
Anaphylactic Shock
Obstructive Shock
Pulmonary Embolus
Diabetic Emergencies
Hypoglycemia
Ketoacidosis
Hyperglycemic Hyperosmolar Nonketotic Coma
Respiratory Failure, Cardiac Failure, and Airway Obstruction
Responding to Respiratory and Cardiac Arrest
Radiographer Action Number One: Airway
Radiographer Action Number Two: Breathing
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Airway Obstruction
Abdominal Thrust: Patient Standing or Sitting
Abdominal Thrust: Patient in Supine Position
Chest Thrust: Patient Sitting or Standing
Chest Thrust: Patient Pregnant or Excessively Obese and Unconscious
Finger Sweep
Cerebrovascular Accident (Stroke)
Syncope (Fainting) and Seizures
Seizures
Generalized Seizures
Partial Seizure
Absence Seizure
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Assess the basic levels of neurological and cognitive functioning.
2. List and describe the progressive stages and types of shock.
3. Explain the radiographer's role in the management of a patient in the early stages of shock.
4. List the symptoms of anaphylactic shock and explain the radiographer's need to recognize it in its earliest stage.
5. Describe the early symptoms of pulmonary embolus, and explain the actions the radiographer must take if these symptoms appear.
6. List the symptoms of hypoglycemia and ketoacidosis, and describe the action the radiographer must take if these symptoms occur.
7. List the initial signs of a cerebral vascular accident and the radiographer's role should these symptoms appear while the patient is in the radiographer's care.
8. List the symptoms of cardiac and respiratory failure, and describe the action that the radiographer must take in each of these emergencies.

9. Explain the symptoms of mechanical airway obstruction and the emergency intervention necessary.
10. Describe the action the radiographer must take if a patient faints or has a seizure while in the radiographer's care.

Glossary

Aminophylline: used as a respiratory stimulant, smooth muscle relaxant, myocardial stimulant, and diuretic
Anaphylaxis: an unusual or exaggerated reaction to foreign protein or other substance
Angioneurotic edema or angioedema: an allergic reaction characterized by rapid development of edematous areas of skin
Antigen: any substance that is capable of inducing a specific immune response and of reacting with the products of that response
Anuria: absence of urine formation
Apathetic: indifferent; having no interest
Arrhythmia: deviation in the normal pattern of a heartbeat
Ataxia: lack of muscular coordination; especially voluntary muscle coordination
Bradycardia: an abnormal circulatory condition in which the heart beats in a regular pattern, but at a rate of less than 60 beats/min
Bradykinin: powerful vasodilator that increases capillary permeability, constricts smooth muscles, and stimulates pain receptors
Cardiac arrest: sudden cessation of the circulatory function of the heart
Cardiac tamponade: compression of the heart due to collection of fluids or blood in the pericardium
Cardiogenic: originating in the heart
Carotid pulse: related to the carotid artery, the principal artery of the neck
Chemotherapy: the treatment of illness by chemical means, that is by medication
Cognitive function: the operation of the mind; process by which we become aware of objects of thought and perception
Comatose: a state of abnormal, deep stupor occurring as the result of illness or injury
Diaphoresis: profuse sweating; heavy perspiration
Diphenhydramine: an antihistamine used in the treatment of allergic disorders
Dyspnea: labored or difficult breathing
Dysrhythmia: disturbance of rhythm
Edema: a local or generalized condition in which the body tissues retain an excessive amount of fluid
Epinephrine: hormone produced by the adrenal gland (adrenaline); powerful vasopressor (substance that increases blood pressure and heart rate)
Fainting: a temporary loss of consciousness caused by inadequate blood supply to the brain
Flaccidity: condition characterized by weakness, laxity, softness
Gestational diabetes: diabetes that appears during second or third trimester of pregnancy
Glasgow Coma Scale: a standardized system for assessing response to stimuli in a neurologically impaired patient
Glucagon: a hormone secreted by islets of Langerhans in response to hypoglycemia or stimulation of growth hormone
Gram-negative: losing the stain or decolorized by alcohol in Gram's method of staining
Gram-positive: retaining the stain or resisting decolorization by alcohol in Gram's method of staining
Hemiparesis: paralysis affecting one side of the body
Hemoptysis: coughing or spitting of blood
Histamine: an amine that is produced by decarboxylation of histidine found in all body tissue
Hypersensitivity: a state of altered reactivity characterized by an exaggerated immune response to a foreign agent
Hypoactine: abnormally decreased action
Hypoglycemic drugs: stimulates beta cells to secrete more insulin, inhibits glucose production, and helps transfer of glucose to muscle cells
Hypotension: an abnormally low blood pressure; blood pressure inadequate to maintain tissue perfusion
Hypovolemia: abnormally decreased volume of circulating fluids (plasma) in the body
Hypoxemia: deficient oxygenation of the blood
Inebriated: drunk
Iodination: the incorporation or addition of iodine in a compound
Lethargy: a condition of indifference or lack of emotion; physical fatigue, drowsiness
Myocardial infarction: loss of circulating blood to a portion of the myocardium resulting in tissue necrosis
Neurogenic: originating from nerve tissue or from nerve impulses
Occlusion: act of closure or state of being closed; an obstruction
Oliguria: a diminished capacity to form and pass urine
Oriented: awareness of one's environment with respect to place, time, and people
Orthostatic hypotension: fall in blood pressure upon standing or as a result of standing motionless in a fixed position
Pallor: absence or lack of skin color
Perfusion: the act of pouring through or over, especially the passage of a fluid through the vessels of a specific organ
Pericarditis: inflammation of the pericardium (fibroserous sac enclosing the heart and coating great vessels)
Plasma: watery, colorless fluid portion of the blood in which the leukocytes, erythrocytes, and platelets are suspended
Pulmonary embolus: a clot or foreign body brought by the circulating blood from a large vessel into a smaller vessel in the lungs, causing obstruction to circulation
Respiratory arrest: complete cessation of lung ventilation
Seizure: a convulsion
Septic: pertaining to sepsis, the presence in the blood or tissue of pathogenic microorganisms or their toxins
Substernal: below the sternum
Supine: lying with face upward or on dorsal surface
Syncope: a temporary suspension of consciousness due to cerebral anemia or fainting
Tachycardia: an abnormal condition in which the myocardium con-

tracts regularly, but at a rate greater than 100 beats per minute
Tachypnea: an abnormally rapid rate of breathing
Tamponade: a stoppage of blood flow to a body organ or part that is caused by pressure
Thrombus: an aggregation of blood factors, primarily platelets and fibrin, with entrapment of cellular elements, frequently causing vascular obstruction at the point of its formation; a blood clot
Tissue perfusion: passage of blood and fluids through small blood vessels into body tissues
Urticaria: a vascular reaction of the skin marked by transient appearances of slightly elevated patches (welts) that are redder or paler than the surrounding area and often attended by severe itching, called hives
Vasodilation: increase in the caliber of a blood vessel
Vasodilator: causing dilation of blood vessels
Venom: poison, especially a toxic substance normally secreted by serpents, insects, or another animals

Many patients come to the radiographic imaging department in poor physical condition. This may be due to illness, injury, or a lengthy preparation for a diagnostic examination. When a person is in a weakened physical condition, his physiologic reactions may not be as expected. Many abnormal physiologic reactions occur quickly and without warning and may be life-threatening if not recognized and treated immediately.

The non–trauma-related medical emergencies most likely to occur while the patient is undergoing radiographic imaging are shock, anaphylaxis (a type of shock), pulmonary embolus, reactions related to diabetes mellitus, cerebral vascular accident, cardiac and respiratory failure, syncope, and seizures. The radiographer may be the first member of the health care team to observe these reactions; therefore, he must be able to recognize the symptoms and initiate the correct treatment.

The radiographer must be able to assess the behaviors that determine a patient's level of neurologic and cognitive functioning on admission for a radiographic procedure. If this initial assessment is performed, the radiographer will be able to recognize changes in the patient's mental status should they occur while the patient is under his care.

In most cases, the first action a radiographer takes in a life-threatening emergency is to call the hospital emergency team, the physician conducting the procedure, and a coworker for assistance. He must learn the correct procedure for calling the hospital emergency team in the institution in which he works. In many health care institutions, this procedure is dubbed "calling a code." The radiographer must memorize the emergency team number and be prepared to explain the exact location of the emergency and the problem that has occurred.

All radiographic imaging departments have an emergency cart that contains the medications and equipment needed when a patient's condition becomes suddenly critical. This is often called "a crash cart." The radiographer must know where to obtain this cart quickly, as well as who is responsible for maintaining the cart with all equipment and supplies in working order. He must be familiar with the oxygen administration equipment so that he can assist with its use quickly.

Assessment of Levels of Neurologic and Cognitive Functioning

The radiographer assigned to care for a patient must be able to quickly assess that patient's neurological functioning. This is important so that if there is a deterioration in the patient's condition, it can be recognized quickly based upon changes in the initial assessment data. Neurological assessment can be highly technical and complex and is not within the scope of the radiographer's practice; however, a rapid neurological assessment tool that is used frequently in health care institutions is the Glasgow Coma Scale. This scale addresses the three areas of neurological functioning and quickly gives an overview of the patient's level of responsiveness. It is simple, reliable, and convenient for the radiographer to use. The three areas—eye opening, motor response, and verbal response (Table 7–1)—can be readily observed by the radiographer. A patient can rate a maximum of 15 points for his neurological functioning. If the patient's score begins to drop after the initial assessment, the physician in charge of the patient must be notified immediately.

Another indicator that a patient's condition is deteriorating is a change in his level of consciousness (LOC). These changes can be subtle but must not be ignored by the radiographer as he cares for the patient. The LOC can be assessed quickly as follows:

1. Ask the patient to state his name, the date, his address, and the reason he has come to

TABLE 7–1
Glasgow Coma Scale

Eyes open	
spontaneously	4
to speech	3
to painful stimuli	2
no response	1
Best motor response	
obeys commands	6
localizes pain	5
withdraws from painful stimuli	4
abnormal flexion	3
extends	2
nil	1
Verbal response	
oriented	5
confused conversation	4
inappropriate words	3
incomprehensible sounds	2
nil	1
Highest possible score	15

the department. *If these responses are given readily and correctly, you learn that the patient responds to verbal stimuli and that he is oriented to person, place, time, and situation. Note any undue need to repeat questions, slow response, difficulty, with choice of words, or unusual irritability.*

2. As you instruct the patient in positioning for your examination, note his ability to follow directions. Also take note of any movement that causes pain or other difficulty in movement, as well as any alterations in behavior or lack of response. Report these to the physician in charge of caring for the patient. *These measures provide a baseline against which changes in the patient's mental and neurologic status can be assessed.*

3. Assess the patient's vital signs at this time if current readings are not on his chart. *You must have baseline readings against which to note changes should they occur.*

If, on initial assessment, the patient has no complaints, this must be noted. If, as a procedure progresses, the patient begins to complain of a headache, becomes restless or unusually quiet, or develops slurred speech or a change in level of orientation, it must be reported to the physician immediately.

Under these circumstances, the procedure should be stopped; the radiographer must stay with the patient and summon assistance, which includes ordering the emergency cart to be brought to the patient. The patient should then be prepared for oxygen and intravenous fluid administration. Changes in a patient's neurological status or LOC must never be ignored.

Shock

Shock is the body's pathological reaction to illness, trauma, or severe physiological or emotional stress. This may be caused by body fluid loss, cardiac failure, decreased tone of the blood vessels, or obstruction of blood flow to vital body organs. Shock is a life-threatening condition that occurs rapidly, often without warning. It may be reversible if it is not allowed to progress. The radiographer might be the first health care worker to observe the initial symptoms of shock; therefore, he must be able to recognize them and begin the interventions that will halt its progress.

CLINICAL PICTURE OF SHOCK

The vital organs of the body depend upon oxygen and other nutrients supplied by the blood for their survival. When this supply is diminished, there are adverse effects on normal physiologic function.

At the onset of the shock syndrome, the changes in physiologic function are in the cells of the body and are not clinically detectable except for a possible increase in heart rate. As the condition progresses, blood is shunted away from the lungs, skin, kidneys, and gastrointestinal tract to accommodate the brain's and the heart's critical need for oxygen. At this stage, called the *compensatory* stage, a host of symptoms are noticeable:

1. Skin is cold and clammy.
2. Urine output decreases.
3. Respirations increase.
4. Bowel sounds are hypoactive.
5. Blood pressure is normal.
6. The patient's anxiety level increases; he may begin to be uncooperative.

If shock is allowed to progress beyond the compensatory stage, the mean arterial pressure (MAP) (the average pressure at which blood moves through the vasculature of the body) falls. All body systems are inadequately perfused, including the heart, which begins to fail to pump adequately.

The peripheral circulation reacts to the chemical mediators released by the body in this state and fluid leaks from the capillaries, further decreasing

the amount of fluid in circulation. There is acute renal failure; the liver, the gastrointestinal system, and the hematologic systems begin to fail. This stage in the shock syndrome is called the *progressive stage*. Progressive stage symptoms are as follows:

1. Blood pressure falls.
2. Respirations are rapid and shallow.
3. Severe pulmonary edema results from leakage of fluid from the pulmonary capillaries.
4. Tachycardia, may be as rapid as 150 beats per minute.
5. The patient may complain of chest pain.
6. Mental status changes that begin with subtle behavior changes such as confusion and later progress to lethargy and loss of consciousness.

If shock progresses beyond this point, it is called the *irreversible stage* (or the refractory stage). The organ systems of the body suffer irreparable damage and recovery is unlikely.

Shock may be classified in several ways. For the radiographer's purposes they can be listed as hypovolemic, cardiogenic, distributive, and obstructive.

HYPOVOLEMIC SHOCK

Hypovolemic shock is caused by an abnormally low volume of circulating blood in the body. It may be due to internal or external hemorrhage, loss of plasma from burns, or fluid loss from prolonged vomiting, diarrhea, or medications.

Signs and Symptoms

Restlessness and anxiety initially; if progression occurs, confusion, lethargy, and loss of consciousness

Thirst

Pallor; cold, clammy skin; cyanosis starting at lips and nails. If the patient is dark-skinned, observe for cyanosis by pressing lightly on his fingernails or earlobes. If he is cyanotic, the color will not return to the compressed area in the usual 1-second interval. A bluish discoloration of the tongue and soft palate of the mouth is also indicative of cyanosis.

Cold extremities

Frequently, excessive thirst resulting from fluid loss

Decreasing blood pressure; systolic blood pressure may be lower than 60 to 90 mm Hg; rapid pulse that becomes weak, thready, and irregular if condition progresses

Rapid respirations

Extreme weakness

Oliguria to anuria

Cardiac and respiratory failure will follow if this condition is allowed to continue

Radiographer's Response

1. Stop the ongoing radiographic imaging procedure; place the patient in a supine position with his legs elevated 30 degrees (unless he has a head or spinal cord injury). Do not place him in Trendelenberg position.
2. Notify the physician in charge of the patient and call for emergency assistance.
3. Make certain that the patient is able to breathe without obstruction caused by positioning or blood or mucus in his airway.
4. If there is blood loss from an open wound, don gloves and apply pressure directly to the wound with several thicknesses of dry, sterile dressing.
5. Have the emergency cart brought to the patient's side.
6. Prepare to assist with oxygen, intravenous fluids, and medications. Have large-gauge intravenous catheters on hand.
7. Keep the patient warm and dry. Do not overheat the patient; to do so will increase body metabolism and increase the need for oxygen.
8. Assess pulse, respirations, and blood pressure every 5 minutes until the emergency team assumes this role.
9. Do not leave the patient unattended. Inform him as appropriate of what is happening to alleviate anxiety.
10. Do not offer fluids even if requested by the patient. Explain to the patient that he may need examinations or treatment that requires that he have an empty stomach.

CARDIOGENIC SHOCK

Cardiogenic shock is caused by a failure of the heart to pump an adequate amount of blood to the vital organs. The onset of cardiogenic shock may occur over a period of time or it may be sudden.

The patient who has been hospitalized for myocardial infarction, cardiac tamponade, dysrhythmias, or other cardiac pathology is most vulnerable.

Signs and Symptoms

Complaint of chest pain that may radiate to jaws and arms

Dizziness and respiratory distress

Cyanosis

Restlessness and anxiety

Rapid change in level of consciousness

Pulse may be irregular and slow; may have tachycardia and tachypnea

Carotid pulse must be checked; if difficult to find, indicates decreased stroke volume of the heart

Decreasing blood pressure

Decreasing urinary output

Cool, clammy skin

Radiographer's Response

1. Summon the emergency team and have the emergency cart placed at the patient's side.
2. Notify the physician in charge of the patient.
3. Place the patient in semi-Fowler's position or in another position that will facilitate respiration.
4. Prepare to assist with oxygen, intravenous fluid, and medication administration. Chest pain must be controlled.
5. Do not leave the patient alone; offer explanation of treatment as appropriate; alleviate the patient's anxiety.
6. Assess pulse, respiration, and blood pressure every 5 minutes until the emergency team arrives.
7. Do not offer fluids.
8. Be prepared to administer CPR if indicated.

DISTRIBUTIVE SHOCK

Distributive shock occurs when there is a pooling of blood in the peripheral blood vessels that results in decreased venous return of blood to the heart, decreased blood pressure, and decreased tissue perfusion. This may be the result of loss of sympathetic tone. This condition is characterized by the blood vessels' inability to constrict and their resultant inability to assist in the return of the blood to the heart. It may also occur when chemicals released by the cells cause vasodilation and capillary permeability, which in turn prompt a large portion of the blood volume to pool peripherally. There are three types of distributive shock: neurogenic, septic, and anaphylactic. Each of these are discussed.

Neurogenic Shock

Neurogenic shock results from loss of sympathetic tone resulting in vasodilation of peripheral vessels. This can be caused by spinal cord injury, severe pain, neurologic damage, extreme psychological stress, or adverse effects of spinal anesthesia.

Signs and Symptoms

Hypotension

Bradycardia

Warm, dry skin

Initial alertness if not unconscious because of head injury

Coolness of extremities and diminishing peripheral pulses

Radiographer's Response

1. Summon emergency assistance.
2. Notify the physician in charge of the patient.
3. Keep patient in supine position; may elevate legs with physician's orders.
4. Have emergency cart brought to patient's side.
5. If spinal cord injury is possible, do not move patient.
6. Stay with patient and offer support.
7. Monitor pulse, respiration, and blood pressure every 5 minutes.
8. Prepare to assist with oxygen, intravenous fluids, and medications.

Septic Shock

Septic shock is the least likely to be observed by the radiographer in his department; however, he must recognize it as a possible consequence of poor practice of medical or surgical asepsis. He may also be called to the intensive care unit or emergency room to take portable radiographs of the patient in septic shock. In spite of the wide

availability and use of antibiotics in recent years, the incidence of septic shock has risen and has a 40% to 50% mortality rate for its victims.

Gram-negative bacteria are the most frequent causative organisms in septic shock; however, gram-positive bacteria and viruses can also be the cause. When invaded by bacteria, the body begins its immune response by releasing chemicals that increase capillary permeability and vasodilation, leading to the shock syndrome.

SIGNS AND SYMPTOMS Symptoms of septic shock are divided into two phases.

First Phase

Skin is hot, dry, and flushed

Heart rate and respiratory rate are increased

Fever, though the elderly patient may not be febrile

Nausea, vomiting, and diarrhea

Normal to excessive urine output

Second Phase

Cool, pale skin

Normal or subnormal temperature

Drop in blood pressure

Rapid heart rate and respiratory rate

Oliguria or anuria

Seizures and organ failure if syndrome is not reversed

RADIOGRAPHER'S RESPONSE The radiographer will rarely be the person who initiates action if this condition is present; however, if he cares for a patient in septic shock, he must remember to keep the patient from becoming chilled. This is important because shivering increases the body's oxygen consumption.

If the radiographer is first on the scene, he should do the following:

1. Stop the procedure; notify the physician in charge of the patient.
2. Notify the emergency team and have the emergency cart available.
3. Place the patient in a supine position.
4. Keep patient as quiet and calm as possible.
5. Do not leave the patient unattended.
6. If the skin is very warm, cover the patient with a lightweight blanket.
7. Monitor vital signs every 5 minutes.
8. Prepare for oxygen, intravenous fluid, and medication administration.

Anaphylactic Shock

Because some imaging procedures use contrast agents that contain iodine, to which some people are allergic, this is the type of shock seen most frequently in radiographic imaging. The radiographer must be able to recognize it at its onset to prevent life-threatening consequences.

Anaphylactic shock (anaphylaxis) is the result of an exaggerated hypersensitivity reaction (allergic reaction) to re-exposure to an antigen that was previously encountered by the body's immune system. When this occurs, histamine and bradykinin are released, causing widespread vasodilation that results in peripheral pooling of blood. This response is accompanied by contraction of nonvascular smooth muscles, particularly the smooth muscles of the respiratory tract. This combined reaction produces shock, respiratory failure, and death within minutes following exposure to the allergen. Usually, the more abrupt the onset of anaphylaxis, the more severe the reaction.

The most common causes of anaphylaxis are medications, iodinated contrast agents, chemotherapeutic agents, anesthetics, foods, and insect venoms. The path of entry may be through the skin, the respiratory tract, the gastrointestinal tract, or injection.

When iodinated contrast agents are being used for diagnostic procedures, the radiographer must observe the patient continuously for signs of allergic reaction. If early symptoms of anaphylactic shock are observed, he must act quickly to halt the progression of symptoms.

Early Signs and Symptoms

Complaints of itching at the site of injection of contrast media or around eyes and nose

Nasal congestion, sneezing, and coughing

Complaints of a feeling of tightness in the chest

Apprehensiveness and expression of a feeling of doom

Nausea, vomiting, and diarrhea often accompany food allergies

Later Symptoms

Angioneurotic edema of the face, hands, and other body parts

Urticaria (hives)

Choking, wheezing, or dyspnea and cyanosis

Decreasing blood pressure; weak, thready pulse, either rapid or unusually slow

Dilated pupils

Altered level of consciousness

If these symptoms are not halted, respiratory and cardiac arrest ensue

Radiographer's Response

1. Before beginning a procedure that requires administration of an iodinated contrast agent, make certain that the emergency cart has been monitored and that all emergency medications are potent and equipment is up-to-date and in working order.
2. Before starting any procedure that involves the use of iodinated contrast medium, ask the patient the following questions:
   "Are you allergic to any food or medicine? Which ones?"
   "Do you have asthma or hay fever?"
   Have you ever had hives or other allergic skin reactions?"
   "Have you ever had an x-ray examination that involved the use of a contrast medium? If so, did you have a reaction during or following that examination?"
3. Do not leave the patient who is receiving an iodinated contrast agent alone. Stop the infusion or injection immediately and notify the radiologist if any of the following occurs: the patient complains of itching, redness or swelling of the skin is observed, or the patient seems unduly anxious.
4. If the patient complains of respiratory distress or has any of the later symptoms listed previously, call the emergency team.
5. Place the patient in semi-Fowler's position or a sitting position to facilitate respiration.
6. Monitor pulse, respiration, and blood pressure every 5 minutes until the emergency team arrives to assume responsibility.
7. Prepare to assist with oxygen, intravenous fluid, and medication administration. Have large-gauge venous catheters available.
8. Prepare to administer CPR.

The medications usually given for anaphylactic shock are epinephrine, diphenhydramine, hydrocortisone, and aminophylline. These are discussed in Chapter 11.

Many radiographic imaging departments have a standardized procedure form that must be completed prior to the administration of contrast agents. The form may request the following information:

Name

Age

Date

Have you had the study that you are having today at any other time?

If the answer is yes, did you have any allergic or unusual reactions?

Are you allergic to any foods, medications, or any other substance? If you are, please specify.

Recent laboratory tests performed and results

Blood urea nitrogen (BUN) and creatinine

Have you had any protein in your urine? If so to what degree: +1, +2, +3, +4?

Do you have heart disease?

Hypertension?

Diabetes mellitus?

Sickle cell anemia?

Asthma?

Have you had any procedures such as a cystogram that involved use of contrast agents? If so, please explain.

Following the examination, a report is completed by the physician indicating the type of procedure used and any unusual responses. If there is an anaphylactic reaction, the nature of the reaction should be written on the patient's film jacket in bold colors. Documentation of the reaction must also be made in the patient's chart by the physician performing the injection and examination.

A copy of this report should be kept in the patient's diagnostic imaging department file and a copy should also be kept by the senior radiographer. If these precautions in documentation are taken, the history of the patient's previous problem will be on record and the correct decisions can be made subsequently.

Patients who have received contrast agents as part of the diagnostic imaging procedure should remain in the department for 30 minutes for observation if they are not patients in the hospital. If they are having no problems after 30 minutes, they may be allowed to return home, accompanied by another person. They should be clearly in-

structed in the signs and symptoms of an anaphylactic reaction and told to return to the hospital emergency department immediately if any of these symptoms appears. If the patient has had even a mild allergic reaction during a diagnostic procedure that involves the use of a contrast agent, he should be instructed to report this if he is ever to receive iodinated contrast media in the future. If the reaction was severe, he may need to wear an alert bracelet to prevent further exposure to antigens of this sort.

OBSTRUCTIVE SHOCK

Obstructive shock results from pathological conditions that interfere with the normal pumping action of the heart; however, the heart itself may be free of pathology. The etiology of obstructive shock may be pulmonary embolism, pulmonary hypertension, arterial stenosis, constrictive pericarditis, or tumors that interfere with blood flow through the heart. Because pulmonary embolism is the only condition mentioned here that may impact upon the radiographer as he cares for his patients, it is the only condition discussed in this chapter.

Pulmonary Embolus

A pulmonary embolus is an occlusion of one or more pulmonary arteries by a thrombus or thrombi. The thrombus originates in the venous circulation and is carried through the vessels to the lungs, where it blocks one or more pulmonary arteries.

The onset of symptoms of a pulmonary embolus is sudden and constitutes a medical emergency. The problem often occurs following a surgical procedure, a prolonged illness, or a traumatic event that results in venous stasis and the formation of thrombi in the venous circulation. The severity of symptoms depends on the size or number of emboli that disturb the pulmonary circulation. The end result is arterial hypoxemia, which may be a life-threatening emergency.

The radiographer working with postoperative patients and patients who have suffered traumatic events affecting the long bones of the body must be aware of this complication and be prepared to initiate emergency action should it occur.

Signs and Symptoms

Chest pain, often substernal, that is abrupt in onset; severity depends on the size of the embolus—a large embolus causes severe pain

Rapid, weak pulse

Hyperventilation

Dyspnea and tachypnea

Tachycardia

Apprehension

Cough and hemoptysis

Diaphoresis

Syncope

Hypotension

Cyanosis

Rapidly changing levels of consciousness

Coma; sudden death may result

Radiographer's Response

1. Stop procedure immediately and call for emergency assistance.
2. Notify the physician and bring the emergency cart to the patient's side.
3. Monitor vital signs.
4. Do not leave the patient alone; reassure the patient.
5. Prepare to assist with oxygen administration, administration of intravenous medication, and fluid administration.

Diabetic Emergencies

Diabetes mellitus is a chronic disease involving a disorder of carbohydrate, protein, and fat metabolism, which affects the structure and function of blood vessels and other organs of the body. The underlying cause of this disease process is a disturbance in the production, action, or utilization of insulin, a hormone normally secreted by the islets of Langerhans located in the pancreas. Medical treatment consists of diet therapy, insulin administration, or use of oral hypoglycemic drugs. Exercise is also an important part of successful treatment.

Diabetes mellitus is diagnosed by patient history and by laboratory measurement of blood glucose levels. A normal adult blood glucose level ranges from 70 to 115 mg/dL. There are currently four major classifications of diabetes and related glucose intolerances. They are as follows:

1. *Type I: Insulin-dependent diabetes mellitus (IDDM).* This occurs most often in persons

younger than 30 years of age, but may occur at any age. The person with this disease produces little or no insulin of their own and must have insulin administered in order to survive. When insulin is absent, the affected individual is prone to ketoacidosis. This disease may be inherited.

2. *Type II: Noninsulin-dependent diabetes mellitus (NIDDM).* It is believed that this is not a single disease, but the result of a number of conditions that produce hyperglycemia. There may be an impaired tissue sensitivity to insulin or a reduced extracellular response to insulin. Initially, more insulin is produced to compensate for the deficiency. Finally, hyperglycemia results when the pancreas cannot produce enough insulin to account for the excessive secretion. This may be an inherited disease.

   Many persons with this disease can control blood glucose levels by weight loss and dietary measures; however, oral hypoglycemic agents may be needed to control blood glucose levels if these measures alone are not adequate. Insulin is sometimes indicated to prevent hyperglycemia but ketoacidosis rarely occurs under normal circumstances. Stress or infection may result in ketoacidosis.

3. *Diabetes mellitus associated with or produced by other medical conditions or syndromes.* Pancreatic diseases or hormonal abnormalities may produce diabetic symptoms and may require treatment with insulin or oral hypoglycemic drugs.

4. *Gestational diabetes* is a diabetic condition that occurs in the later months of pregnancy. It is caused by hormones secreted by the placenta that prevent the action of insulin. This condition is usually treated with diet, but insulin may be prescribed to maintain blood glucose levels.

   There are other conditions or physiologic problems that result in impairment of glucose tolerance that are not discussed in this text as they do not usually result in the need for emergency care. The radiographer must remember that persons who have diabetes mellitus are extremely susceptible to infections and therefore require extra skin care and infection-control precautions.

HYPOGLYCEMIA

Hypoglycemia occurs when persons who have diabetes mellitus have an excess amount of insulin or oral hypoglycemic drug in their bloodstream, an increased metabolism of glucose, or inadequate food intake with which to utilize the insulin.

When the blood glucose level falls below 50 to 60 mg/dL, hypoglycemia may result. A patient who has diabetes mellitus may come to the diagnostic imaging department after he has taken insulin or another hypoglycemic agent, but before he has had sufficient food intake to use the insulin. The result may be a hypoglycemic reaction. The onset of symptoms is rapid, and immediate action is necessary to prevent coma.

Signs and Symptoms

Mild reaction: mild tremor, sweating, complaint of hunger, tachycardia, nervousness, and irritability

Moderate reaction: dizziness, headache, and numbness of lips or tongue; confusion; profuse perspiration; cold, clammy skin; blurred or double vision; incoordination; irrational behavior; slurred speech

Severe reaction: disorientation; difficulty arousing from sleep; impaired motor function; diminishing level of consciousness; seizures and rapid lapse into coma

Radiographer's Response

1. If the patient is conscious and complains of any early or moderate symptoms or says that he is a diabetic, has not eaten, and feels shaky or weak, notify the physician and administer some type of sugar immediately.

2. If there is nothing else available, the packets of sugar kept in most coffee rooms are acceptable. If the patient is carrying glucose tablets, 2 to 4 commercially prepared glucose tablets should be taken. If orange juice is available, it may be offered. Hard candy or 6 to 10 Life-saver-type candies are also acceptable.

3. If the patient complains of such symptoms, the radiographer must check the chart or look for a bracelet that identifies the patient as a diabetic.

4. If the patient is having trouble swallowing or is unconscious, place 2 teaspoons of granulated sugar, corn syrup, or jelly into his mouth under his tongue. It will be absorbed through the mucous membranes.

5. Stop the diagnostic imaging procedure immediately and call for emergency assistance.

6. Do not leave the patient unattended.
7. Monitor vital signs every 5 minutes.
8. Prepare to assist with administration of oxygen, intravenous medications, and fluids.
9. Glucagon, 1 mg intramuscularly or subcutaneously may be given, or 20 to 50 mL of 50% glucose in solution may be administered intravenously.

Hypoglycemia must be treated immediately because it interferes with the oxygen supply to the brain and may quickly result in cerebral damage or death.

KETOACIDOSIS

When there is insufficient insulin in the body, the amount of glucose entering body cells is decreased and the liver begins to produce more glucose, which results in hyperglycemia. The kidneys attempt to compensate for this by excreting glucose with water and electrolytes. There is excessive urination (polyuria) with an outcome of dehydration and electrolyte imbalance in the body.

Another physiologic reaction to insulin deficiency in the body is the breakdown of fat into free fatty acids and glycerol. The liver in turn converts these free fatty acids into ketone bodies (ketosis) because insulin is not present to prevent this from occurring. Ketone bodies in the bloodstream result in metabolic acidosis. If this condition is not corrected quickly, the patient will become comatose and may die. Ketoacidosis occurs more slowly than hypoglycemia, but may result from a diabetic patient being detained for so long in the diagnostic imaging department that he misses a dose of insulin or hypoglycemic agent.

Signs and Symptoms

Weakness, drowsiness, headache, blurred vision, abdominal pain, nausea, and vomiting

Sweet odor to the breath and orthostatic hypotension

Warm, dry skin; parched tongue; dry mucous membranes; extreme thirst (polydipsia); and polyuria

General weakness, lethargy, and fatigue

Flushed face; deep and rapid respirations

Tachycardia; weak, thready pulse; and coma

Radiographer's Response

1. Check patient chart or look for a bracelet identifying the patient as a diabetic. Remember that patients with this condition may not be identified as diabetic.
2. Stop treatment and notify the physician.
3. Call for emergency assistance.
4. Do not leave patient unattended.
5. Monitor vital signs.
6. Prepare to assist with administration of intravenous fluids, medications, and oxygen.

HYPERGLYCEMIC HYPEROSMOLAR NONKETOTIC COMA

Hyperglycemic hyperosmolar nonketotic coma may be a complication of diabetes mellitus or may occur in an elderly person with only mild symptoms of noninsulin-dependent diabetes mellitus.

Frequently, the patient is perceived as being inebriated or having had a stroke but is, however, in an extremely serious, life-threatening condition. Factors that precipitate this reaction are acute illness; therapeutic procedures such as dialysis; and diagnostic procedures that require changes in diet, especially a procedure requiring the patient to have nothing by mouth for 12 hours. There is a loss of effective insulin, leading to diuresis and loss of fluid and electrolytes. The blood glucose level in patients with this problem is often greater than 600 mg/dL; there is little or no ketosis and plasma is hyperosmolar.

Signs and Symptoms

Extreme dehydration; dry skin, sunken eyes

Hypotension, tachycardia, increased body temperature

Extreme thirst; muscle twitching; difficult, slurred speech

Mental confusion, seizures, hemiparesis, coma

Radiographer's Response

1. Call for emergency assistance; do not leave patient unattended.
2. Notify the physician in charge of the patient and stop the diagnostic procedure.
3. Monitor vital signs; prepare to administer intravenous fluids, medication, and oxygen.

Respiratory Failure, Cardiac Failure, and Airway Obstruction

Respiratory failure, cardiac failure (cardiac arrest), or an airway obstruction may occur in the radiographic imaging department without warning and when least expected. The radiographer may be the first person to witness this event and will be the person to "call the code" and to initiate emergency action. The human brain can survive without oxygen for only 2 to 4 minutes. This means that there is little time to ponder the situation before acting.

All health care staff, including radiographers, are required to be prepared to perform basic cardiopulmonary resuscitation (CPR) and the abdominal thrust maneuver. Many health care facilities have classes for their employees on a regular basis to teach and keep them current in these procedures. Other health care facilities require that the employee obtain this training at classes offered in the community. The American Red Cross and the American Heart Association provide basic CPR classes regularly for the general public. The techniques must be demonstrated by a licensed instructor and return demonstrations must be given by the student until he is proficient.

The radiographer must understand that brief explanations of CPR and the abdominal thrust maneuver do not prepare him to administer these techniques. Complete explanations and directions are not within the scope of this text. It is the radiographer's obligation to receive adequate training in basic CPR from a licensed agency and instructor.



Figure 7–1
Disposable mask with a one-way valve.

Basic life support for an infant or small child requires special consideration and is addressed only briefly in this text.

In order to protect oneself from communicable diseases contracted through exposure to blood and body fluids, the radiographer must wear gloves when clearing a patient's airway. A disposable mask with a one-way valve is recommended when performing CPR (Fig. 7–1). This type of mask should be available in every radiographic imaging room. A manual resuscitation bag may be used if it is available and the radiographer has been instructed in its use.

Responding to Respiratory and Cardiac Arrest

Respiratory dysfunction may be the result of airway obstruction caused by positioning, the tongue falling back into the throat, or a foreign object lodged in the airway; disease; drug overdose; injury; or coma. Whatever the cause, gas exchange is no longer adequate to meet the needs of the body.

Symptoms of a partially obstructed airway include labored, noisy breathing; wheezing; use of accessory muscles of the neck, abdomen, or chest for breathing; neck-vein distention; diaphoresis; anxiety; cyanosis of the lips and nail beds; and, possibly, a productive cough with pink-tinged, frothy sputum.

If the patient displays symptoms of dyspnea, the radiographer should call for help, stay with the patient, and assist him to a sitting or semi-Fowler's position to facilitate respiration. Every attempt should be made to relieve the patient's anxiety. The radiographer will also need to prepare to assist with oxygen administration and have the emergency cart prepared.

If the patient lapses into complete respiratory failure, his pulse will continue to beat briefly; however, the pulse quickly becomes weak and then stops. Chest movement stops and no air can be detected moving through the patient's mouth or nose. If this occurs or if the patient suddenly stops responding, immediate intervention is necessary.

RADIOGRAPHER ACTION NUMBER ONE: AIRWAY

1. If you suspect that the patient has had respiratory or cardiac arrest, assess level of consciousness: shake the patient and call him loudly by name and say "Are you all right?"

2. If he does not respond, call loudly for help stating your location. "I need help STAT in room 102." Do not leave the patient.
3. When someone responds, tell him to call a code for your room. Move the patient to a supine position on a hard surface. A back board is available for use in hospital rooms. Since radiography tables have a hard surface, this may not be an issue. If a neck or spinal cord injury is suspected, the patient must be log-rolled into a supine position. Meanwhile, open the airway. The procedure is as follows:
   a. Put on gloves.
   b. Tilt the head back by placing one hand on the patient's forehead and applying firm backward pressure with the palm.
   c. Place fingers of the other hand under the lower jaw near the chin and lift so that the chin is brought forward and the teeth are almost together. Lips should be parted. Do not use your thumbs for this maneuver as they may press too firmly and occlude respiration (Fig. 7–2). If the patient has dentures that do not stay in place, remove them.



Figure 7–2
Tilt the patient's head by placing one hand on the forehead and applying firm backward pressure. Place the fingers of the other hand under the lower jaw near the chin and lift so it is brought forward.

   d. For an infant or small child, tilt the head and lift the jaw only slightly. Do not tilt the head if there has been a head or neck injury.
   e. If a neck or cervical spine injury is suspected, use the jaw thrust maneuver as follows:
      The head should be well supported without tilting or moving it.
      Place one hand on each side of the jaw, grasp the angles of the jaw, and lift.
      Pull the mandible forward; do not extend the neck.
   f. After positioning, sweep the mouth with your index finger to remove any vomitus or foreign material that may be blocking the airway. Use caution to avoid pushing a foreign object further back in the mouth or throat. *Do not perform blind finger sweeps!* Never sweep the mouth of an infant or small child unless you can see the object.

RADIOGRAPHER ACTION NUMBER TWO: BREATHING

When the airway is open, assess for respirations. Proceed as follows:

1. Observe for chest movement; if not visible, put your ear close to the patient's nose and mouth. If you do not feel air, ventilate twice.
   a. To ventilate, place the mask tightly over the nose and mouth and give two full breaths into the airway of the mask. If correctly done, the patient's chest will rise as you breathe. Maintain the head position as you do this. If a mask is not available, seal the nostrils by pinching them together; place your mouth over the patient's, and give two full breaths. If the patient is an infant or small child, tilt his head with one hand and lift his jaw with the index and middle fingers of the other hand. Do not tilt his head if there is a head or neck injury. Place your mouth or the mask tightly over the mouth and nose. A smaller mask is required for an infant or small child.
   b. Allow the patient to exhale as you inhale more air.
   c. If the chest does not rise, reposition the patient's head and repeat the ventilations.
   d. If the chest still does not rise, give 6 to 10 abdominal thrusts and repeat the finger sweep (explanation of diaphragmatic thrusts will be discussed later in this section).

2. Assess for a carotid pulse.
3. If no pulse is felt, cardiac compression must be started immediately.

This initial procedure should take no longer than 1 or 2 minutes as the radiographer will be prepared to assess the patient and, by recall, proceed. If the second responder has not returned to the room, one-man cardiopulmonary resuscitation will be necessary.

RADIOGRAPHER'S ACTION NUMBER THREE: CIRCULATION

External cardiac compression is effective only if the patient is lying on a firm surface. If he is on a radiographic table, the radiographer must kneel on the table beside the patient. If the patient is lying on a soft surface, a cardiac board may be placed under his chest. If none is available, the patient must be moved to the floor.

An adequate amount of time should be taken to determine pulselessness (5 to 10 seconds). Performing cardiac compressions on a person whose heart is functioning is extremely dangerous to the patient. Once cardiac compressions have been started, they should not be interrupted for more than 7 seconds at a time. Two-person CPR is not discussed in this text as it demands actual demonstration and return demonstration to be successful.

The radiographer must be certain that his hands are positioned correctly to prevent internal injury as the cardiac compressions are being performed. This is done in the following manner:.

1. Move your fingers up the lower margin of the rib cage to the area where the ribs and the sternum meet. When you have located this area, place your index finger above it and place the heel of your hand beside the index finger with the second hand on top of it (Fig. 7–3).

2. Your hands should be located one and one-half inches from the tip of the xiphoid process toward the patient's head. The fingers should not touch the chest wall. Use the weight of the body for compression of the chest wall and keep your elbows straight (see Fig. 7–3*B*). Be certain that your hand is on the midline of the sternum above the xiphoid process. Pressure on the xiphoid or the rib cage may cause internal injuries.

3. Compress the sternum 1½ to 2 inches directly downward, then release the compression completely.

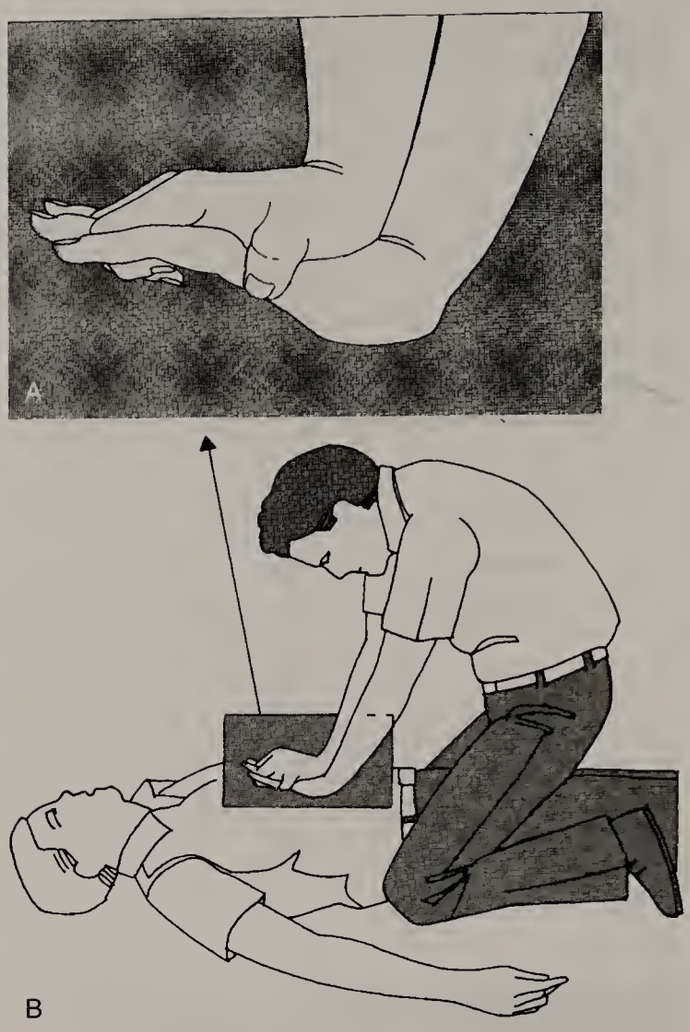


Figure 7–3
(**A**) Hand placement for cardiac compression. (**B**) External cardiac compression.

4. Keeping your elbows straight, give 15 compressions in a smooth, even rhythm.

5. Inflate the patient's lungs two more times.

6. Reassess the carotid pulse and respiratory status of the patient. If there is no pulse or respiration, continue with 15 compressions followed by 2 inflations until the emergency team arrives.

7. Allow them to take over at a time specified for the change.

The initial procedure is the same for an infant or a child (two slow breaths); however, the brachial pulse is assessed on the infant. If no pulse is felt, cardiac compression is begun. For the infant, cardiac compression is performed with two fingers pressing on the midsternum at the midline of the chest one fingerbreadth below the nipples (Fig. 7–4). For larger children, the heel of only one hand is used for compression. The palm of the hand is placed one to two fingerbreadths up from the sternal notch. Compression should be done at

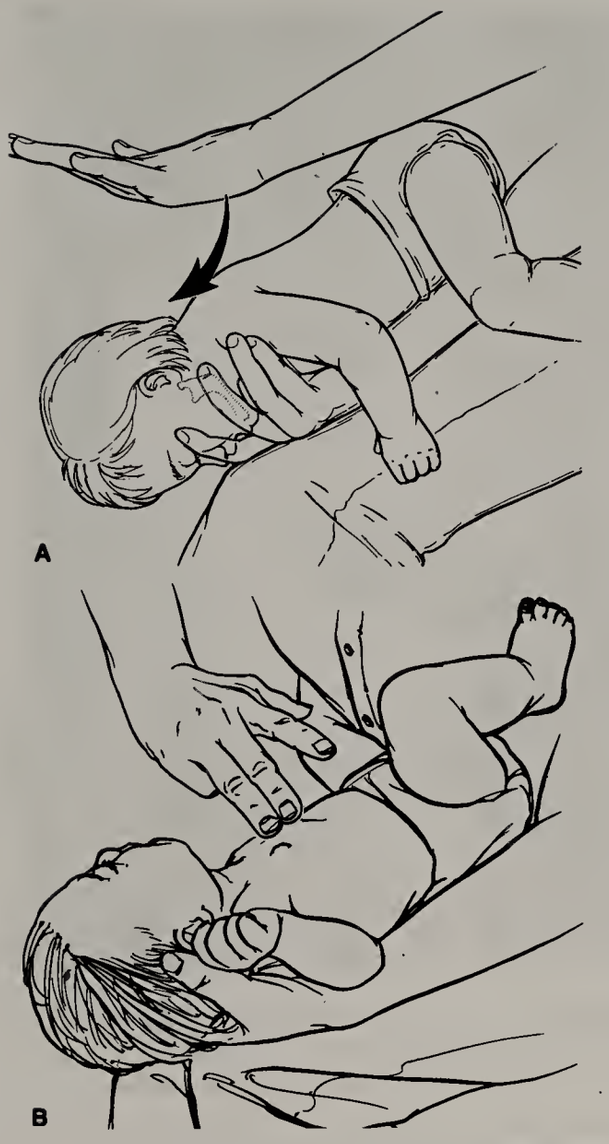


Figure 7–4
Back blows (**A**) and chest compression (**B**) to relieve complete foreign body airway obstruction in an infant. (American Heart Association. Pediatric basic life support. Journal of the American Medical Association 268;2251–2261).

a rate of 100 times per minute for an infant and 80 to 100 times per minute for a larger child, depending on his size.

For one person performing CPR on an infant or child, the ratio is one breath then five compressions until assistance arrives. The hand must come completely away from the chest between compressions. A one-way mask is also used for the infant or child to protect the radiographer. If the radiographer is adequately trained in the use of a breather bag, he may use it (Fig. 7–5).

Radiographers and all health care personnel must guard against becoming infected by a communicable disease while performing lifesaving procedures by wearing disposable gloves and by learning to use a manual resuscitation bag or a one-way face mask. Education in the use of this equipment must be obtained before it can be used effectively; such education should be a part of CPR training.



Figure 7–5
Rescue breathing with breather bag.

Airway Obstruction

A foreign body such as a piece of chewing gum or food may lodge in a patient's throat and produce respiratory arrest. This type of accident occurs most often in the elderly, the very young, or the intoxicated while they are eating. However, it must be considered by the radiographer in any case of respiratory arrest.

Signs and Symptoms

When airway obstruction caused by a foreign object occurs, the patient usually appears to be quite normal, then suddenly begins to choke.

He grabs his throat and is unable to speak.

If no one is present to observe this, the patient eventually loses consciousness.

Unless the early signs are observed, it is impossible to know the cause of the unconscious state.

Airway obstruction may occur with the patient sitting, standing, or lying down and must be dealt with initially in that position.

Radiographer's Response

1. If the patient does not respond, and breathlessness is established as described in the preceding paragraphs, seal the nose and mouth and ventilate the patient as in the initial steps of CPR.
2. If you see the patient's chest rise and fall, proceed as for basic CPR.
3. If the chest does not rise and fall, reposition the head using the head tilt, chin lift, or jaw thrust as indicated. Then attempt to ventilate again.
4. If this is unsuccessful, assume that the airway is obstructed and use the abdominal thrust to attempt to remove the obstruction.

Abdominal Thrust: Patient Standing or Sitting

The radiographer stands behind the patient and grasps him with both hands above the umbilicus and below the xiphoid process of the sternum. The lower hand is positioned with the thumb inward; the other hand firmly grips the lower hand. The radiographer then makes a rapid upward movement that forces the abdomen inward, and thrusts upward against the diaphragm (Fig. 7–6). This maneuver forces air up through the trachea and dislodges the foreign object. The radiographer must never attempt to practice this maneuver on a person not in distress because he may cause serious injury. The hands must be placed so that the xiphoid process is avoided to prevent internal injury.



Figure 7–6
Abdominal thrust, standing.

Abdominal Thrust: Patient in Supine Position

The patient is placed in a supine position with face up. The radiographer kneels astride the patient's thighs and places the heel of one hand against the patient's abdomen above the navel and below the tip of the xiphoid process. The second hand is placed over the first and the abdomen is quickly pressed upward. The radiographer must be certain to direct the thrust directly up, and not to deviate to the left or right (Fig. 7–7). This maneuver acts in the same way for the patient who is sitting or standing.

Chest Thrust: Patient Sitting or Standing

This position is used to dislodge a foreign object only if the patient is in advanced stages of pregnancy or is excessively obese, and the abdominal thrust cannot be used effectively.

The radiographer stands behind the patient and puts his arms under the patient's armpits and around his chest. The thumb side of the fist is placed in the middle of the sternum, avoiding the xiphoid process and the margins of the rib cage. The other hand is placed on top and thrust backward. This maneuver is repeated until the object is dislodged.

If the patient is an infant and an airway obstruction is suspected, he should be placed face down over the radiographer's forearm with his legs straddling the radiographer's elbow. The head and neck should be supported on the radiographer's hand between the thumb and index finger with the head lower than the chest but not straight down. Five sharp blows should be delivered to the back between the shoulder blades. If this is not successful, chest thrusts must be performed with two or three fingers on the midsternum and applied at about one each second.

The method of dealing with foreign body airway obstruction for infants and children also varies with their weight, age, and size.

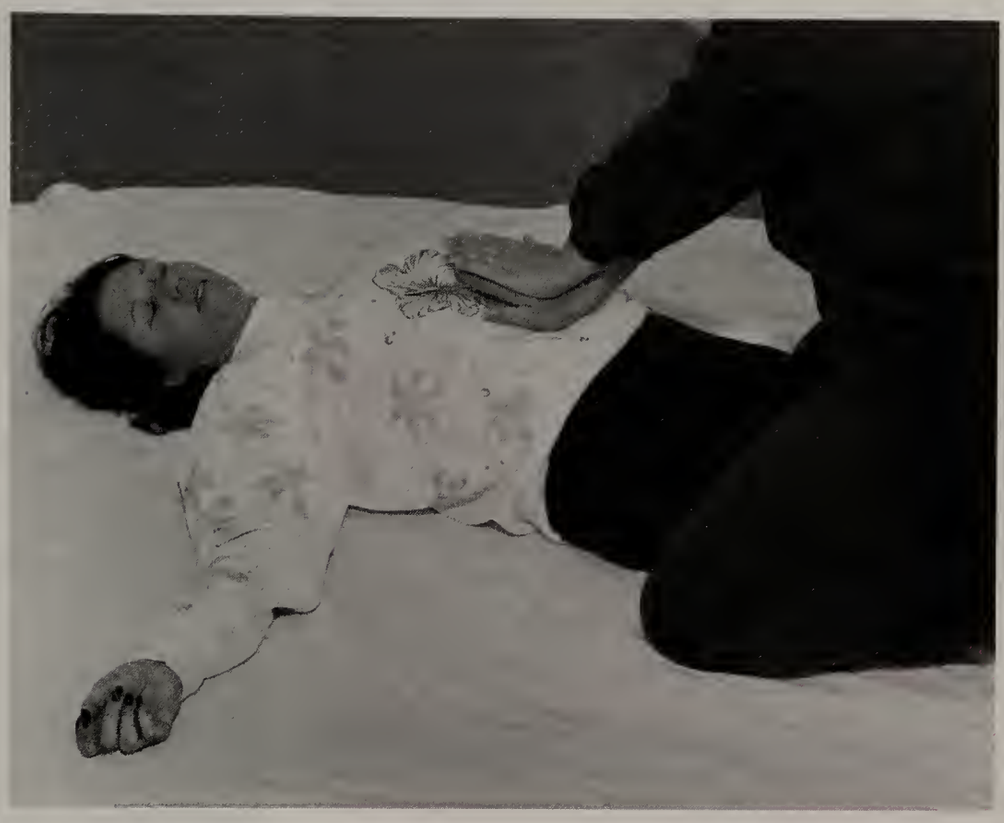


Figure 7–7
Abdominal thrust, patient in supine position.

Chest Thrust: Patient Pregnant or Excessively Obese and Unconscious

Breathlessness is determined in the prescribed manner; ventilation is then attempted. If this is not successful and the patient is in the advanced stages of pregnancy or is excessively obese, the chest thrust may be used to attempt to dislodge the foreign object.

The radiographer should kneel beside the patient and place the hands in the same position as that used for external cardiac compression. Thrusts should be slow and firm and performed as many times as is necessary to relieve the obstruction.

Finger Sweep

This maneuver is to be used only on an unconscious patient with the patient lying in a supine position, face up. The radiographer opens the patient's mouth by grasping the tongue and lower jaw between the thumb and fingers. The mandible is then lifted. This is done to move the tongue away from a foreign body that may be lodged behind it. Next the index finger of the other hand is inserted along the base of the tongue using a hooking motion to dislodge and remove the object (Fig. 7–8). This must be done with extreme care so that a foreign object is not forced further into the airway. For infants and small children, this must not be done if the object is not clearly visible in the mouth.

Reminder: The methods described in this text to remove airway obstructions for adult, child, or infant patients are taught in basic CPR classes, and all radiography students must have formal instruc-



Figure 7–8
Finger sweep.

tion in this type of treatment. The foregoing descriptions do not render the radiographer competent to perform these maneuvers.

Cerebrovascular Accident (Stroke)

Cerebrovascular accidents (CVAs) are caused by occlusion of the blood supply to the brain or rupture of a cerebral artery, resulting in hemorrhage directly into the brain tissue or into the spaces surrounding the brain. Strokes vary in severity from mild transient ischemic attacks (TIAs) to severe, life-threatening situations. CVAs occur most frequently with little or no warning and may possibly occur in the radiographic imaging department during a stressful procedure. The radiographer must be familiar with the warning signs and symptoms of this medical crisis and be prepared to initiate emergency care.

Signs and Symptoms

Possible severe headache

Muscle weakness or flaccidity of face or extremities, usually one-sided

Eye deviation, usually one-sided; may lose vision

Dizziness or stupor

Difficult speech (dysphasia) or no speech (aphasia)

Ataxia

May complain of stiff neck

Nausea or vomiting may occur

Loss of consciousness

Radiographer's Response

1. Call for emergency aid and notify the physician in charge of the patient.
2. Have emergency cart brought to patient's side.
3. Place patient in supine position with head elevated 30 degrees.
4. Monitor vital signs every 5 minutes.
5. Prepare for administration of oxygen, intravenous fluid, and medication.
6. Prepare to administer CPR if patient becomes breathless and pulseless.

Syncope (Fainting) and Seizures

Fainting and seizures are medical emergencies that can occur in the diagnostic imaging department. Both require immediate action in order to prevent injury to the patient.

Syncope, or fainting, is a transient loss of consciousness usually resulting from an insufficient blood supply to the brain. Heart disease, hunger, poor ventilation, extreme fatigue, and emotional trauma are all possible causes. The elderly patient who is asked to change positions from lying to standing too quickly may also have a syncopal reaction due to orthostatic hypotension. Orthostatic hypotension is an abnormally low blood pressure occurring when a standing position is assumed before the blood pooled in the extremities has time to circulate to the upper body.

Patients are frequently instructed not to eat breakfast before coming to the diagnostic imaging department from their homes or hospital rooms. Often they are ill, and lack of nourishment may increase the likelihood of fainting. The patient cannot choose the "proper" place in which to faint, so he may fall and injure himself. The radiographer must be able to recognize and watch for the symptoms that indicate that a patient is about to faint.

If the radiographer suspects that the patient is in a weakened condition due to a recent traumatic injury or illness, he must not request that the patient stand for a diagnostic film and then leave him to support himself; the patient is likely to fall. The radiographer must consider other methods of obtaining the exposure or have an assistant stand beside the patient to support him if necessary.

The radiographer caring for an elderly patient must allow the patient time to sit for several minutes before requesting that he stand or walk. The radiographer must always be at the patient's side to protect him from falling.

Signs and Symptoms

Pallor, complaints of dizziness and nausea

Hyperpnea, tachycardia

Cold, clammy skin

Radiographer's Response

1. If the patient complains of feeling dizzy or appears to be confused, have him lie down.
2. If the patient has actually fainted, place him in a prone position and elevate his legs.

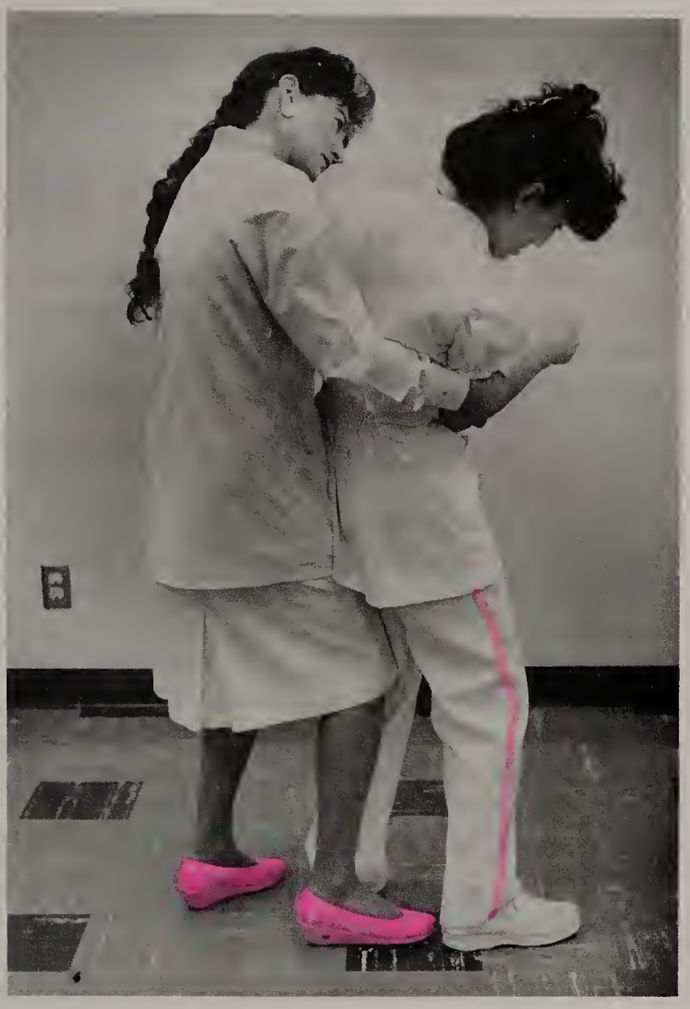


Figure 7–9
Place your knee behind the patient's knee to support her.

3. If the patient begins to fall, do not try to keep him standing. Support and assist the patient to the floor in a manner that prevents injury. Place your knee behind the patient's and your arm around his waist and assist him to the floor (Fig. 7–9).
4. When the patient is in a safe position, summon medical assistance.

Seizures

A seizure is an unsystematic discharge of neurons of the cerebrum that results in an abrupt alteration in brain function. It usually begins with little or no warning and may last only seconds or for several minutes. A seizure is accompanied by a change in the level of consciousness.

Seizures are a syndrome or symptom of a disease, not a disease in themselves. They may be caused by infectious disease, especially those that are accompanied by high fever. They may also be caused by extreme stress, head trauma, brain tumors, structural abnormalities of the cerebral cortex, genetic defects (epilepsy), birth trauma, vascular disease, congenital malformations, or postnatal trauma. Odors and flashing lights can cause a seizure in a person who is seizure prone.

There are basically three types of seizure: generalized, partial, and absence.

all ages, 1-3 mins.

GENERALIZED SEIZURES ⇒ Tonic clonic (now) grand mal (old)

Signs and Symptoms

May utter a sharp cry as air is rapidly exhaled

Muscles become rigid, and eyes open wide (tonic phase)

May exhibit jerky body movements and rapid, irregular respirations (clonic phase)

May vomit

May froth and may have blood-streaked saliva caused by biting his lips or tongue

May exhibit urinary or fecal incontinence

Usually falls into a deep sleep following the seizure

Radiographer's Response

1. Prevent the patient from injuring himself by restraining him gently.
2. Call for assistance, but do not leave the patient.
3. Do not attempt to insert hard objects into the patient's mouth during a seizure, and do not put your fingers into his mouth as they may be bitten. Remove dentures and foreign objects from the patient's mouth if possible, but do not finger sweep!
4. Stay with the patient and protect him from hitting his head or limbs on hard objects. Do not attempt to move him to the floor unless he has fallen there from a standing position. Prevent him from falling from the radiographic table.
5. Provide privacy from curious onlookers during the seizure.
6. After the seizure activity has ceased, position the patient to prevent aspiration of secretions and vomitus. Turn the patient to a Sims' position and put his head back and face downward so that secretions can drain from his mouth (Fig. 7–10).



Figure 7–10
Position the patient with his head and face downward so secretions may drain from his mouth.

7. Prepare to assist with suctioning.
8. Note and report as much about the onset and progress of the seizure as possible to the physician.
9. After the seizure, the patient may have a period of confusion or agitation. Stay with him, reassure him, and reorient him to his location and purpose in being there. Do not attempt to continue with your procedure without physician's orders.

PARTIAL SEIZURE

The seizure activity may be restricted to a specific part of the brain. Consciousness may be maintained in simple partial seizures. In complex partial seizures, the patient is not responsive to the environment, although he appears to be awake. A complex partial seizure lasts from 1 to 4 minutes.

Signs and Symptoms of Complex Partial Seizure

Lip smacking

Chewing and facial grimacing

Swallowing movements

Patting and picking and rubbing oneself or one's clothing

Confusion for several minutes following seizure activity

ABSENCE SEIZURE

This seizure activity may go unobserved because of its brevity and may occur in clusters of several episodes over the course of 1 or 2 days. This type of seizure is difficult to control medically. It does not often occur in adults.

Signs and Symptoms

May be a tremor of one limb only accompanied by brief loss of consciousness (about 15 seconds)

A brief loss of awareness accompanied by a blank stare—eyes seem to not focus; then a total return of consciousness

May be eye blinking or mild body movement

May be a sudden loss of all muscle tone resulting in a fall

Summary

Medical emergencies occur frequently in the radiographic imaging department. The radiographer may be the first or only person present at the onset of symptoms, so it is important that he learn how to recognize an emergency situation and take the appropriate action should an emergency occur.

The radiographer must assess his patient's levels of neurological and cognitive functioning as he prepares him for the assigned procedure. He will then he able to identify changes in the patient's level of consciousness and mental status should they occur while he works with the patient.

Shock is a common medical emergency. There are many causes of physiologic shock. Blood loss, infection, and cardiac failure are among the most common. Anaphylactic shock is caused by an allergic reaction and is the type that the radiographer is most likely to see in his work. This is because iodinated contrast agents that are used for some radiographic procedures and examinations may produce this reaction. If early symptoms of an anaphylactic reaction are suspected, the radiographer must not wait, but must stop the administration of the contrast agent immediately and initiate emergency action. Early symptoms of an anaphylactic reaction are apprehensiveness; sneezing; itching at injection site or around the eyes and nose; angioneurotic edema of face, hands, and other body parts; choking and shortness of breath; and ultimately, if the situation is not reversed, respiratory failure.

Pulmonary embolus is a medical emergency that may occur without warning. If symptoms are observed, the radiographer must take emergency action immediately.

Hypoglycemia, ketoacidosis, and hyperosmolar nonketotic syndrome may be seen in the diagnostic imaging department. Patients who have dia-

betes mellitus may come for examinations or procedures after having taken insulin or oral hypoglycemic medication and be without sufficient food intake to use the drug. This may induce a hypoglycemic reaction. Ketoacidosis occurs when a diabetic patient has not had sufficient insulin and his body is not able to metabolize the glucose present. Hyperosmolar nonketotic syndrome occurs most frequently in elderly diabetic patients who have had a recent acute illness, therapeutic procedures such as dialysis, or recent changes in diet. Any of these reactions constitutes a medical emergency that, if left untreated, will result in coma and death. Administration of glucose in some form is the treatment for a hypoglycemic reaction. For all diabetes mellitus–related reactions, the physician in charge of the examination or treatment must be notified at once, and the radiographer must call for emergency assistance and be prepared for oxygen and intravenous fluid and medication administration.

Cerebrovascular accidents are medical emergencies that must be recognized and dealt with immediately in order to prevent life-threatening consequences. The early signs and symptoms are often one-sided flaccidity of face and limbs, difficult or absent speech, eye deviation, dizziness, ataxia, possible neck stiffness, nausea, vomiting, and loss of consciousness.

Respiratory failure and cardiac failure should be differentiated by the radiographer. Respiratory failure can be recognized by a lack of chest movement, absence of breath sounds, a diminishing pulse rate, and loss of consciousness. Cardiac failure results in an immediate cessation of the pulse and respiration and a loss of consciousness. Both call for immediate action if the patient's life is to be saved.

Airway obstruction caused by a foreign object should be suspected if the patient is feeling well and suddenly begins to demonstrate respiratory distress, or if a patient is found unconscious and, when ventilation is attempted, the chest cannot be made to rise and fall as it should during resuscitation. The abdominal thrust maneuver must be performed in response to this emergency.

Fainting and convulsive seizures may occur with little or no warning. The radiographer should be able to recognize these problems and protect the patient from injuries caused by aspiration of saliva or vomitus, by falls, or by hitting his head or extremities against hard surfaces.

The radiographer must know where the emergency cart, oxygen, suction equipment, and other supplies are kept in the diagnostic imaging department. When the physician and the emergency medical personnel have come to the patient's assistance, the radiographer should stay close by to offer assistance as needed.

It is the radiographer's professional obligation to be prepared to administer basic life support procedures to adults and children. He must keep his classroom training current by taking a refresher course as recommended by specialists in this care.

Chapter 7, Pre–Post Test

1. List and describe the levels of neurological functioning according to the Glasgow Coma Scale.
2. Explain the method of assessing mental status.
3. General signs and symptoms that the radiographer must learn to recognize as probable indicators that his patient is in shock are
   a. Strong, irregular pulse; hypertension; flushed face; noisy respiration
   b. Aggressive behavior, acetone breath, convulsions, and decreased temperature
   c. Decreased temperature; weak, thready pulse; rapid heartbeat; hypotension; and skin pallor
   d. Deep, shallow respirations; hot, flushed skin; confusion; and decreased pulse rate
4. For what reason is anaphylactic shock the type of shock most often seen in diagnostic imaging?
   a. Patients who come for diagnostic imaging procedures are weak and debilitated
   b. Iodinated contrast agents are frequently used
   c. Patients here have more allergies
   d. X-radiation causes this problem
5. Early signs and symptoms of anaphylactic reaction are
   a. Choking, dyspnea, and cyanosis

b. Hypertension; pallor; a calm, relaxed facies
c. Itching, sneezing, and apprehension
d. Hypotension; weak, rapid pulse; dilated pupils

6. Myrtle Maywriter is a 43-year-old female who has come to diagnostic imaging this morning from her home for an upper GI series. After she has been in the room for a short time, she begins to complain of a severe headache. Shortly after that, you notice that she has cold, clammy skin and speaks in a slurred manner. You suspect that Ms. Maywriter is
a. A diabetic and is having a ketoacidotic reaction
b. Having a cardiac arrest
c. An alcoholic and is drunk
d. An epileptic and is having a seizure
e. A diabetic and is having a hypoglycemic reaction

7. Your immediate emergency treatment of Ms. Maywriter's problem in question 6 would include
a. To prepare for oxygen administration and call the emergency team
b. Check for an identification of the patient as a diabetic, give her some form of concentrated sugar, and notify the physician in charge
c. Place the patient in a supine position, keep her warm, and call the emergency team
d. Continue with your work, do not leave the patient alone, and stop the IV

8. Symptoms of a partially obstructed airway may include
a. Cold, clammy skin; pallor; weakness; anxiety
b. Flushed, hot skin; hyperactivity; confusion; seizures
c. Labored, noisy breathing; wheezing; use of neck muscles to assist with breathing
d. Acetone breath, irregular pulse, noisy respiration, rapid heartbeat, flushed skin

9. A 16-year-old patient comes into the diagnostic imaging department for a computed tomography examination. He is lying on the table in a supine position. He suddenly seems to lose consciousness and begins to move violently, with jerking motions. You realize that he is having a generalized seizure. The action that you must take is
a. Go to the patient immediately and restrain him gently
b. Call for help, but do not leave the patient
c. Place the patient on the floor and begin CPR
d. a and b
e. a, b, and c

10. Mrs. Gertrude Glucose, aged 35, had an open reduction of the left femur 3 days ago and has been transported to the diagnostic imaging department by gurney from her hospital room for a radiographic film. As you prepare the patient for the film, she suddenly begins to complain of pain in her midchest and appears to be out of breath. You stop your preparation and take her pulse and blood pressure. You find that her blood pressure is 120/80 and her radial pulse is 120 per minute and is very difficult to palpate because it is so weak and thready. You quickly notify the physician of the problem and he directs you to call the emergency team. You do this and make other emergency preparations. You believe that this patient may be having
a. A stroke
b. A seizure
c. A pulmonary embolus
d. Syncope

11. Fainting is a common medical emergency in the diagnostic imaging department. If a patient appears to be fainting, the first thing that the radiographer should do is
a. Assist the patient to a safe position and then call for help
b. Give smelling salts
c. Get the emergency cart
d. Prepare to administer oxygen

12. Match the following items:

1. Hypovolemic shock _____
2. Cerebrovascular accident _____
3. Airway obstruction _____
4. Cardiogenic shock _____
5. Anaphylactic shock _____

a. Difficult speech; severe headache; one-sided, drooping eye and face; loss of consciousness
b. Choking, inability to speak, eventual loss of consciousness
c. Itching of eyes, apprehensiveness, wheezing, choking
d. Loss of consciousness; decreased blood pressure; weak, rapid pulse
e. Pallor; thirst; cold, clammy skin; restlessness

13. List the questions that the radiographer must ask a patient prior to the patient's receiving an iodinated contrast agent

14. Compare the symptoms of diabetic ketoacidosis, hyperosmolar coma, and hypoglycemia.

○ *Laboratory Reinforcement*

All radiography students must take a formal class in cardiopulmonary resuscitation and emergency treatment of airway obstruction. This will include laboratory practice of these emergency measures.

1. Using a fellow student or a mannequin as a patient, demonstrate the jaw-thrust method of clearing the airway.
2. Using a mannequin or a fellow student, demonstrate opening and clearing the mouth of foreign material before beginning CPR.
3. Demonstrate the position in which a patient should be placed following a generalized seizure.

Critical Thinking Problems

1. You have just received a 16-year-old male from the emergency room for radiographs of his skull following a traffic accident. He walks into the department and responds to your greeting and questions appropriately. After he is positioned for examination, he becomes drowsy and is slow to respond to your directions. How will you proceed with this patient?
2. A 45-year-old female comes to the department for an upper and lower gastrointestinal series. The preparation for this examination requires fasting and cleansing enemas the morning of the examination. Her chart states that she has insulin-dependent diabetes mellitus. The patient enters the examining room and as you begin to question her, she complains of a headache. You note that her skin is cool and moist and she is moving her mouth strangely. How will you proceed with this patient?

8

Care of Patients With Special Problems

The Pediatric Patient
The High-Risk Newborn Infant
The Adolescent or Older Child
Transporting Infants and Children
Immobilizing the Anxious Child
- Sheet Immobilizers
- Mummy-Style Sheet Immobilizers
- Commercial Immobilizers

Child Abuse
Administering Medication to the Pediatric Patient in Radiographic Imaging
The Geriatric Patient
Changes Associated with Aging
- The Integumentary System
- Changes in the Head and Neck
- The Pulmonary System
- The Cardiovascular System
- The Gastrointestinal System
- The Hepatic System
- The Genitourinary System
- The Musculoskeletal System
- The Neurological System

Culture and Aging
Traumatic Injuries
The Patient With a Head Injury
The Patient With a Facial Injury
The Patient With a Spinal Cord Injury
The Patient With a Fracture
The Patient With Abdominal Trauma or in Acute Abdominal Distress
The Patient Who Has Had Arthroplastic Surgery
The Agitated or Confused Patient
The Intoxicated Patient
The Patient in His Home
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Describe the special care needs of the pediatric and adolescent patient during radiographic imaging procedures.
2. Demonstrate safe methods of immobilizing a pediatric patient.
3. Discuss the special problems of geriatric patients in radiographic imaging and describe their special care needs.
4. List the precautions to be taken by the radiographer if the patient has a head injury.
5. List the precautions to be taken by the radiographer if the patient has facial injuries.
6. List the precautions to be taken by the radiographer if the patient may have a spinal cord injury.
7. List the precautions to be taken by the radiographer if the patient may have a fracture.
8. List the precautions to be taken by the radiographer if the patient has abdominal trauma or is in acute abdominal distress.
9. Explain the precautions to be taken by the radiographer if the patient has had an arthroplasty.

10. List the precautions to be taken by the radiographer if the patient is confused, agitated, or aggressive.
11. Describe precautions the radiographer must take if the patient is intoxicated or has taken mind-altering drugs.
12. Describe the special care needs of the patient having radiographs taken in the home.

Glossary

Abrasion: a scraping or rubbing away of the surface skin by friction
Actinic keratosis: a slow, localized thickening of the outer layers of the skin as a result of chronic, excessive exposure to the sun
Adduct: to draw toward a center, or median, line
Alzheimer's disease: an illness characterized by dementia, confusion, memory failure, disorientation, restlessness, speech disturbances, and an inability to carry out purposeful movements; onset usually occurs in persons aged 55 or older
Appendicitis: an inflammation of the vermiform appendix, usually acute in onset
Arthroplasty: plastic repair of a joint
Aspiration: the inspiration into the airway of foreign material
Asymmetrical: lacking in similarity of form on either side of a dividing line or plane; not proportional
Baroreceptor: a sensory nerve terminal that is stimulated by changes in pressure
Basal: at the base; the lowest possible level
Biotransformation: the chemical changes a substance undergoes in the body, usually by the action of enzymes
Buccal mucosa: the mucous membranes inside the cheek
Cervical: of or pertaining to the neck
Cholecystitis: inflammation of the gallbladder
Conjunctiva: the thin, transparent membrane lining the eyelids
Contusion: an injury that does not break the skin; caused by a blow to the body; characterized by swelling, discoloration, and pain
Delusional: a false belief that is firmly maintained in spite of incontrovertible and obvious proof to the contrary and in spite of the fact others do not share the belief
Dementia: organic mental syndrome characterized by general loss of intellectual abilities involving impairment of memory, judgment, and abstract thinking
Depression: a morbid sadness, dejection, or melancholy
Dyspnea: labored or difficult breathing
Ecchymosis: an oozing of blood from a vessel into tissues forming a discolored area on the skin
Ectopic pregnancy: an abnormal pregnancy in which the embryo implants outside the uterine cavity
Emesis: vomiting or sudden removal of stomach contents through the mouth
Ethical: descriptive of rules or principles that govern right conduct
Extension: the movement by which the two ends of any jointed part are drawn away from each other
Flaccid paralysis: loss of muscle tone and loss of tendon reflexes, producing a limp, toneless limb or muscle
Flail chest: loss of stability of the chest due to multiple rib fractures or detachment of the sternum from the ribs
Folate: a salt or folic acid
Gait: manner of moving or walking
Gastrointestinal: of or pertaining to the organs of the digestive tract, from the mouth to the rectum
Genitourinary: of or pertaining to the genital and urinary systems
Geriatrics: the branch of medicine that deals with all aspects of aging, including pathologic and social problems
Hallucination: a sensory impression (sight, sound, touch, smell, or taste) that has no basis in external stimulation
Hemiparesis: paralysis affecting one side of the body
Hemothorax: collection of blood in the pleural cavity
Hyperflexed: flexion of a limb or part beyond the normal limit
Hypothermia: an abnormal and dangerous condition in which the body temperature falls below 95°F
Hypovolemic: abnormally decreased volume of circulating fluid (plasma) in the body
Hypoxia: decrease in the oxygen supplied to or used by the body
Kyphosis: an abnormal condition of the vertebral column in which there is increased convexity in the curvature of the thoracic spine
Laceration: a torn, jagged wound
Lentigines: round, flat, brown, highly pigmented spots on the skin; caused by increased deposition of melanin; often occurs on the exposed skin of the elderly
Lordosis: an abnormal and increased degree of curvature of any part of the back
Lucidity: clearness of mind
Macule: a small, flat blemish or discoloration that is flush with the skin surface
Neonatal: newborn, from the time of birth until the 29th day of life
Neuron: nerve cell
Palsy: paralysis
Pancreatitis: an inflammation of the pancreas
Perinatal: relating to the period shortly before and after birth
Pneumothorax: accumulation of air or gas in the pleural cavity resulting in collapse of the lung on the affected side
Polypharmacy: administration of excessive medication or of many drugs together
Postnasal drip: a drop-by-drop discharge of nasal mucus into the posterior pharynx
Priapism: persistent, abnormal erection of the penis, accompanied by pain and tenderness
Proprioception: perception mediated by any of the sensory nerve endings that gives information concerning movement and position of the body
Prosthesis: an artificial substitute for a missing part
Protocol: an explicit, detailed plan
Psychosis: a state in which a person's mental capacity to recognize reality, communicate, and relate to others is impaired
Sclerosis: an induration or harden-

ing of an organ or tissue; in the case of the nervous system this condition is due to hyperplasia of connective tissue or hardening of blood vessels

Sensorimotor: concerning both sensory and motor modalities

Somatic: pertaining to or characteristic of the body (soma)

Spatial: pertaining to space

Thermal: pertaining to heat

Transection: a cross section

Urinary incontinence: inability to control urinary functions

Pediatric patients range in age from infancy to 15 years. Children in this broadly defined group require special care, depending on their age and ability to comprehend the treatment plan. The radiographer must adjust his method of communication and execution of the required procedure according to the child's age in order to be both sensitive and effective in performing the procedure.

The elderly patient also has special needs. There is a gradual decline in bodily functions as one ages; however, the aging process varies with each individual. The radiographer must assess each elderly person's abilities individually and then determine what adaptations will be required to maintain the patient's safety and comfort as he performs the designated examination or procedure.

The assigned patient may be severely traumatized; have a fracture, a spinal cord injury, or head or facial injuries; or be in acute pain due to an intra-abdominal crisis or injury. Acutely ill or injured patients are usually admitted through the emergency suite and are then sent to the radiographic imaging department to determine the extent of the injury or to assist with the diagnosis of the illness. If circumstances do not permit the patient to be taken to radiographic imaging, the radiographer will be requested to take diagnostic radiographs in the emergency suite.

As a rule, the radiographer is expected to produce radiographs of high quality; however, in emergency situations, this may not be possible without extending the patient's injury or causing the patient extreme pain and discomfort. The radiographer must understand potential problems when planning the care of patients with traumatic injuries or a critical illness and exercise great care in discharging his duties.

Arthroplasty, or joint replacement, is a surgical procedure being performed with increasing frequency. Radiographs of the operative area are required perioperatively (during the procedure) and postoperatively. There are special care considerations that must be observed by all health care professionals who work with these patients. The radiographer must be aware of the special care needs of these patients and take the precautions necessary to prevent injury when the patient is in his care.

Occasionally, the radiographer will be required to take radiographs of a patient who is confused, agitated, combative, intoxicated, or under the influence of a mind-altering drug. Working with patients who have these problems requires care in order to protect the patient and the radiographer from injury.

Home care has become an increasingly popular method of caring for persons with all types of diagnoses and all levels of illness acuity. Many persons being cared for in the home are too ill or immobile to be transported to the radiographic imaging department. The radiographer must go to their home to take diagnostic radiographs. Care of patients in the home requires special assessment and planning skills that the radiographer must consider.

Before caring for patients in emergency situations, the radiographer must take time to don the appropriate protective gear. The injured or acutely ill patient is often hemorrhaging or losing body fluids, so care must be taken to prevent the spread of infection.

The Pediatric Patient

Caring for infants and children demands special safety and communication techniques. It also requires a sensitive approach to the accompanying parents or guardian.

The radiographer may be required to take portable radiographic films in the neonatal intensive care nursery. This assignment requires use of protective isolation technique as described in Chapter 3.

Children of all ages respond in a positive manner to honesty and friendliness. A small child may be very frightened when he enters the radiographic imaging department and sees the darkened rooms and the massive equipment. If the radiographer spends a few moments establishing a rapport with the child and acquaints him with the new environment, he will save himself a great deal of time later and the child will leave the department with a positive attitude.

Most children resist immediate close contact with strangers. Therefore, it is best to talk to the

child from a comfortable distance and allow him to become accustomed to your presence before approaching him. The radiographer must explain what is going to occur during the procedure to the child who is old enough to understand. He should also give the child an estimate of how long the procedure will last and what will be expected of him. The child should be prepared for any discomfort that he may feel. If he is to receive medication, the method of administration should be explained. Explanations to children are most effective if they are brief, simple, and to the point. The child should not be given choices when it is not appropriate, as it may be confusing to him.

The radiographer should speak to the child face to face even if he must sit or kneel on the floor to do so. To avoid misunderstandings, only one person should explain and direct the child. It may, therefore, be necessary to reach an agreement with the accompanying adult about who is going to assume this responsibility. Using a soft tone of voice and speaking in terms that are simple and familiar will enhance communication. The radiographer must be certain that the child understands what is being said. If the child wishes to carry a toy or security item with him to the examining room, he should be allowed to do so if at all possible. If it is not practical, the radiographer may take the toy with him and place it so that the child can see it during the examination and return it to him immediately after the procedure.

When explaining a procedure to a child, it is necessary to tell him what part of his body will be examined, why, and who will be performing the examination. It is also important to explain how the examination will proceed, what part of his body must be touched to accomplish the procedure, and why he must hold still during the process.

Some children are very modest. If a child's body must be exposed for an examination, only the necessary part should be exposed. The radiographer must also guard against allowing the child to become chilled while in his care. This is of particular importance for infants, as they lose body heat rapidly and their health can be jeopardized by loss of body heat.

Radiation protection is a priority for infants and children. The radiographer is responsible for placing the correct radiation shields on them before beginning his work.

Parents or guardians who accompany the child feel less anxious if they are given an explanation of the procedure. Their cooperation is easily enlisted by the radiographer who encourages them to explain the child's special needs and sensitivities. If the adult can be allowed to remain with the child during the examination without jeopardizing the child's safety or the successful completion of the examination, the radiographer must be certain that he or she is protected from exposure to radiation. Parents or guardians must be given specific instructions about what is expected of them during the procedure.

The child must be protected from falling from the examination table by the adult who is holding him. If lead aprons and protective equipment are to be donned by the parent, the radiographer must assist them into these garments. The child must not be left unattended while this is being done. The radiographer must never assume that the parent is watching the child on an examination table. He must instruct parents in the exact measures that he wishes them to take. For instance:

> **RADIOGRAPHER:** *I would like you to stand on this side of the table with your hands on your child at all times. It will be necessary for you to wear this lead apron while the radiographic films are being taken to prevent exposure to radiation. I will hold the child while you put on the apron. The apron fastens with Velcro attachments in the back. Now, if you will please keep your hands on the child at all times, I will proceed.*

If the child refuses to follow directions and is emotionally distraught, it may be necessary for the radiographer to ask the accompanying adult to leave the room. In this case, the child must be made to understand that his doctor and his parents wish the examination to be done and that it will be done. Then, the radiographer should repeat the directions and proceed. The child's behavior should not be belittled or criticized; the radiographer should remain nonjudgmental and matter-of-fact and accomplish his task as quickly as possible.

The High-Risk Newborn Infant

Many hospitals have special care units for high-risk newborn infants. In many areas of the United States, infants are transported to such facilities for special care from the hospital in which they were born. Infants may be considered to be at high risk for life-threatening problems if they are of low birth weight or if they have other perinatal problems.

Infants whose lives are at risk require special care considerations in highly specialized neonatal intensive care units (NICU). Here they are protected from threats to their nutritional status, en-

vironmental problems such as changes in their body temperature, or infection by being placed in isolettes with environmental and thermal control and by the practice of meticulous infection-control measures.

A surgical scrub or a 2-minute scrub as for medical asepsis is required of all persons entering these nurseries. Protective gowns are worn over uniforms. A sterile gown, gloves, and a mask may be required. The radiographer must inquire about the isolation procedure for each infant on an individual basis prior to beginning his work in the intensive care nursery. He must also be certain that his portable machine is wiped clean with a disinfectant solution and is dust free before he enters the nursery.

The radiographer consults with the nurse in charge of the infant's care and is assisted by that nurse in positioning and holding the infant. The radiographer must take care to prevent chilling the infant or dislodging any catheters or tubing as he works. He must provide the nurse who assists him with a protective lead apron if the nurse is to hold the infant (Fig. 8–1).

If the radiographer has any sort of respiratory infection or infected cuts on his hands, he should have another radiographer take the NICU assignment in order to prevent introduction of infectious microorganisms into this protective environment.

The Adolescent or Older Child

The older child or early adolescent is often expected to act as an adult would act under similar circumstances. This is not a fair expectation since children of this age are not yet adults. When they are threatened by illness or injury, they will return to the more familiar role of being a child.

The teenager is apt to be perceived as hostile and self-centered. Communication will cease if a feeling of disapproval is conveyed by the health care worker. The radiographer can overcome this behavior by conveying a nonjudgmental attitude and using the therapeutic communication techniques described in Chapter 2.

When caring for the older child, the radiographer should be as direct and as honest as possible in his explanations of what will occur during the procedure. He should use simple terms and allow the patient to ask questions and express his fears and apprehension. If the child feels more secure with his parent accompanying him, this should be allowed, if it is permitted. If not, the adult must be allowed to stay close by and be with the child between exposure times, or as often as is appropriate and safe. The child's privacy must be respected. No part of his body should be exposed without an explanation of the necessity for doing so. If he can be



Figure 8–1
Radiographing an infant in the neonatal intensive care unit.

allowed to make choices, he should be allowed to do so. This will give the older child a feeling that he has some control of the situation.

Transporting Infants and Children

The radiographer will be responsible for transporting infants and children from place to place in the radiographic imaging department and may be responsible for transporting them to the department from hospital rooms. Additional safety measures must be taken to prevent injuring the very young patient.

Care must be taken to ascertain the identity of the patient as he cannot speak for himself. The identity of a patient who comes to the department from outside the hospital must be verified with his adult caretaker. The type of procedure that the child is to receive must also be verified with that person or persons before the child is taken from the adult.

A child who is in the hospital will be wearing an identifying band on his wrist or ankle. This band must be checked with the nurse in charge of the patient before he is taken from the ward, and again with his chart or the requisition for the procedure when he arrives in the department.

The method of transfer will depend on the child's size and the nature of the illness or injury. Under most circumstances, it is safe to carry infants and very small children for short distances (e.g. from one diagnostic imaging room to another). For longer distances, it will be necessary to place the child in a crib with all sides up and locked.

Some cribs come with tops to prevent the active child from climbing over the crib rails. Crib rails must never be placed in a half-raised position as an active child can climb over them and will fall from a greater height than if the rails had not been raised at all.

Older children may be transported on a gurney with side rails up and locked and a safety belt securely fastened. Some older children may prefer to be transported in a wheelchair. If this means of transportation is appropriate, the safety belt must be securely fastened for the entire time that the child is seated in the wheelchair. Children must never be left alone while in diagnostic imaging. If they are placed on a radiographic table, an attendant must be at their side until the procedure is complete and they are taken from the procedure room.



Figure 8–2
(**A**) Horizontal hold supporting the infant's back and head. (**B**) Upright hold supporting infant's back and head.



Figure 8–3
Sheet immobilizer allowing abdomen to remain exposed.

If they must wait in an outside corridor, they must be attended at all times.

It is necessary to provide back support for infants or small children if they are being held or carried. This may be done in a horizontal hold with the child supported against the body and the head supported on the radiographer's arm at the elbow with his hand grasping the patient's thigh (Fig. 8–2). Another method of holding an infant or small child is upright with the buttocks resting on the radiographer's arm and the other arm around the infant supporting the back and head.

When a child is returned to a hospital room, the radiographer must be certain that the side rails of the crib are up; they must be checked to be certain that they are locked. There should be no bedside stand at close range that the child might use as a stepping place to climb out of the crib. No unsafe items or liquids should be in reach of the child's crib. The nurse in charge of the child must be notified that the child has been returned to his room.

IMMOBILIZING THE ANXIOUS CHILD

Occasionally the very anxious or frightened child will not be able to stay quietly in one place long

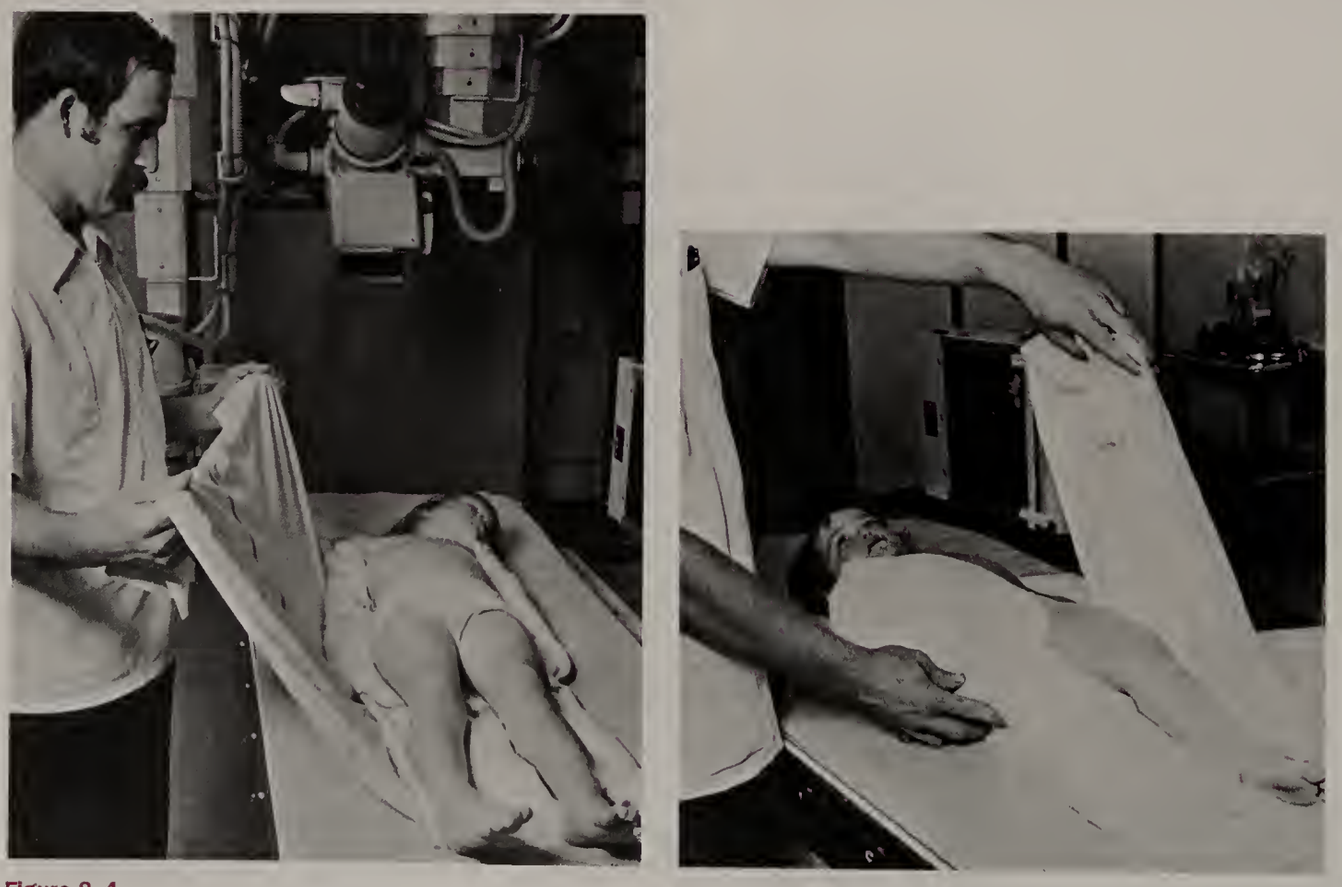


Figure 8–4
Mummy restraint for both limbs and the lower torso.

enough for a successful diagnostic procedure to be completed, and he will have to be immobilized. In other situations, a child may not be able to be held safely in position for an examination and immobilizers (restraints) will be necessary. Immobilizers should be used only when no other means are safe or logical and should be of a quality that will not cause injury to the patient.

There are several methods of immobilizing children. An immobilizer can be made by folding a sheet in a specified manner, or there are commercial immobilizers that are effective for certain procedures. The child may also be held in position by one or two assistants. Whatever type of immobilizer chosen, the child who is old enough must be made to understand, before the immobilizer is applied, that this is not a method of punishment and it will be removed as soon as the procedure is completed. His parents must also be informed of the use of the immobilizer and the reason for it.

If a child is to be physically restrained by an assistant during an examination, the radiographer must instruct the assistant not to be too forceful. Care should be taken not to pinch or bruise the skin or to interfere with circulation. It is better to use a sheet or mechanical immobilizer than to have the assistant use force, because the former is less frightening to a child. In order to prevent a small child from rolling his head from side to side, the person holding the child should stand at the head of the table and support the child's head between his hands, making sure that there is no pressure on the ears or on the fontanels. Any person who holds a child during a radiographic examination must wear a protective lead covering.

Sheet Immobilizers

Sheet immobilizers are effective and can easily be formed into any size or fashion desired. To make a sheet immobilizer, a large sheet is folded lengthwise. The top of the sheet is then placed at the child's shoulders and the bottom at his feet. The greater portion of the sheet is left at one side of the child. The longer side is brought back over the arm and under the body and other arm. Next, the sheet is brought back over the exposed arm and under the body again. This type of restraint keeps the two arms safely and completely restrained and leaves the abdomen exposed (Fig. 8–3).

Mummy-Style Sheet Immobilizers

Another method of immobilization is the mummy-style sheet immobilizer. It is made by folding a sheet or a blanket into a triangle and placing it on the radiographic table. The distance from the fold to the lower corner of the sheet should be twice the length of the child. The child is placed onto the sheet, with the folds slightly above the shoulders. The child's clothes are loosened or removed. One corner of the sheet is brought over one arm and under the child's body. If both arms are to be restrained, the same procedure is done with the other side of the sheet. If the legs are to be immobilized, the sheet is turned and the procedure repeated for the legs (Fig. 8–4). This immobilizer can be used to restrain one extremity or all extremities (Fig. 8–4*B*).

Kerlix or roller gauze can be used to immobilize an arm or leg of an infant.

Commercial Immobilizers

There are commercial immobilizers that are also recommended. The Pigg-o-stat is a mechanical immobilizer that is excellent for holding a child safely in an upright position (Fig. 8–5). It is useful for making exposures of the chest or upright abdominal exposures. Another immobilizer is a plastic mold that has straps to hold the extremities (Fig.



Figure 8–5
The Pigg-o-stat. The cassette is inserted into slots directly in front of the child.



Figure 8–6
Molded immobilizer with Velcro straps for limbs.

8–6). If it is available, this is the best type of restraint for a procedure such as an intravenous pyelogram.

Child Abuse

Unfortunately, the incidence of child abuse has increased in recent years. Abuse may take the form of neglect, physical injury, emotional mistreatment, or sexual abuse. The radiographer may be the person assigned to radiograph injuries that are the result of child abuse. It will be his ethical, and perhaps his legal obligation to report this to the person in his institution who makes the inquiries and reports required in such cases. In some states, all health care personnel are obligated to report suspected cases of child abuse. In others, designated health care providers are obligated to do so. The radiographer must learn the legal parameters for this obligation in the state in which he works. Each institution also has a protocol that dictates the method of processing suspected cases of child abuse, which the radiographer is also obliged to know and use if the situation arises.

Any radiographer assigned to take radiographs of a child's injuries who notes bruising, burns, or possible fractures that seem out of proportion to the report of how the injury occurred may need to consider abuse. Perhaps an older child will tell a story about how the injuries occurred that does not correspond to what his caretaker has related. A child may report that he has not eaten for an inordinately long time because his parents have not provided him with food. Whatever form the suspected abuse takes, the radiographer must report it to the designated person in his workplace. In most states, the health care worker who reports suspected child abuse is protected from legal action if the report is proven to be false; however, care must be taken to refrain from false accusations. Children often misjudge what is a safe action and suffer accidents because of their own mistaken judgment.

Administering Medication to the Pediatric Patient in Radiographic Imaging

Administering medications to children in diagnostic imaging is a sensitive issue. The medical care of children is most frequently the role of physicians and registered nurses who have specialized education in pediatrics. Medicating children can be life-threatening and must not be undertaken by the radiographer. If a registered nurse is not available to administer medication or a contrast agent to persons under 18 years of age, the radiologist must do this.

Drug absorption, biotransformation, distribution, use, and elimination are different in infants, children, and early adolescents than in adults. For this reason, knowledge of pediatric medication administration is required to administer drugs accurately and safely to patients in these age groups.

The radiographer must be aware of the potential for overmedication or for an adverse reaction to a drug or contrast agent in children. Before an infant or child receives medication or a contrast agent, an assessment must be performed. Questions that must be asked of the child's parents or caregiver follow:

1. Does the child have allergies to any foods or medicines?
2. How does the child respond to medicines?
3. In what form are medicines administered to the child at home?
4. Will a parent be able to supervise the child after he is discharged from this department following this procedure?

5. Are there any unusual circumstances concerning this child and his ability to take medicines that the physician should know prior to drug administration?
6. Is the parent educated in the action, the purpose, and the potential side effects of the drug being administered?

If it was the radiographer who gathered this data, he must pass the information on to the physician who will prescribe the drug and to the nurse who will administer it.

The radiographer must make certain that the child receiving drugs or contrast agents in his department is carefully monitored and is not released from the department until there is no risk of complications. The assessment and care of the child is usually done by a registered nurse who works in diagnostic imaging; however, if a nurse is not present, the radiographer and the physician must ensure that this is done. Before the child who has received a contrast agent or sedating medication is discharged, he must be assessed by a physician and given authorization to leave with his parent or guardian. If the child is sleeping, he must remain hospitalized until he awakens.

The Geriatric Patient

The number of people aged over 65 in the United States has tripled since 1900. At the present time, one in every eight persons falls into this category. Persons over 85 years of age constitute one of the fastest-growing portions of the population. For health care workers, this means that the majority of their patients will be 65 years of age or older; therefore, they must understand the changes that occur as one ages. The radiographer must understand that age 65 is an arbitrary age that has been designated for convenience as the age at which an individual is eligible for Medicare benefits, Social Security benefits, and retirement from many positions. Many persons at this age are still quite youthful and productive; therefore, all persons must be assessed on an individual basis, not merely by their chronologic age.

The human body undergoes normal physiologic and anatomic changes as it ages. These changes do not occur uniformly in all people, so it is not correct to say that all persons begin to demonstrate the changes of age at the same time. Lifestyles, culture, and hereditary factors contribute to the aging process. When the radiographer admits an elderly patient to the radiographic imaging department, he must be able to differentiate between the normal changes of aging and deficits resulting from a disease process.

The elderly person is more frequently burdened with major illnesses that are chronic rather than acute in nature. Heart disease, cancer, and strokes are the cause of 80% of deaths in persons aged over 65. Hypertension, arthritis, diabetes mellitus, pulmonary diseases, and visual and hearing impairments are also common conditions requiring long-term care. These conditions result in a great deal of physical discomfort and a multitude of social and psychological problems.

Large numbers of medications are prescribed and consumed by the elderly. Many of these medications affect the patient's response level. Often, problems that are attributed to the aging process are the result of multiple medication consumption, which is frequently called *polypharmacy.*

Depression is a frequent and debilitating emotional problem of the aged person. The threat of becoming a burden on one's family, the fear of losing one's good health, or the necessity of giving up an independent lifestyle due to chronic disease result in feelings of helplessness and hopelessness that can result in a major depressive episode. Symptoms of depression in the elderly person are often confused with dementia.

Symptoms of dementia, including disorientation, confusion, gross memory deficits, paranoid ideation, hallucinations, and depression are not part of the normal aging process. When these symptoms are present in an elderly patient, the radiographer must remember that they are indicative of a disease process. Alzheimer's disease presents with symptoms of dementia and usually occurs in persons aged over 65, although it may occur at an earlier time. Persons with Alzheimer's disease, or other diseases that produce symptoms of dementia, are frequently seen for radiographic imaging examinations.

If the radiographer is caring for a patient who exhibits symptoms of dementia, he must remember that the person may not be able to understand or retain directions given him. The radiographer will have to explain to the patient what is to be done and then assist him to follow the directions. The patient who is confused or has paranoid ideation may become frightened when confronted by the forbidding atmosphere of the radiographic imaging department. Allowing a familiar person to be present in the examination room to assist the patient may make the patient feel more secure and allow the procedure to be accomplished more efficiently.

Persons who are depressed may be so preoccupied that they do not respond to outside stimuli. It

may be necessary for the radiographer to give the same instructions a number of times to a depressed person, and then to assist the patient in following those directions.

When an examination of the geriatric patient is complete, the radiographer must assist him to return to the dressing room or to the lavatory, because the stress of the procedure may result in forgetfulness. The radiographer must make certain that the patient is attended before leaving him. The elderly patient must not be left alone in the radiographic imaging room as he may become confused and may be in danger of falling from the examining table.

CHANGES ASSOCIATED WITH AGING

Older adults may not have the same symptoms of a disease as a younger adult. They may have nonspecific symptoms such as dizziness, falls for no apparent reason, infection without fever, or urinary incontinence, to name a few. These are symptoms of disease and not a part of the normal aging process. The radiographer must be able to differentiate what is normal from what is pathological.

As aging progresses, the body systems change in a gradual manner. A brief overview of how the body systems change with normal aging, as well as the precautions the radiographer must consider because of these changes, follows.

The Integumentary System

Normal Changes of Aging

The skin wrinkles, becomes lax, and loses turgor.

The vascularity of the dermis decreases and the skin of white people begins to look paler and more opaque.

Skin on the back of the hands and forearms becomes thin and fragile.

Areas of skin lose pigment; purple macules and senile purpura may appear as a result of blood leaked through weakened capillaries.

Brown macules called *senile lentigines* appear on the backs of the hands, on the forearms, and on the face.

Seborrheic keratoses and actinic keratoses may develop.

Nails lose their luster and may yellow and thicken, especially the toenails.

Hair loses its pigment and begins to gray.

Hair patterns change and the hair becomes thin and more brittle.

There is hair loss on the scalp and other body areas.

Many skin changes listed above occur only in white races and are not normal in persons of dark-skinned races.

IMPLICATIONS FOR THE RADIOGRAPHER The skin of the geriatric patient is more fragile than that of a younger person and is thus more easily traumatized. Care must be taken to ensure that the skin of the elderly patient is not damaged. The preventive measures listed in Chapter 4 must be utilized at all times.

Changes in the Head and Neck

Normal Changes of Aging

There is a mild loss of visual acuity, particularly presbyopia (loss of ability to focus on near objects).

The light-sensing threshold is affected and adaptation from light to dark and color perception diminishes.

Tear production is either reduced or increases.

The skin of the eyelid loosens and the muscle tone decreases.

Sensory, neural, and conductive changes occur in the ear.

Hearing loss is common.

There is loss of muscle mass in the neck.

There is an accentuated forward upper thoracic curve, which may result in kyphosis.

The sense of taste and smell decreases.

IMPLICATIONS FOR THE RADIOGRAPHER Rapid changes in lighting, such as moving from a briefly lighted waiting room into a darkened examining room, may cause the elderly patient momentary blindness. The radiographer must offer patients assistance so that they do not fall.

Loss of sense of smell and hearing loss must be considered. The radiographer must ascertain that the patient is able to hear his directions and must speak loudly enough for him to understand what is being said. It must not be assumed, however, that all older persons have a hearing deficit and need to be spoken to in an abnormally loud voice.

The Pulmonary System

Normal Changes of Aging

Pulmonary function changes with age; lung capacity diminishes due to stiffening of the chest wall, among other changes.

The cough reflex becomes less effective.

Exercise tolerance decreases.

The normal respiratory defense mechanisms lose effectiveness.

IMPLICATIONS FOR THE RADIOGRAPHER The patient will become breathless and fatigue more easily. Due to the decreasing effectiveness of the cough reflex, the patient is more apt to aspirate fluids when drinking. There will be an increased risk of pulmonary infections resulting from the loss of respiratory defense mechanisms. A patient with chronic pulmonary disease cannot be expected to lie flat for more than brief periods of time as this position increases dyspnea.

The Cardiovascular System

Normal Changes of Aging

There are structural changes in the heart as aging progresses.

The coronary arteries calcify and lose elasticity.

The aorta and its branches dilate and elongate; the heart valve thickens.

There is a decline in coronary blood flow.

The baroreceptors in the aorta and internal carotid arteries become less sensitive to blood volume and pressure changes.

IMPLICATIONS FOR THE RADIOGRAPHER Owing to normal cardiovascular changes of aging, the elderly patient tires more easily; imaging examinations and procedures should be conducted in as efficient a manner as possible to avoid fatigue. If a procedure is unavoidably lengthy, the patient must be allowed to rest at intervals.

Hypothermia and complaints of feeling cold are common problems for the elderly patient because of decreased circulation; therefore, it is important to avoid chilling.

One fourth of people over age 65 have postural hypotension (a drop in systolic blood pressure of 20 to 30 mm Hg) for 1 to 2 minutes after changing from a prone to a standing position. Rapid position changes will result in a feeling of dizziness and the patient may fall. The radiographer must always assist the elderly patient to a sitting position for a short time before he stands and steps off of the radiographic table. This allows him to adjust to the new position before walking.

The Gastrointestinal System

Normal Changes of Aging

There is decreased gastric secretion, absorption, and motility.

There is a predisposition to dryness of the mouth, and the swallowing reflex becomes less effective.

The abdominal muscles weaken.

There is a decrease in absorption of iron, vitamin B_{12} and folate, with resulting potential for anemia.

Many elderly patients will be edentulous (without teeth) or the teeth present will be decayed or the gums diseased. Many have full dentures or partial plates.

Esophageal motility declines.

The tone of the internal anal sphincter decreases.

IMPLICATIONS FOR THE RADIOGRAPHER If the patient is required to fast prior to a diagnostic examination, the examination should be scheduled for the early morning so that the patient can have his breakfast close to the usual time.

Medications may not be dissolved and absorbed from the stomach as effectively or as they are meant to be. Ability to swallow is also affected. This may impair the elderly patient's ability to drink liquid contrast agents. The radiographer must instruct the patient to drink slowly to avoid choking. The patient who must drink liquid in the imaging department must be positioned in an upright sitting position to prevent aspiration.

The radiographer must be cautious when dealing with the patient's dentures or partial plates. If they must be removed for some reason, they should be placed in a plastic denture cup and put in a place where they will not be broken or lost. They should be returned to the patient as soon as it is possible to do so safely.

The elderly patient may have a difficult time holding barium during a lower gastrointestinal examination due to loss of sphincter control. This potential problem must be considered when planning care.

The Hepatic System

Normal Changes of Aging

The liver size decreases.

There is a decrease in enzyme activity and a decrease in the synthesis of cholesterol.

There is reduced bile storage.

IMPLICATIONS FOR THE RADIOGRAPHER The elderly person has an increased potential for drug toxicity as most drugs are metabolized in the liver. The radiographer must be alert for adverse drug reactions in the elderly patient.

The Genitourinary System

Normal Changes of Aging: Females

There is a decrease in muscle tone and bladder capacity.

Pubic hair becomes sparse.

There is vaginal atrophy.

There is an increase in involuntary bladder contractions.

Normal Changes of Aging: Males

There is a reduction in the capacity of the urinary bladder by 500 to 900 mL.

The prostate gland enlarges and the tone of the bladder neck increases.

There is a decrease in the size of the penis and testes due to sclerosis of blood vessels.

There is a change in sexual response in males and females, but both can remain sexually active, if they are healthy, into the seventh or eighth decade of life.

IMPLICATIONS FOR THE RADIOGRAPHER Loss of muscle tone in the female genitourinary system may make the patient more susceptible to urinary incontinence in stressful situations. Both the elderly male and female patient may have a limited bladder capacity and need to urinate more frequently. The radiographer caring for the elderly patient should have a bedpan and urinal available for patients who cannot use the lavatory easily.

The Musculoskeletal System

Normal Changes of Aging

There is a loss of bone mass and bones become weaker.

There is a decrease in muscle mass. Muscle cells decrease in number and are replaced by fibrous connective tissue.

Muscle strength decreases.

Intervertebral discs shrink and vertebrae collapse, resulting in shortening of the spinal column.

Articular cartilage erodes.

The normal lordotic curve of the lower back flattens.

Flexion and extension of the lower back are diminished.

Placement of the neck and shaft of the femur change.

Posture and gait change. In men, the gait narrows and becomes wider based. In women, the legs bow and the gait is somewhat waddling.

IMPLICATIONS FOR THE RADIOGRAPHER Increased muscular weakness increases a patient's discomfort when he is expected to assume positions necessary for imaging procedures. Painful joints and deformities accompanied by decreased tolerance for movement will also increase discomfort.

The radiographer must assist the patient to the required position and then support him with sandbags or blocks to facilitate maintaining that position. The risk of falls increases when caring for elderly patients owing to musculoskeletal changes. It is the radiographer's obligation to assist patients in positioning and in getting on and off of the radiographic table to prevent falls.

The Neurological System

Normal Changes of Aging

There is a change in brain weight that may be due to reduced size of neurons.

In the absence of disease, there is little change in the ability to store information; however, there is some short-term memory loss.

There is a normal loss of speed in learning and processing information.

There is a decrease in sensorimotor function.

There is a decrease in reaction time to both simple and complex stimuli.

The time needed to perform activities increases.

The lens of the eye thickens, making the pupils of the eye appear smaller.

There is a decrease in postural stability that is greater in women than in men.

A decrease in proprioception creates problems with spatial relations.

There is a loss of sensitivity to deep pain.

IMPLICATIONS FOR THE RADIOGRAPHER The radiographer must remember that the elderly patient will be less responsive to painful stimuli and will not be aware of a painful stimulus until an injury has occurred. The radiographer must increase his awareness of potential for patient injury.

The elderly person will process information and directions in a slower fashion. The radiographer must be certain that his patient understands his directions and must allow him more time to execute his moves. The elderly patient will have visual problems in the dim light of the radiographic imaging department. He will also need guidance to avoid colliding with objects that are not seen quickly. The radiographer will be responsible for preventing this type of accident.

CULTURE AND AGING

The culture of the patient is reflected in his attitude toward aging, illness and its treatment, pain, death, and dying. Some elderly patients are accepting of whatever treatment the physician and other health care workers offer. Others require a detailed explanation and reassurance at every step. The relationships between the patient and his caregiver will also vary with the cultural beliefs of the patient and his family.

There will be some caregivers who are highly solicitous and anxious concerning the treatment that their relative is to receive. Others will leave the patient in the health care workers' hands and attend to other affairs.

The radiographer's teaching plan during and following a procedure must be performed with the patient's cultural differences in mind. In some societies, it is understood that the adult child who is the caregiver will attend to every detail of a parent's medical treatment, while in others the patient himself is expected to know and understand how to conduct his care. If a caregiver is to oversee the patient's care, he should be included in the instruction. If this is not the case, the patient will need careful and complete direction. Whatever the culture of the patient, the radiographer must take these differences into consideration. If this is done, the examination or treatment will be more comfortable for the patient and will prevent conflict with caregivers.

Traumatic Injuries

The radiographer is one of the first members of the health care team to see the patient admitted to the emergency unit following traumatic injury or acute illness. Trauma patients can have a single injury or multiple injuries. When the radiographer is called to the emergency unit to take diagnostic radiographs, he must assume that he will be exposed to the patient's blood or body fluids. To prevent infecting himself or the patient, the radiographer must always have clean disposable gloves available before beginning the assignment. Gloves, mask, goggles, and a protective gown or apron should be worn when caring for a patient who is hemorrhaging or who is nauseated and vomiting. If it is necessary to touch an open wound, sterile gloves must be worn.

Many patients admitted to the emergency unit are in severe pain. The radiographer will be required to assist in diagnosing the extent of injuries or illness by taking a series of radiographs. This requires patience and skill. The goal of the assignment must be accomplished without extending injuries or increasing the patient's discomfort. Usually, time for achieving the goal is brief as the patient's life is at risk.

If the patient is transferred from the emergency room to the radiographic imaging department for radiographs, the radiographer must observe the injured or acutely ill patient for symptoms of shock. The patient's neurological status and level of consciousness must be assessed prior to beginning the assignment and reassessed every 5 to 10 minutes while the patient is in the department. If any changes are observed in the patient's condition, the radiographer must quickly alert the physician and the emergency team and prepare to assist with emergency measures as outlined in Chapter 7. General guidelines to follow when caring for a patient who has traumatic injuries are as follows:

1. Do not remove dressings or splints.
2. Do not move patients who are on a stretcher or backboard until ordered to do so by the physician in charge of the patient. The quality of the radiographic films may have to be sacrificed for the patient's safety.
3. Request direction from the physician when planning moves and assemble adequate assistance to move the patient safely and as painlessly as possible.
4. Do not disturb impaled objects. Support them so that they do not move as you work with the patient.

5. Do not remove pneumatic antishock garments.
6. Have oxygen, suction equipment, and an emesis basin ready for use.

The Patient With a Head Injury

Injuries to the head are exceedingly common. Each year approximately 10 million head injuries are predicted to occur in the United States. The term *head injury* may refer to any injury of the skull, the brain, or both, that requires medical attention. The radiographer will be called upon frequently to make diagnostic radiographs of patients brought into the emergency suite with a head injury. These injuries are all potentially serious because they may involve the brain, which is the seat of consciousness and controls every human action.

There are two basic types of head injury, open and closed. With an open injury to the skull or meninges, the brain is vulnerable to damage and infection because its protective casing has been broken. If the injury is closed (also called a *blunt injury*), the brain tissue may swell; the swelling is limited by the confines of the skull, and the resulting pressure may cause extensive brain damage. The brain has little healing power, so any injury to it must be considered potentially permanent and serious.

Fractures at the base of the skull (*basal skull fractures*) often have accompanying fractures of the facial bones. This type of injury may result in a tear in the *dura mater*, the outer membrane surrounding the brain and spinal cord, and a leakage of cerebrospinal fluid may result.

The radiographer must consider all patients with head injuries to have accompanying cervical spinal injuries until it is medically disproven. Precautions to alleviate potential extension of these injuries must be taken as a matter of routine.

Signs and Symptoms of Head Injury

Closed Injury

Varying levels of consciousness, ranging from drowsiness, confusion, irritability, and stupor to coma

Lucid periods followed by periods of unconsciousness possible

Loss of reflexes

Changes in vital signs

Headache, visual disturbances, dizziness, and giddiness

Gait abnormalities

Unequal pupil dilation

Seizures, vomiting, and hemiparesis

Open Injury

Abrasions, contusions, or lacerations apparent on the skull

A break or penetration in the skull or meninges apparent by inspection or on radiographs

Basal fractures may result in leakage of cerebrospinal fluid, demonstrated by leakage of blood on the sheet or dressing surrounded by a yellowish stain (the halo sign). Cerebrospinal fluid may leak from the nose, ears, or as a postnasal drip.

Varying levels of consciousness

Subconjunctival hemorrhage

Hearing loss

Perioribtal ecchymosis (raccoon's eyes)

Facial nerve palsy

Radiographer's Response

1. Keep the head and neck immobilized until injury to the spinal cord is ruled out by the physician.
2. If possible, the patient's head is elevated 15° to 30°.
3. Do not remove sandbags, collars, or dressings. Take all radiographs with these in place.
4. Do not flex the neck or turn it to either side. Rotation of the head may increase intracranial pressure.
5. Keep patient's body temperature as normal as possible. Do not allow the patient to become chilled or overheated.
6. Check the patient's pulse and respirations frequently while working with him.
7. Observe for airway obstruction.
8. Apply a sterile pressure dressing if bleeding becomes profuse, and call for emergency assistance.
9. Observe the patient for signs and symptoms of hypoxia and changes in level of consciousness. If a patient who is initially alert and cooperative suddenly appears to be

drowsy or slow to respond, notify the physician in charge of the patient immediately.

10. Be prepared to assist with oxygen administration and other emergency treatment. Patients with head injuries must not be suctioned through nasal passages.

The Patient With a Facial Injury

Injuries to the facial bones are usually associated with injury to the soft tissues of the face. Often these injuries do not seem serious, but they are all potentially disfiguring. The radiographer must treat all patients who have serious facial injuries as if they also have basal skull fractures and injuries of the cervical spine until such injuries are ruled out.

Signs and Symptoms

Misalignment of the face or teeth

Pain at site of injury

Ecchymosis of the floor of mouth and buccal mucosa

Distortion of facial symmetry

Inability to close the jaw

Edema

Abnormal movement of face or jaw

Flatness of the cheek

Loss of sensation on side of injury

Diplopia (double vision)

Blindness caused by detached retina

Nosebleed (epistaxis)

Conjunctival hemorrhage

Paresthesia

Halo sign (indicates basal skull fracture with leaking cerebrospinal fluid)

Changes in level of consciousness; unconscious patient may have respiratory distress or failure caused by obstruction of tongue, loose teeth, bleeding, or other body fluids in airway.

Radiographer's Response

1. Observe for airway obstruction. Watch for noisy, labored respiration.
2. Do not remove sandbags, collars, or other supportive devices or move a patient unless supervised by his physician.
3. Apply a sterile pressure dressing if bleeding is profuse, and call for assistance.
4. Patients must not have suction through nasal passages performed on them.
5. Wear sterile gloves if in contact with open wounds.
6. If you find teeth that have fallen out, place them in a container moistened with gauze soaked in sterile water.
7. Be prepared to assist with oxygen and other emergency treatment if necessary.
8. Observe for symptoms of shock; notify physician in charge if condition of patient or level of consciousness changes.

The Patient With a Spinal Cord Injury

The spinal cord carries messages from the brain to the peripheral nervous system. It is housed in the vertebral canal, which extends down the length of the vertebral column. The spinal column is protected by the fluid in the canal and by the vertebrae---the bony structures encircling the canal. Motor function depends on the transmission of messages from the brain to the spinal nerves on either side of the spinal cord. Injury to or severing of the spinal cord causes message transmission to cease. The result is a cessation of motor function and partial or complete cessation of physical function from the level of damage to the cord to all parts below that level.

Most spinal cord injuries occur in the cervical or lumbar areas because these are the most mobile parts of the spinal column. The spinal cord loses its protection when there is injury to the protective vertebrae, and such an injury may result in compression or partial or complete severing of the cord. Spinal cord tissue, like brain tissue, has little healing power; injuries to it usually cause permanent damage.

The radiographer will be among the first health care workers to attend the patient with a possible spinal cord injury to assist in making the diagnostic assessment of the injury. If signs or symptoms of cervical spine injury are present, the patient will need a full cervical spine series. Great care must be

taken in obtaining these radiographs to prevent extending the existing damage to the spinal cord. A cross-table lateral radiograph may be taken in the emergency suite without moving the patient or removing the back brace, collar, or sandbags used to immobilize the spine (Fig. 8–7). The radiographer must remember that any movement can result in bone fragments or unstable vertebrae compressing the spinal cord and extending the injury.

Signs and Symptoms

Complete Transection of Spinal Cord

Flaccid paralysis of the skeletal muscles below the level of the injury

Loss of all sensation (touch, pain, temperature, or pressure) below the level of injury; pain at site of injury possible

Respiratory distress

Bradycardia

Loss of body temperature control

Absence of somatic and visceral sensations below the site of the injury

Unstable, lowered blood pressure

Loss of ability to perspire below level of injury

Bowel and bladder incontinence

Possible priapism in males

Partial Transection of Spinal Cord

Asymmetrical, flaccid paralysis below level of injury

Asymmetrical loss of reflexes

Some sensory retention: feeling of pain, temperature, pressure, and touch

Some somatic and visceral sensation

More stable blood pressure

Ability to perspire intact unilaterally

Possible priapism in males



Figure 8–7
If a spinal cord injury is suspected, a cross-table lateral radiograph is taken without moving the patient.

Radiographer's Response

1. Monitor vital signs.
2. Maintain an open airway. If respirations change, notify physician at once and call for assistance. If in respiratory failure, use jaw-thrust maneuver to move jaw downward. Do not tilt the head.
3. Do not allow or request that the patient move for radiographs. Patient must be log rolled with a synchronized move supervised by the physician.
4. Do not move head or neck if position is awkward.
5. Do not remove sandbags, collars, antishock garments, backboard, or other supports until diagnosis is confirmed and physician supervises the removal.
6. Observe for signs and symptoms of shock.
7. Keep patient warm.
8. If patient is a trauma victim and is unconscious, assume spinal cord injury and treat as such until directed to do otherwise by the patient's physician. All patients with head injuries should be assumed to have cervical spine injuries and be treated as such.

The Patient With a Fracture

A fracture may be defined as a disturbance in the continuity of a bone. Fractures can be classified simply as open or closed. The term *open* fracture indicates a visible wound that extends between the fracture and the skin surface. The broken bone itself often breaks through the soft tissue, making the fracture clearly visible.

A *closed* fracture may not be obvious to the untrained eye. Often there is swelling around the injured area, pain, and a deformity of the limb. All or some of these symptoms may be absent and a closed fracture still be present.

Internal injuries caused by fractures of the pelvic bones are a leading cause of death following motor vehicle accidents. The radiographer caring for trauma patients must always consider the possibility of a fractured pelvis when caring for patients with multiple traumatic injuries. Extreme caution must be used when making initial diagnostic radiographs because the slightest movement may initiate hemorrhage or irreparable damage to a vital organ. Patients with suspected pelvic fractures may be on a backboard or in pneumatic antishock garments. These are radiolucent and must remain in place during initial assessment radiographs. At times, it may be feasible to move the patient to the radiographic table on the backboard that has been placed by the emergency team as this device allows the patient to remain immobilized.

A large number of trauma deaths result from blunt or penetrating trauma to the thorax. Multiple rib fractures can cause a flail chest, which in turn may result in pneumothorax (air or gas in the pleural space that collapses the lung) or hemothorax (blood in the pleural space). Fractured ribs are extremely painful and can be life threatening. Stab and gunshot wounds can also cause fractures to the ribs and hemorrhage into the pleural cavity. The radiographer working with patients who have suffered this type of trauma must work quickly while observing the patient for symptoms of shock due to hemorrhage. He must also avoid causing further pain or extending injuries.

Hip fractures and fractures of the femur are common among elderly patients as a result of bony changes related to age and disease (Fig. 8–8). These fractures are a common result of home accidents in elderly patients and must be treated with utmost care by the radiographer to prevent extension of the injury.

Signs and Symptoms

Pain and swelling

Functional loss

Deformity of the limb

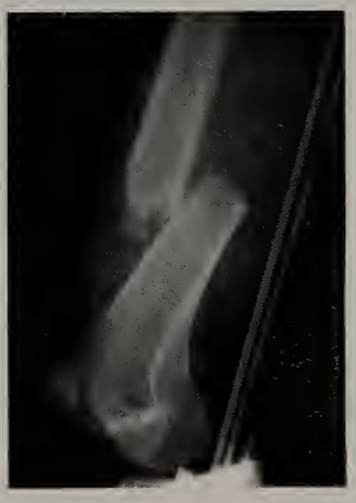


Figure 8–8
Open or comminuted fracture of the distal femur. (Farrell J, Illustrated Guide to Orthopedic Nursing, 3rd ed. Philadelphia, JB Lippincott, 1986, p. 44.)

Grating sound or feel of grating (crepitus) if moved

Discoloration of surrounding tissue caused by hemorrhage within tissue (closed fracture)

Overt bleeding (open fracture)

Possible signs and symptoms of shock

Radiographer's Response

1. Keep affected limb or body part immobilized.
2. Any patient movement must be directed by the physician in charge of the patient.
3. Inform the patient of any intended moves and enlist his support.
4. Do not remove splints or other supportive devices.
5. In moving a splinted limb, support the joint and support the limb both above and below the fracture. Move the limb with one person at the distal end and one at the proximal end. On a specified signal, the limb must be moved as a single unit (Fig. 8–9).
6. If there is an open fracture, wear sterile gloves if in contact with the wound, and use strict infection control measures.
7. Observe the patient for signs and symptoms of shock, and be prepared to act if that emergency should occur.

The Patient With Abdominal Trauma or in Acute Abdominal Distress

There are a number of causes of acute abdominal distress, and many of these are life threatening. Among them are blunt or penetrating trauma resulting in internal and possible external hemorrhage, appendicitis, bleeding ulcers, ectopic pregnancy, cholecystitis, pancreatitis, and bowel obstruction. Whatever the cause of the distress, the symptoms are somewhat similar and, for the radiographer's purposes, may be grouped together. It will be the radiographer's responsibility to take the diagnostic radiographs as quickly as possible and with the least possible discomfort to the patient. An assistant may be needed to help position and move the patient who is too ill to assist. Patients in acute abdominal distress are frequently sent to the operating room for a surgical procedure following diagnosis.



Figure 8–9
Move a patient with a splinted limb with one person at the distal end and one at the proximal end. The limb must be moved as a single unit.

Signs and Symptoms

Possible abrasions, lacerations, entry and exit bullet wounds, seat belt contusions

A rigid abdomen

Severe abdominal pain

Nausea and vomiting

Extreme thirst

Possible symptoms of hypovolemic shock

Radiographer's Response

1. Do not remove antishock garment.
2. If patient has open wounds, wear gloves; sterile gloves are indicated if in direct contact with the wound.
3. Call for assistance if the patient is too ill to help move himself.
4. If the patient is unable to stand for upright exposures or maintain his position on a tilt table, use other means of obtaining necessary radiographs.
5. Transport the patient by gurney.
6. Have an emesis basin and tissues prepared in case vomiting occurs.
7. Do not give the patient anything to drink or eat.
8. Observe for symptoms of shock and be prepared to call the emergency team.

The Patient Who Has Had Arthroplastic Surgery

Total joint replacement has become a common procedure in hospitals throughout the United States. The joints of many elderly persons become very painful because of degenerative joint disease and an operative procedure is done to replace the diseased joint with a prosthesis. Arthroplasty is also indicated for persons with joint diseases like rheumatoid arthritis or for persons with joint deformities due to injury. Although knee and hip arthroplasty are the most common, almost any joint that is malfunctioning can be replaced (Fig. 8–10).

Radiographs are frequently requested several days following arthroplastic surgery to determine the rate of the healing process and the ability of the patient to return to his daily activities. There are restrictions on movement and positioning ordered postoperatively by the patient's surgeon that must be followed by all health care workers involved in the patient's care to prevent damage to the new joint.

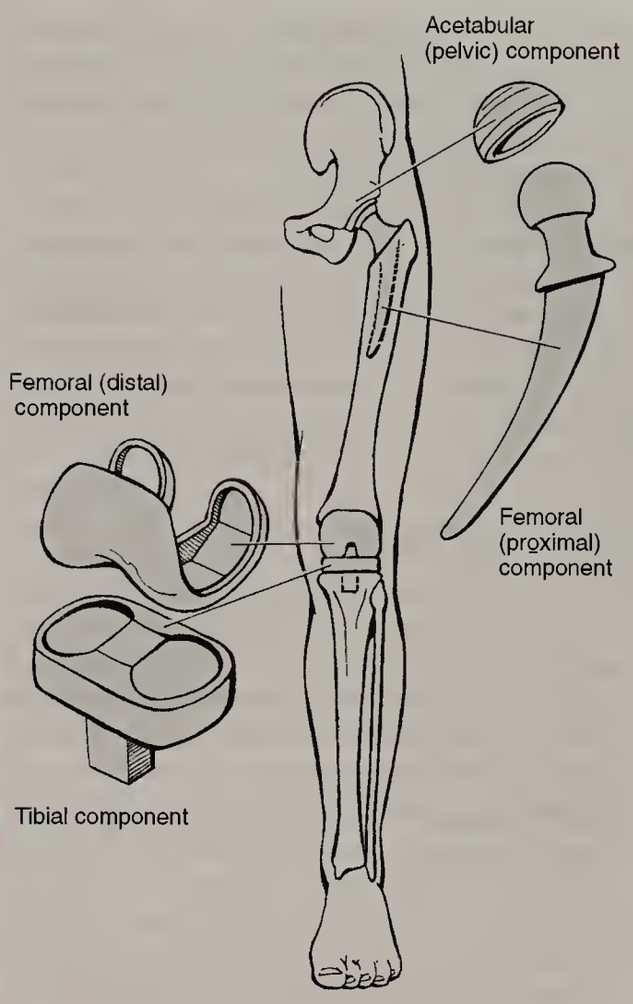


Figure 8–10
Hip and knee replacement. (Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996, p. 1868.)

Following hip replacement, the most common complication is dislocation of the prosthesis. Correct positioning following surgery is necessary to prevent this. The affected leg must be prevented from adducting and the operative hip must be kept in extension. A special pillow is sometimes used for this purpose; at other times, a regular, large pillow is used. When sitting in a chair, the patient's legs must remain uncrossed and his hips must not be flexed more than 90°. Weight bearing on the affected side is restricted for varying lengths of time depending upon the type of prosthesis chosen. The radiographer must understand the needs of the patient who has had an arthroplasty so that the patient will not be injured as he is cared for in radiographic imaging.

Following knee arthroplasty, the patient is sometimes placed on a continuous passive motion device. Weight bearing is restricted and restored gradually. The knee should not be hyperflexed and the patient should not kneel.

For shoulder and elbow arthroplasty, protocols for postoperative care are variable. Ankle replacement has not achieved widespread use at this time. Whatever the arthroplasty, the radiographer must understand the restrictions on weight bearing and movement for each patient and adhere to them in order to prevent irreparable damage to the joint involved.

Radiographer's Response

1. When the patient with a recent arthroplasty comes to the radiographic imaging department, the radiographer must understand and adhere to the limits that have been placed on the patient's weight bearing and mobility of the restricted joint.
2. Move patients who have had hip, knee, or ankle arthroplasty to and from the department by gurney. They cannot get onto and off of the radiographic table without placing weight on the affected limb. Move patients toward their affected side in this situation.
3. Following hip arthroplasty, do not allow the affected leg to adduct (move toward the center of the body). Keep a pillow or block between the legs to prevent this.
4. Do not position the patient with weight on the surgical incision site.
5. If the patient is sitting, prevent hip flexion beyond 90°.
6. Do not hyperflex affected joints.

The Agitated or Confused Patient

Patients with emotional problems may come to the emergency suite for treatment that requires diagnostic radiographs, or patients who are hospitalized in mental health units may require diagnostic imaging procedures. These patients are frequently agitated or confused and may become combative.

Patients who react in a combative or aggressive manner usually do so because they are frightened or feel that they have no control over what is happening to them. They resort to violent behavior as a means of self-protection. This behavior may be caused by chemical abuse or by psychosis of varying etiologies. At times, the confused elderly patient forgets that he is not at home and mistakes the radiographer for an intruder from whom he must protect himself by attack. Whatever the cause, the radiographer must take precautions to protect himself and the patient when threatened with this type of behavior.

Patients whom the radiographer can predict will demonstrate combative behavior are those who have a history of such outbursts or a history of growing confusion and disorientation. Other warning signals are increasing agitation demonstrated by rapid pacing back and forth across the room; a patient in animated and increasingly noisy conversation with a person who is not present; a demonstration of illogical thought processes; refusal to cooperate; distrust of the radiographer and his explanation of a procedure; and examination of the diagnostic imaging room or equipment unnecessarily. Patients who are combative may occasionally display no emotion at all or display irrational fear of a procedure.

Before approaching a patient who is not reacting in a rational manner, the radiographer should discuss the case with nursing personnel or with the patient's physician. If the patient is behaving in a combative manner or has a history of combativeness, the radiographer should request assistance with the examination. It is wise to trust first instincts about a patient's behavior. The radiographer should not isolate himself with a potentially assaultive patient. A door should always be left open, and a direct path cleared so that the radiographer is able to leave the room if necessary. If the patient is apt to become violent, the radiographer should not begin the procedure without assistance from a person who can protect him and the patient, if necessary. The person often chosen to assist in these situations is a security officer.

At times, patients who are agitated or confused react more favorably to persons of a specific sex. If this seems to be the case, having a radiographer of the preferred sex conduct the procedure will be helpful.

It is best to approach a patient who is agitated or confused from the side, not face to face. The radiographer should never touch a confused or agitated patient without first asking his permission and explaining what he is planning to do. Simple, concise statements should be used to explain the purpose of the radiographer's visit. The radiographer should call the person by his name. An angry

person is given the opportunity to express his anger. There should be no attempt made to defend or try to reason with the patient.

If the patient is speaking in a delusional or irrational manner, it is important that the radiographer not become involved in his conversation. To do so might increase his agitation.

If the patient refuses to proceed, the radiographer simply stops what he is doing and returns him to his quarters. The radiographer explains that he will complete the examination at a later time. To continue to work with an agitated and confused person who is belligerent may cause injury to the radiographer or to the patient.

If the radiograph is essential to the patient's treatment, he will have to be restrained and supervised by persons in the hospital who are educated to care for such patients. Use of immobilizers is explained in Chapter 4.

If the situation escalates beyond control and the patient is actually prepared to strike out at those around him, the radiographer should put as much distance as possible between him and the patient. Proceed as follows:

1. Speak in a calm but firm voice to the patient.
2. Let him know that you are uneasy and ask what can be done to appease him.
3. Ally yourself with the patient by making statements such as, "You must be really angry at the people here for putting you through all of these tests."
4. If this does not work, get out of the area and summon help. Do not approach the patient or make any effort to take anything out of his hands.

The Intoxicated Patient

Patients who are intoxicated are often involved in accidents that result in injuries to themselves and to others. When the intoxicated patient is brought to the emergency unit for care, he may be quarrelsome and reluctant to cooperate; he may also neglect all rules of safety while being treated and may inadvertently fall from a gurney or radiographic table.

The radiographer caring for an intoxicated patient should keep communication simple, direct, and nonjudgmental. He should not become involved in an intoxicated patient's attempts to argue. If the patient refuses treatment or becomes increasingly difficult to manage, the radiographer should call for help immediately. He must not attempt to complete his assignment until there is adequate assistance to do so safely. The patient must not be left alone and must be observed at all times to prevent falls. One or two strong persons may be needed to assist the radiographer who is taking radiographic films of an intoxicated person.

Often, an intoxicated patient is accompanied by a person who is also intoxicated and belligerent. The companion may become aggressive and combative. If the radiographer assesses such a situation, the intoxicated companion should not be allowed to come into the examining room with the patient. The companion is simply informed that it is against the rules of radiation safety to be present and that he must therefore wait outside. If this request is debated, the radiographer stops the assignment and calls for assistance. Under no circumstances should an intoxicated patient be allowed to leave the health care facility accompanied by an intoxicated companion. If necessary, the radiographer must notify the police to prevent this.

The Patient in His Home

The home is rapidly becoming one of the major areas for health care. As the cost of hospital care increases, the patient is being discharged from the hospital, in many instances, while he is still acutely ill. This change requires members of the health care team to go to the patient in his home to continue care. The radiographer may be required on occasion to go to a patient's home to take portable radiographs.

In order for a patient to be eligible for health care in his home, he must be acutely ill, homebound, and in need of skilled nursing care. The cost of home health care is usually paid for by Medicare, Medicaid, or private health care insurance, although it may be paid for by the individual recipient. The majority of home health care visits are paid by Medicare as the greatest need for home care is for the elderly patient.

Radiography in the home must be ordered by the patient's physician and, if the patient has private health care insurance, approved by the insurance carrier as well. The radiographer who goes to a private home must expect some differences in his methods of delivering care. He must realize that he is a guest in the patient's home and, as such, has little control of the environment in

which he works. The cleanliness, organization, and general environment may not be as he would like; however, he must realize that he is not in control of these aspects of the patient's care and must work within the limits of each situation. At the same time, he must practice sound medical aseptic technique, patient safety, and radiation safety procedures as he would in his own professional environment. He must also adhere to the rules of patient confidentiality.

Use of therapeutic communication techniques to establish rapport with the patient and the patient's caregivers is the first step toward a successful home visit. The radiographer must then prepare the patient for the prescribed radiographs by instructing him in what is to be done and planning the procedure with the patient. If the patient is unable to participate in planning the procedure, his caregiver will be asked to assist in planning. The patient and caregiver must be instructed in the requirements of radiation safety. When the assignment is complete, the radiographer must be certain that the patient is safe and that the caregiver understands that the visit is over and that the patient's physician will inform the patient and caregiver of the results of the radiographs.

Summary

The pediatric patient ranges in age from newborn to 15 years of age. The radiographer must relate to all patients with whom he works in an appropriate and specific manner, regardless of their age. The infant is usually accompanied by his parents. The radiographer should attempt to ease their anxiety by giving them an explanation of the procedure to be performed and the approximate amount of time it will take.

If it is necessary to immobilize the child, the reasons for this procedure should be explained to the child, if he is old enough to understand, and to his parents. If it is necessary to immobilize a child, an immobilizer made of soft material such as a sheet may be used. If the child is to be immobilized by being held, it should be done in a firm, safe manner in order to prevent injury to the child. A radiographer should never place his body over a child as an immobilizer. A sheet immobilizer or one manufactured commercially may be less traumatic for the patient and more effective. Protective garments and shields should be worn by persons immobilizing a child to prevent exposure to radiation.

The radiographer must assess each elderly patient in order to determine his special needs. He must understand that one cannot generalize concerning the disabilities of aging because they vary in each individual. He must be able to distinguish the physical limitations that are part of the normal aging process from those resulting from disease processes.

The radiographer should follow the general precautionary guidelines when assigned to care for patients with traumatic injuries. He must also remember to follow universal blood and body fluid precautions when called to the emergency unit.

Patients with a spinal cord injury must be moved in a specific manner and only with specific directions from the physician in charge. Supportive devices should not be removed without physician's orders.

Patients with head injuries and facial injuries should be treated as though they also have spinal cord injuries until it is verified that they do not. Basal skull fractures must also be considered if the patient has injuries to the facial bones. Patients with these injuries should not be moved for initial diagnostic radiographic films without orders from the physician in charge of their care or without his supervision.

While the radiographer is working with trauma patients, he should be observing for changes in the level of consciousness, mental status, hemorrhage, shock, and respiratory distress. Patients with fractured extremities should also be moved with great care and under their physician's supervision so that the movement does not increase their pain or extend the injury. If splints or antishock garments are in place, they must not be removed. Strict aseptic practices must be used for patients with open fractures to prevent infection.

Abdominal trauma and acute abdominal distress are also emergencies. Patients with acute abdominal pain are often very ill and are unable to assist the radiographer. Radiographs should be made as quickly and gently as possible. An assistant should be on hand to help the radiographer move the patient in severe pain. The patient may not be able to be placed in an upright position while the exposures are being made. If this is so, other methods of obtaining the necessary diagnostic information must be used. These patients should be transported by gurney.

Patients who have had joint replacement surgery have specific postoperative orders for care. The radiographer is obligated to inquire about the patient's restrictions concerning mobility and weight bearing. Patients who have had a knee, hip, or ankle arthroplasty must be transferred to and from the radiographic imaging department by gurney as they are not able to get on and off of the radiographic table without placing weight on the af-

fected joint. Patients who have had hip arthroplasty must not adduct the affected leg and, when sitting, must not flex their hip more than 90°. Patients who have had knee arthroplasty must not flex their affected joint more than 90°.

The radiographer may have to work with patients who are agitated, confused, and potentially assaultive. The cause may be chemical abuse, psychosis, or confusion due to stress, as is occasionally the case in the elderly patient. The radiographer must be cautious in his approach to patients with this type of problem in order to protect himself and the patient from injury. If the patient refuses treatment, the radiographer should immediately comply with his refusal and return him to his quarters. If the radiographs are essential to the patient's treatment, the radiographer should be assisted by personnel who are educated in the care of mentally disturbed patients.

When caring for an intoxicated patient, the radiographer must behave in a nonjudgmental manner and address the patient simply and directly. If the safety of the patient or the radiographer is threatened, the radiographer must not continue his work until there is adequate personnel present to complete the assignment safely.

Home health care is increasingly common. The radiographer may be assigned to make a home radiography visit. If this is the case, he must remember that he is a guest in the home and cannot control the environment as he would in his own department. He must, however, adhere to the same rules of radiation safety and medical asepsis that apply in the department.

Chapter 8, Pre–Post Test

1. List four considerations the radiographer must incorporate into his communication with a child.

2. Describe the variations in communication the radiographer must use in communicating with an adolescent.

3. Describe symptoms a child may display that may indicate abuse.

____ 4. Describe the normal changes of aging as related to the following body systems:
   - **a.** Integumentary system
   - **b.** Cardiovascular system
   - **c.** Pulmonary system
   - **d.** Hepatic system
   - **e.** Gastrointestinal system
   - **f.** Neurological system

a 5. When caring for a pediatric patient, the best method of transport is always
   - **a.** A gurney
   - **b.** Carrying the child
   - **c.** A crib
   - **d.** Depends on the distance involved and the age of the child

6. Explain the normal changes of aging as related to each body system.

b 7. Confusion and other symptoms of dementia are to be expected in an elderly patient as they are part of the normal aging process.
   - **a.** True
   - **b.** False

c 8. Eighty percent of death in persons aged over 65 is due to
   - **a.** Trauma, peritonitis, and emphysema
   - **b.** Fractures, chemical abuse, and schizophrenia
   - **c.** Cancer, heart disease, and strokes
   - **d.** Diabetes mellitus, arthritis, and hypertension

____ 9. When a radiographer must schedule an elderly patient for a difficult diagnostic examination, it is best to schedule the examination for
   - **a.** Evening hours, so that the patient has the day to rest

b. Early morning hours so that the patient can have breakfast as close to the usual time as possible
c. In the middle of the day so that traffic is less hectic
d. At a time that is convenient for the radiographer

c **10.** When the radiographer is called to the emergency unit, he must expect to need
a. Gloves
b. A mask
c. A protective gown
d. Goggles
e. a, b, c, and d

11. List the guidelines the radiographer should follow when caring for a patient with a traumatic injury.

d **12.** The radiographer must consider that all patients with head injuries may also have
a. Fractures
b. Seizures
c. Shock
d. Cervical spine injuries
e. Changes in vital signs

e **13.** What precaution(s) must the radiographer follow when taking radiographic exposures of a patient who has a head injury?
a. Keep the head and neck immobilized until cervical spine injury is ruled out by the physician in charge
b. Wear sterile gloves if there are open wounds
c. Check the patient's vital signs frequently
d. a and b
e. a, b, and c

e **14.** What precaution(s) must the radiographer take when caring for a patient with a fractured extremity?
a. Support the joint above and below the fracture and at the joints if moving a splinted limb
b. Do not remove splints without direction of the physician in charge
c. Inform the patient before you move his fractured limb
d. none
e. a, b, and c

c **15.** When caring for a 6-year-old child, the radiographer should
a. Explain the procedure to the patient in great detail
b. Tell the patient that there will be no pain or discomfort, regardless of the type of examination
c. Be friendly, honest, and concise in his explanation to the child
d. Routinely immobilize the child to be examined

c **16.** Physiologic changes that come with aging that should be considered by the radiographer as he works with the elderly patient include
a. Loss of the sensation of pain
b. Loss of sensitivity to heat or cold
c. Diminishing gag reflex
d. Loss of the sense of humor
e. a, b, and c

b **17.** You have been assigned to radiograph Mr. J. J. He has been transported by the local police to the emergency room of the hospital in which you are employed. He is complaining of severe pain in his right leg. As you approach the patient, you notice that he is walking rapidly up and down the corridor. His head is bent and he is talking rapidly to persons who are not present. He occasionally stops, looks

up at the ceiling, and shouts that he has to "get them." Your best manner of dealing with this situation would be to

a. Walk directly up to the patient, introduce yourself, and explain your purpose in being there
b. Get an assistant, approach the patient from his side, stop slightly away from him, and explain your purpose
c. Tell the emergency room nurse to forget it
d. Have the male orderlies restrain the patient

e **18.** Assessment of the elderly should include

a. Ability to see and hear
b. Ability to move without assistance
c. Level of understanding
d. a and b
e. a, b, and c

19. List three factors that the radiographer must consider when caring for the patient with acute abdominal distress.

d **20.** If the agitated patient refuses to be radiographed, the radiographer should

a. Ask the patient to cooperate for just one more minute
b. Explain what he is going to do in short, concise statements
c. Call for help
d. Stop immediately and return the patient to his quarters

d **21.** Special care is necessary when caring for a patient whose brain or spinal cord might be injured, because

a. Extreme pain may result from the movement
b. This type of injury heals slowly
c. The incidence of infection is high
d. These tissues have very little ability to heal

22. Explain how the radiographer should deal with an intoxicated patient when assigned to his care.

23. List six precautions the radiographer must take when a patient who has had an arthroplasty is to have follow-up radiographs 4 days following surgery.

24. Explain the change in patient care emphasis if the patient is to be radiographed in his own home.

○ *Laboratory Reinforcement*

1. In the school laboratory, using a mannequin, demonstrate moving a patient who has a fractured femur.

2. Demonstrate in the school laboratory, using a pediatric mannequin, three methods of immobilizing a child.

Critical Thinking Problems

1. Jennifer is a 4-year-old Caucasian female who has been seen in the emergency suite this evening because of severe respiratory distress. She has a history of asthmatic attacks and her physician has ordered that she have radiographs of her lungs prior to hospital admission. She is accompanied by her mother who appears to be very anxious. How will you proceed?

2. Alice Anelly is an 84-year-old African American female who is scheduled for an upper gastrointestinal series. She has driven herself to the hospital and is waiting to be cared for. How will you proceed?

9

Care of Patients During Imaging Examinations of the Gastrointestinal System

Types of Contrast Media
Negative Agents
Barium Sulfate
Barium Studies of the Lower Gastrointestinal Tract
The Cleansing Enema
Saline Enemas
Hypertonic Enemas
Oil-Retention Enemas
Tap-Water Enema
Soap Suds (SS) Enemas
Self-Administered Cleansing Enema
Barium Enema
Patient Care Considerations During Examinations of the Lower Gastrointestinal Tract
Instructions Following Barium Studies of the Lower Gastrointestinal Tract
The Patient With an Intestinal Stoma
Administering a Barium Enema to a Patient With an Ostomy
Barium Studies of the Upper Gastrointestinal Tract and Small Bowel
Instructions Following Barium Studies of the Upper Gastrointestinal Tract
Scheduling Diagnostic Imaging Examinations
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Differentiate between positive and negative contrast agents.
2. Explain the radiographer's teaching responsibilities before, during, and after radiographic imaging examination of the gastrointestinal (GI) system.
3. List the potential adverse effects of positive contrast agents when they are used in imaging examinations of the GI system.
4. List the potential adverse effects of negative contrast agents when they are used in imaging examinations of the GI system.
5. List the types of cleansing enemas that the radiographer may need to instruct the patient to use before or after a GI series.
6. Explain the precautions that must be taken during administration of a barium enema or a cleansing enema.
7. Demonstrate the correct method of administering a barium enema and a cleansing enema in the school laboratory.
8. Describe the patient care precautions to be taken when assisting with upper and lower GI series.
9. Describe the patient care considerations for a patient with an ostomy who is having a barium enema.
10. Explain the correct order of scheduling radiographic imaging examinations if multiple examinations are ordered.

Glossary

Adverse effects: the development of undesired side effects or toxicity caused by the administration of drugs
Alimentary canal: the organs of digestion; the digestive tract
Anal sphincter: the circular muscle constricting the outer rectal opening
Anticholinergic: blocking of acetylcholine receptors in the body that results in the inhibition of parasympathetic nerve impulses
Arthroscopy: an examination of the interior of a joint performed by inserting a specially designed endoscope through a small incision in the skin
Aspiration pneumonia: inflammation of the lungs caused by foreign matter taken into the respiratory tract during inspiration
Barium granuloma: a formation of fiber-like growth of intestinal matter mixed with barium; usually caused by a perforation
Biliary: of or pertaining to bile or to the gallbladder and its ducts
Colostomy: an artificial opening (stoma) created in the large intestine and brought to the surface of the abdomen for the purpose of evacuating the bowels
Diverticulitis: inflammation of a sac or pouch protruding from walls of the intestines, especially the colon
Electrolyte imbalance: an imbalance in the body of sodium, potassium, calcium, magnesium, and phosphates, the chief conductive ions responsible for nerve and muscle activity and acid–base balance
Enterostomal therapist: a health care worker, usually a registered nurse, who is specially educated to assist patients who have had an ostomy to learn proper methods of caring for their ostomy sites and assist them to adjust to the body change emotionally
Fecal impaction: accumulation of putty-like or hardened feces in the rectum or sigmoid
Flatus: gas expelled from the digestive tract through the anus
Fluoroscopic: an instrument for the direct x-ray visualization of the action of the body's joints, organs, and systems
Gallium scans: a nuclear medicine procedure using the radioisotope gallium 67 in the form of gallium citrate
Glucagon: a hormone, produced by alpha cells in the islets of Langerhans, that stimulates the conversion of glycogen to glucose in the liver
Hyperosmolar: abnormally increased osmotic concentration of a solution
Hypertonic: having a greater concentration than another solution
Ileostomy: an artificial opening (stoma) erected in the small intestine (ileum) and brought to the surface for the purpose of evacuating feces
Infusion: a liquid substance introduced into the body by way of a vein for therapeutic purposes
Interstitial: pertaining to the space between the body cells
Kinesthetic: ability to perceive extent, direction, or weight of movement
Nocturia: excessive urination at night
Omentum: an extension of the peritoneum that enfolds one or more adjacent organs in the stomach
Osmolarity: osmotic pressure (the amount of pressure necessary to stop the flow of water across a membrane); the concentration of osmotically active particles in a solution
Ostomy: general term for an operation in which an artificial opening is formed
Peritonitis: inflammation of the serous membrane lining the abdominal cavity and surrounding the abdominal organs
Polyuria: excessive urination
Radioisotope: a radioactive form of an element used in medicine for diagnosis and treatment; the most commonly used are cobalt, gold, iodine, iron, and phosphorus
Radionuclide: a radioactive nuclide; one that disintegrates with the emission of electromagnetic radiation
Retroperitoneum: the space between the peritoneum and the posterior abdominal wall

Radiographic imaging examinations of the upper and lower gastrointestinal (GI) system are done in relatively large numbers. The radiographer may begin to consider some of these examinations as routine duties, but he must remember that they are not routine experiences for the patient receiving them. They can be stressful and uncomfortable examinations that may place the patient in physical and emotional jeopardy. This is particularly true for the very young and the very old patient.

Barium studies and contrast studies that include the use of high-density barium and air are effective methods of detecting conditions of the upper and lower GI system. When imaging of the GI tract using barium is contraindicated, an iodinate contrast agent may be prescribed.

There are a number of methods of imaging the liver, the gallbladder, and the biliary tree. These can involve the use of iodinated contrast agents given by the oral or intravenous route. Ultrasound and radionuclide studies are other methods used to visualize particular areas of the GI system. These special methods of imaging are discussed in Chapter 13.

When the radiographer is working with contrast agents, he must know the indications and contraindications for their use, the potential adverse reactions of each, safe methods of patient care, and the patient teaching that must accompany their use.

The radiographer must devote an additional amount of time to patient teaching for procedures of this nature because many patients have had no experience with the preparation required for them. Hesitation, and perhaps even revulsion, with the technical aspects of enema administration, dietary restrictions, and medication prescribed prior to these examinations is not unusual.

The radiographer who uses a matter-of-fact, professional manner when instructing the patient will be able to alleviate patient anxiety.

Types of Contrast Media

There are two types of radiographic contrast agent, positive and negative. Positive contrast agents are used to increase organ density and improve radiographic visualization. Negative contrast agents decrease organ density in order to produce contrast. The most commonly used positive contrast agents are barium sulfate and iodinated preparations. The most commonly used negative agents are carbon dioxide and air. Iodinated contrast agents are discussed in Chapter 11.

NEGATIVE AGENTS

Carbon dioxide and air are the negative contrast agents that are most frequently used. They may be used singly or in combination with a positive contrast medium in examinations of the GI system. Complications associated with the use of negative contrast agents can result from inadvertent injection of air into the bloodstream, producing an air embolus. When a negative agent is injected into a joint for an arthroscopic examination, the patient may have residual distention of the joint and discomfort caused by the gaseous medium.

BARIUM SULFATE

Barium sulfate is the most frequently chosen contrast medium for radiologic examination of the GI tract. It is a white, crystalline powder that is mixed with water to make a suspension. It may be administered by mouth for examination of the upper GI tract, by rectum for examination of the lower GI tract, or by infusion of a thin suspension through a duodenal tube to visualize the jejunum and ileum. The toxic effects of barium are negligible if the suspension remains within the GI tract; however, if there is a break in the gastric mucosa caused by injury or disease, the barium sulfate may pass into the peritoneal cavity or into the bloodstream and result in adverse reactions. When perforation of the GI tract is suspected, an absorbable iodinated contrast medium is used in place of barium.

If barium leaks into the peritoneal cavity, peritonitis may result. This possibility increases if the barium is mixed with fecal material. Fibrosis or formation of a barium granuloma may be a further complication. The possibility of leakage of the barium into the venous circulation through a perforation in the gastric mucosa as a result of trauma or disease must also be considered. This would produce an embolus that might be fatal.

Barium sulfate is often constipating. If the patient is not properly instructed following a procedure that involves its use, he may ignore the condition rather than have it treated, and fecal impaction or a bowel obstruction may result.

If the patient reports that a previous administration of oral barium suspension produced a sensation of nausea, the radiologist should be notified before it is administered again, because if the patient vomits, aspiration pneumonia can result.

The use of high-contrast barium solution in the alimentary canal reveals organ outlines and demonstrates pathologic conditions of the visceral walls. By using double contrast of barium and air, the ability to detect small lesions is improved.

Computed tomography is the imaging technique used most frequently to investigate potential pathology of the omentum, the retroperitoneum, and the liver. Ultrasound, technetium scans, and Gallium scans are other imaging modalities used for evaluation of the GI system.

When a patient is scheduled for imaging examinations of both the upper and the lower GI system with barium as the contrast agent, the lower GI series should be scheduled first, because the barium clears most quickly from the lower bowel.

Barium Studies of the Lower Gastrointestinal Tract

Correct preparation of the patient for barium studies of the lower GI tract is essential and may seem relatively complex to the patient. This preparation varies across health care facilities and with each patient's special needs. It will be the radiographer's responsibility to learn the specific procedure in his place of employment. If the patient is an outpatient, the radiographer may be responsible for giving him the appointment for the examination and for instructing him in the preparation. The following directions will generally apply at most institutions, with modifications for particular patients.

If time allows, the patient is instructed to eat foods low in residue for 2 to 3 days prior to the examination. A low-residue diet excludes tough meats; raw, cooked, and dried fruits; raw vegetables; juices containing the pulp of fruits or vegetables; whole-grain breads and cereals, especially

bran and cracked wheat types; nuts, peanut butter, and coconut; olives, pickles, seeds, and popcorn; and dried peas and beans. No more than two cups of milk each day should be taken and strong cheeses must be avoided. The patient should be encouraged to increase his fluid intake for 2 to 3 days prior to the examination to assist in clearing the lower bowel of waste. Water is the recommended fluid.

Twenty-four hours prior to the examination, a clear liquid diet is usually prescribed. A clear liquid diet may include coffee or tea with sugar but no milk; clear gelatin; and clear broth and carbonated beverages. The patient should be instructed to drink five 8-ounce glasses of water or clear liquids during this 24 hours.

The afternoon preceding the examination, 10 ounces of magnesium citrate or its equivalent is prescribed. The evening prior to the examination, another laxative may be ordered. Laxatives must never be given to a patient without his physician's order. They can be harmful to persons with bowel obstructions and other pathologies of the GI tract.

Patients with insulin-dependent diabetes mellitus and noninsulin dependent diabetes mellitus require special pre-examination orders and instruction. The radiographer must ascertain the patient's medical status before giving him instructions in preparation for any GI series. Patients with diabetes mellitus must also be instructed concerning administration of morning insulin or other antidiabetic medications. Usually they are postponed until the examination is complete and the patient is able to eat.

Cleansing enemas are generally prescribed the night before the examination or early in the morning of the examination. Since there are several types and variations of cleansing enemas, the radiographer must become familiar with all of them and must be able to administer one, if necessary. Occasionally a patient comes to the radiographic imaging department poorly prepared for a radiographic examination of the lower bowel and it is necessary for the radiographer to complete the preparation in the department by administering an additional cleansing enema. By learning the procedure, the radiographer is able to give clear directions to the patient who needs instruction.

The Cleansing Enema

The type of cleansing enema to be used is always ordered by the physician. The radiographer does not decide on the type of enema the patient is to receive, but he may administer a cleansing enema if it is ordered. The most frequently used cleansing enemas include the saline enema, the tap-water enema, the soap suds enema (SS enema), and the oil-retention enema.

Cleansing enemas can influence fluid and electrolyte balance in the body to varying degrees because they each have a different degree of osmolarity, which influences the movement of fluids between the colon and the interstitial spaces beyond the intestinal wall. This means that, in the presence of some cleansing solutions that are instilled into the lower bowel, the bowel extracts fluid from the surrounding interstitial spaces. This happens because the higher osmolarity of the cleansing solution (hyperosmolar) induces the fluid to move across the semipermeable membranes of the intestinal wall. The body fluid that has moved into the large intestine is then excreted from the body along with the enema solution. If an excess of body fluid is excreted from the body, the result is dehydration. This situation can be reversed. An excess of fluid with low osmolarity (hyposmolar) may be instilled into the lower bowel and absorbed into the interstitial spaces surrounding the colon, thus creating a fluid excess in the body. This is called fluid toxicity. These potential hazards must be considered when the physician orders a particular solution for use as a cleansing enema.

SALINE ENEMAS

There are two types of saline enema, normal saline and hypertonic saline. Normal saline is the safest solution to use for a cleansing enema because it has the same osmolarity as that in the interstitial spaces that surround the colon; therefore, it will not change the fluid balance in the body. It is the only safe fluid to use for cleansing enemas for infants and children because they can tolerate very little change in fluid and electrolyte balance. This solution is also used for elderly patients for this reason. The amount of solution will vary according to the age and size of the adult or child.

In hospitals, commercially prepared normal saline is available in containers of varying sizes. For an adult patient, 750 mL to 1000 mL is the average amount used. The amount of fluid used for infants and children varies with their age and weight. If children are to be given a cleansing enema, it should be done by a nurse educated in caring for pediatric patients. If commercial preparations of normal saline are not available or are too expensive for the patient to purchase, a normal saline solution can be made by adding 1 teaspoon

of table salt per 500 mL of water. If a parent is to administer the cleansing enema to an infant or child, he should be instructed in the procedure by a pediatric nurse or physician.

HYPERTONIC ENEMAS

An enema using a hypertonic saline solution or a solution of water and Fleet Phospho-Soda can be administered quickly and easily and is effective for relief of constipation or for eliminating barium sulfate residue after a barium examination. It is packaged commercially in a small plastic container with a prelubricated tip. The tip is inserted into the rectum. The patient is asked to retain the fluid for several minutes and then to evacuate it.

Hypertonic solutions pull fluid from the interstitial spaces around the sigmoid colon and fill it with fluid, thereby initiating peristalsis. Only a small amount of solution is required to do this (120 to 180 mL). Hypertonic saline enemas are often available under the name Fleet enema (Fig. 9–1*A*). Hypertonic enemas should not be administered to dehydrated patients or to infants and children.

OIL-RETENTION ENEMAS

The oil-retention enema is given for relief of chronic constipation or fecal impaction or for eliminating barium sulfate residue after a radiographic examination. A small amount of mineral oil or olive oil (120 to 140 mL) is instilled into the rectum, and the patient is requested to retain the oil for as long a time as possible, preferably up to 1 hour, and then expel it. The oil lubricates the rectum and colon and softens the fecal material, thereby making it easier to expel.

Although the radiographer will probably not be administering this type of enema, he must be knowledgeable about it so that he can discuss it as part of his patient-teaching plan. Oil-retention enemas are usually commercially prepared and can be purchased in a container ready for use with a prelubricated tip. The tip is inserted into the rectum, and the oil is slowly instilled into the rectum.

TAP-WATER ENEMAS

Tap water may be used to cleanse the bowel prior to diagnostic imaging procedures; however, the radiographer must remember that there is the po-



A



B

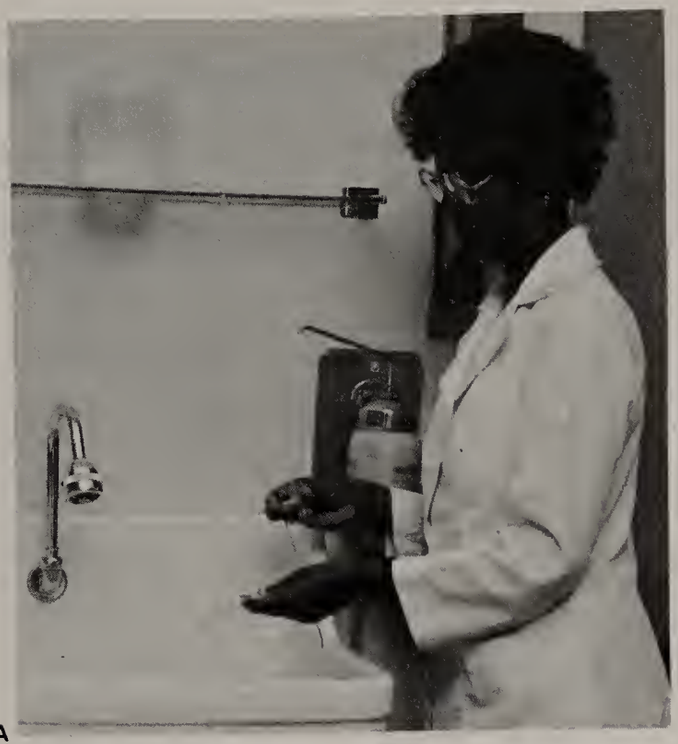
Figure 9–1
(**A**) Hypertonic saline enema set (Fleet enema). (**B**) Two types of cleansing-enema sets.

tential for fluid toxicity if this is used. The procedure for administration is the same as for the soap suds enema, which is described in the following section.

SOAP SUDS (SS) ENEMAS

Soap may be added to tap water or to normal saline to increase the irritation of the intestine, thereby promoting peristalsis and defecation. The only soap safe to use for this purpose is a pure castile soap. Detergents and strong soaps may result in intestinal inflammation. For each 1000 mL of liquid, 5 mL of soap is recommended. The SS enema is the cleansing enema most frequently used prior to barium studies of the lower GI tract. The procedure for administering an SS enema to an adult patient follows:

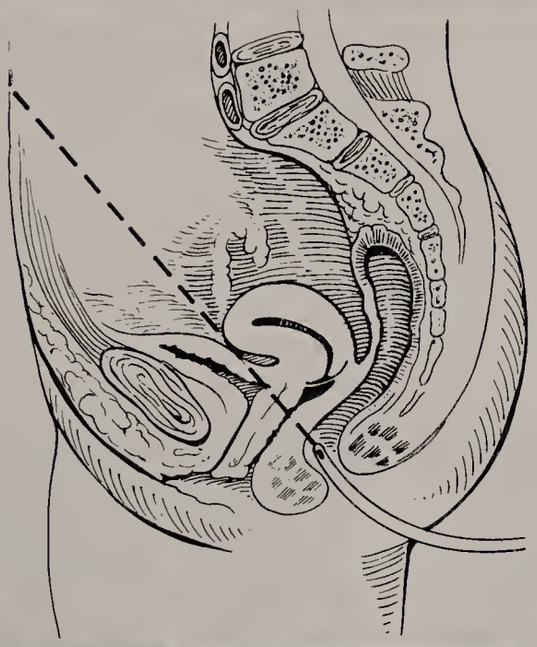
1. The radiographer must ascertain that the treatment is ordered by the patient's physician or the radiologist in charge of performing the procedure. Giving an enema to persons with some GI diseases is contraindicated.
2. Go to the patient and explain that a cleansing enema has been ordered, as well as why it has been ordered; explain the procedure to him.
3. Wash your hands; then assemble the equipment that is needed for the procedure. This will include:
   a. A plastic container that holds 1000 mL of fluid. This may be a bucket or a plastic bag with an attached plastic tubing.
   b. A plastic tubing with a 22- to 26-French lumen (French measurement is discussed in Chapter 14) about 4 feet long with a smooth, perforated tip and a clamping device (see Fig. 9–1*B*).
   c. The liquid to be instilled
   d. Liquid castile soap (5 mL)
   e. Water-soluble lubricant
   f. A paper or cloth pad to place under the patient's hips, paper towels to receive the soiled enema tip, and a towel to protect the table where the equipment is placed
   g. A bedpan
   h. The patient's shoes or slippers and a robe
   i. Clean, disposable gloves
   j. A drape sheet to cover the patient
4. Attach the tubing to the container, if this has not been done, and close the clamp.
5. Go to a utility area that has a sink and hot and cold running water. Prepare the enema solution. The water used should be warmed to 105°F (41°C). Fill the container with 1000 mL of water, place the soap in the container, and mix it.
6. Open the clamp and allow some of the fluid to run through the tubing into the sink to displace the air and to ensure that the enema set is working correctly (Fig. 9–2*A*).
7. Take the equipment assembled on a tray, if one is available. Place it on a table or stand near the patient. Close the door or otherwise arrange for privacy.
8. Drape the patient with the drape sheet and position him in a left Sims' position. Arrange the drape sheet so that only the area of the buttocks that must be exposed for insertion of the enema tip is exposed. Place the towel under the patient's hips to avoid soiling the table or sheet on which the patient is lying (see Fig. 9–2*B*).
9. Explain to the patient that you are about to begin the instillation of the fluid. Tell him that he may feel some cramping as the fluid runs in; if this is the case, tell him to inform you and that you will stop the instillation until the cramping stops. Also inform the patient that he should try to retain the fluid for as long as he is able. Explain that there is a bedpan at hand if he is unable to get to the bathroom. If the patient is on a radiographic table, have a stepping stool ready to assist the patient off the table.
10. Tell the patient when you are about to insert the tube and ask him to exhale as you do this.
11. Don your gloves. Lubricate the tip of the tube if it does not come in a kit in which it is prelubricated.
12. Lift the patient's right buttock with the heel of your hand to expose the anus.
13. Ask the patient to slowly exhale and gently insert the enema tip into the rectum toward the umbilicus 3 to 4 inches (see Fig. 9–2*C*). Make certain that you are visualizing the anus as you insert the tip to prevent injuring the patient. Do not insert the tube forcefully, as the mucous membranes may be damaged (see Fig. 9–2*D*).
14. When the tip has been inserted, hold it in place with your nondominant hand and release the tube clamp with the other hand. Then raise the container of fluid 18 inches (see Fig. 9–2*E*).
15. Allow the fluid to run in slowly. It should take about 10 minutes for all the fluid to be instilled. If the physician orders the transverse and ascending colon to be cleansed, the patient may be asked to turn onto his



A



B



C



D



E

Figure 9–2
Administering a cleansing enema. (**A**) Allow the air in the tubing to be displaced by the enema solution. (**B**) Place a towel under the patient's hips. (**C**) Insert the enema tip into the rectum toward the umbilicus. (**D**) Insert the tube gently to prevent injury. (**E**) Raise the container of enema fluid 18 inches.

back and then onto his right side as the fluid is being instilled. The quantity of fluid that a patient can retain will vary, but if possible, at least 500 mL of fluid should be instilled. Instruct the patient to tell you when he is unable to take more fluid.

16. Clamp the tube before the fluid has reached the bottom of the container so that air will not enter the rectum.
17. Gently remove the enema tip, wrap it in a paper towel, and place it in the enema container. Dispose of the set in the appropriate receptacle, and remove your gloves according to the rules of medical asepsis.
18. If the patient is able, have him rest quietly on the table for as long as he can before going to the lavatory to expel the enema. Stay close by to assist him to the bathroom. If the patient cannot go to the lavatory, place him on the bedpan; don gloves to remove the bedpan as discussed in Chapter 3.

The radiographer can clean the area and wash his hands as for heavy contamination while the patient is expelling the enema. The patient is instructed not to flush the commode until the expelled material has been assessed. The radiographer must note the color, quantity, and consistency of the fecal material. Preparation for some barium studies requires that a second or even a third enema be administered so that the bowel is thoroughly cleansed. This process is referred to as giving enemas "until clear" and means that the enema fluid returns with no fecal matter present. This procedure must not be repeated more than three times because the patient's fluid balance may be jeopardized.

THE SELF-ADMINISTERED CLEANSING ENEMA

If a patient is coming from his home to the radiographic imaging department for a barium study of the lower bowel, he must be taught to administer his own enemas effectively. The radiographer must be able to assume this teaching responsibility. The patient should be instructed to purchase an enema kit when he goes to the pharmacy for his laxative medication. The enema prescribed is usually a cleansing enema; the adult patient will be required to add 1000 mL water and 20 mL liquid soap. The radiographer should carefully explain to the patient the type of enema set needed, because there will be many to choose from. The patient should know that, even if the laxative has the desired effect, he will not be adequately prepared if he does not take his enemas as instructed.

The radiographer's instruction to the patient regarding the preparation of the enema proceeds as described earlier.

1. The enema should be taken on the morning of the examination.
2. If the patient has no one at home to assist him, explain that he should place a terry towel or newspaper on the floor near the toilet in his bathroom at home.
3. Instruct him to place the enema set with the prelubricated tubing on a low stool or chair near him so that, when he is lying down, the solution will be about 18 to 24 inches above the hip level. Since the enema solution must cleanse the entire colon, the procedure must not be performed with the patient in a sitting position.
4. He may insert the enema tip while lying on his left side. Explain that if he changes position from his left side to his back and then to his right side while the enema is being instilled, he will be more certain that the solution is reaching his entire colon.
5. Instruct the patient to try to relax by taking deep breaths during the procedure so that he will be able to hold the solution more easily.
6. If the procedure is unsuccessful the first time, or if the patient has been directed to take enemas "until clear," he will be required to repeat this procedure.

Barium Enema

Barium studies and double-contrast studies using high-density barium and air or carbon dioxide are used to diagnose pathological conditions of the lower GI tract. If there is a possible indication of a disease entity or injury that would result in a perforation or tear of the lower GI tract, an iodinated contrast agent must be used rather than barium. This is done to protect against barium peritonitis, a condition that results from barium leakage into the peritoneal cavity.

A much larger catheter is required than is used for a cleansing enema to allow the viscous suspension to be instilled into the lower bowel. The catheter may have a plain tip or a tip with an inflatable cuff attached (Fig. 9–3). If a tip with an inflatable cuff is selected by the physician for use in the examination, the cuff is inflated after the tip is inserted to hold the catheter in place and to prevent

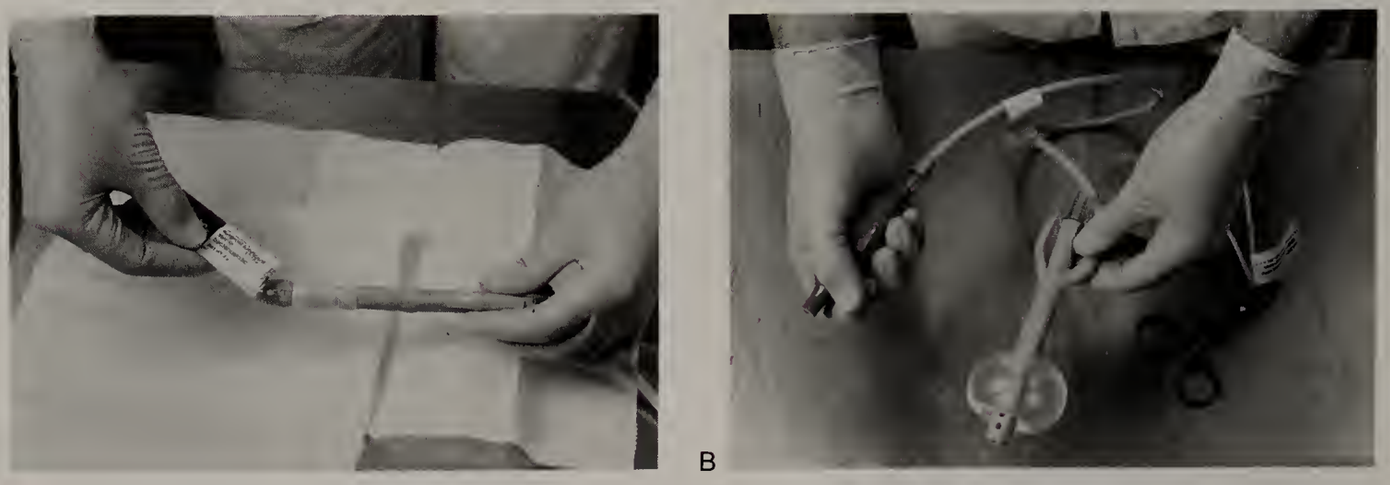


Figure 9–3
(**A**) Plain tip for barium enema. (**B**) Inflatable cuff.

involuntary expulsion of barium. The cuff is never inflated until it is certain that it is positioned beyond the anal sphincter (Fig. 9–4).

Barium is available in a prepared, prepackaged form. When adding water to the suspension, the radiographer should remember that the consistency should be dense so that x-rays are absorbed (Fig. 9–5). After it is mixed with water, barium should remain in suspension for some time before resettling; it should also be able to flow freely. Foam is undesirable in the mixture because if it is present, the barium suspension will not coat the mucosal walls evenly, which is necessary for diagnostic purposes.

The radiographer should have ready for use a plastic container of barium that has been well mixed (Fig. 9–6). The quantity needed for examination of an adult is generally 1500 mL, though it may vary. The amount used for infants or children will be much less and depends on their age and size. The correct amount must be ordered by the physician in charge of the procedure. A normal saline solution may be mixed with the barium instead of water to prevent electrolyte imbalance if the patient is an infant, a child, or a frail elderly person. The barium solution is passed through the tubing in the same manner as the solution for a cleansing enema in order to displace the air in the tubing before inserting the tip. Premixed preparations of barium should be remixed so that the suspension is uniform, and they should be administered at room temperature.

The bag containing the barium is hung from a metal standard. A clamp on the tubing opens and closes the tubing easily. The bag should be placed about 30 inches above the table. The radiographer must not begin instillation of barium until the ra-



Figure 9–4
Hand inflation pump.



Figure 9–5
Mix the barium well with water.



Figure 9–6
Barium in lower bowel (radiograph, lower GI series).

diologist is present in the room to direct the procedure. The radiographer may insert the rectal catheter. The procedure is much the same as for the cleansing enema. The radiographer washes his hands, places the patient in the Sims' position, and drapes him so that only the anal area is exposed. The tip of the catheter is heavily lubricated. The radiographer then dons clean, disposable gloves. The patient is then instructed to exhale slowly as the tip of the catheter is inserted 3 to 4 inches or until it passes the anal sphincter. Force should not be used to insert the catheter because of the potential for laceration of the mucous membranes. If the tip cannot be easily inserted, the procedure should be stopped and the radiologist asked to complete the task. The patient may be returned to a supine position after the catheter is in place.

When a retention-type catheter with an inflatable cuff is used to administer barium, the cuff may be inflated with a hand inflation pump or with a syringe. The radiographer must be certain that the cuff is inserted beyond the rectal sphincter before it is inflated. Initially, the cuff should be inflated with no more than 30 mL of air for an adult patient. If more air is desired, the radiologist may add more. An inflatable cuff is not used for an infant or a child. The tube may be taped in place with hypoallergenic tape.

Occasionally, a patient has an allergy to items made of latex (including barium enema tips) and many medical products. The radiographer must ask the patient prior to the procedure if he is allergic to latex. If this is the case and another type of tip is not readily available for substitution, the radiographer must report this to the radiologist.

Patient Care Considerations During Examinations of the Lower Gastrointestinal Tract

The radiographer must remember that patients are extremely uncomfortable during this type of procedure and usually highly anxious. They are forfeiting their dignity and comfort in order to discover the cause of their illness. The radiographer must be aware of this and do all that he can to alleviate the patient's discomfort and anxiety.

If the patient cannot hold the barium and cannot tolerate an inflatable cuff, an inflatable bedpan can be placed under the patient during the examination (Fig. 9–7). The patient should be instructed to inform the radiographer if he is having abdominal cramping during the examination so that administration of barium will be stopped until the cramping subsides.

The patient should be informed that he will be moved into several positions to afford maximum

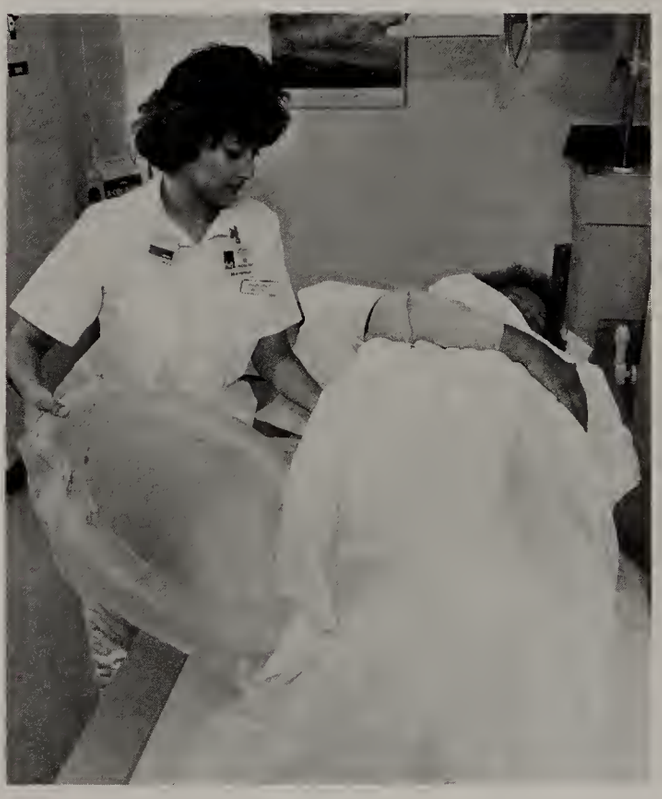


Figure 9–7
Inflatable bedpan.

visualization while the examination is in progress. It will be necessary to explain that the radiologist will be giving the radiographer instructions that the patient may mistakenly think are being addressed to him. These single-word commands—"open," "close," "off," "on"—can be safely ignored by the patient. The patient must be informed of the approximate amount of barium that he will be given. He will need to know that any urge to defecate can be relieved when he is taken to the lavatory immediately following the procedure.

Air is often placed into the bowel during this examination. If barium has been instilled first, the patient is usually allowed to evacuate some of the barium before the air instillation. A rectal catheter with an air-insufflating mechanism attached is then inserted, and air is injected as a second contrast medium. The patient will be extremely uncomfortable during this study. The radiographer should remain in close proximity to the patient in order to reassure him. The patient should be informed that cramping and a feeling of a need to defecate are normal sensations during this examination.

The patient is often requested to move about on the table during the examination and the table may be positioned at different angles. The radiographer must assist the disabled patient to assume the various positions and must be certain that the patient is safe as he moves or as the table is tilted.

Before removing a rectal catheter that has an inflatable cuff attached, the radiographer must be certain that the cuff is deflated. The barium is sometimes removed by gravity flow before the catheter tip is removed. This is done by placing the barium bag lower than the level of the patient's hips and allowing it to flow back into the bag. The air is then permitted to escape from the cuff. Following this, the radiographer may gently remove the catheter. If there is any resistance, the physician should be summoned to remove it.

The radiographer must assist the patient to the lavatory following a barium enema. It may be necessary to allow the patient to evacuate some of the barium into a bedpan before attempting the trip. The radiographer must stay with the patient until the problem is resolved because he will need assistance and direction.

INSTRUCTIONS FOLLOWING BARIUM STUDIES OF THE LOWER GASTROINTESTINAL TRACT

A patient must never be dismissed from the radiographic imaging department following a procedure without instruction in postexamination care. This is particularly true for the patient who has received barium because, without adequate care, the patient may retain barium, which can cause fecal impaction or intestinal obstruction. He may also suffer from extreme dehydration as a result of preparation for the test.

The radiographer must explain to the patient that his stools will be white or very light-colored until all of the barium is expelled. Some physicians regularly prescribe a laxative medication or an enema following barium studies. If the physician in charge of the patient does not, tell the patient that if he has not had a bowel movement within 24 hours following the test, he should contact his physician. Stress the importance of eliminating the barium.

It is also of extreme importance that the patient increase his fluid intake and the fiber in his diet for several days if this is not medically contraindicated. The patient should be instructed to rest following the examination. If he feels weak or faint; has abdominal pain, constipation, or rectal bleeding; is not passing flatus; or has polyuria, nocturia, or abdominal distention, he must contact his physician immediately.

The Patient With an Intestinal Stoma

There are a number of conditions of the lower GI tract that require creation of a stoma through which the contents of the bowel can be eliminated. A stoma is created by bringing a loop of bowel to the skin surface of the abdomen. Some diseases that are treated in this manner include cancer, diverticulitis, and ulcerative colitis. Traumatic injuries of the bowel may also require this type of treatment.

The surgical procedure done to repair the bowel and create the ostomy is named by the area of bowel on which the operation is done. For instance, if the opening is from the colon, it is called a colostomy; if it is from the ileum, it is known as an ileostomy (Fig. 9–8). The stoma may be temporary, done in order to rest and heal a diseased portion of the bowel, or permanent, done in order to remove a diseased or traumatized portion of the bowel.

The stoma may have either one or two openings, depending on the type of surgery that was performed. When two openings are surgically created, one opening will be located toward the rectum and the other toward the small bowel. One opening, called the proximal stoma, will emit fecal material. The other opening, the distal stoma, will be relatively nonfunctioning and will emit only

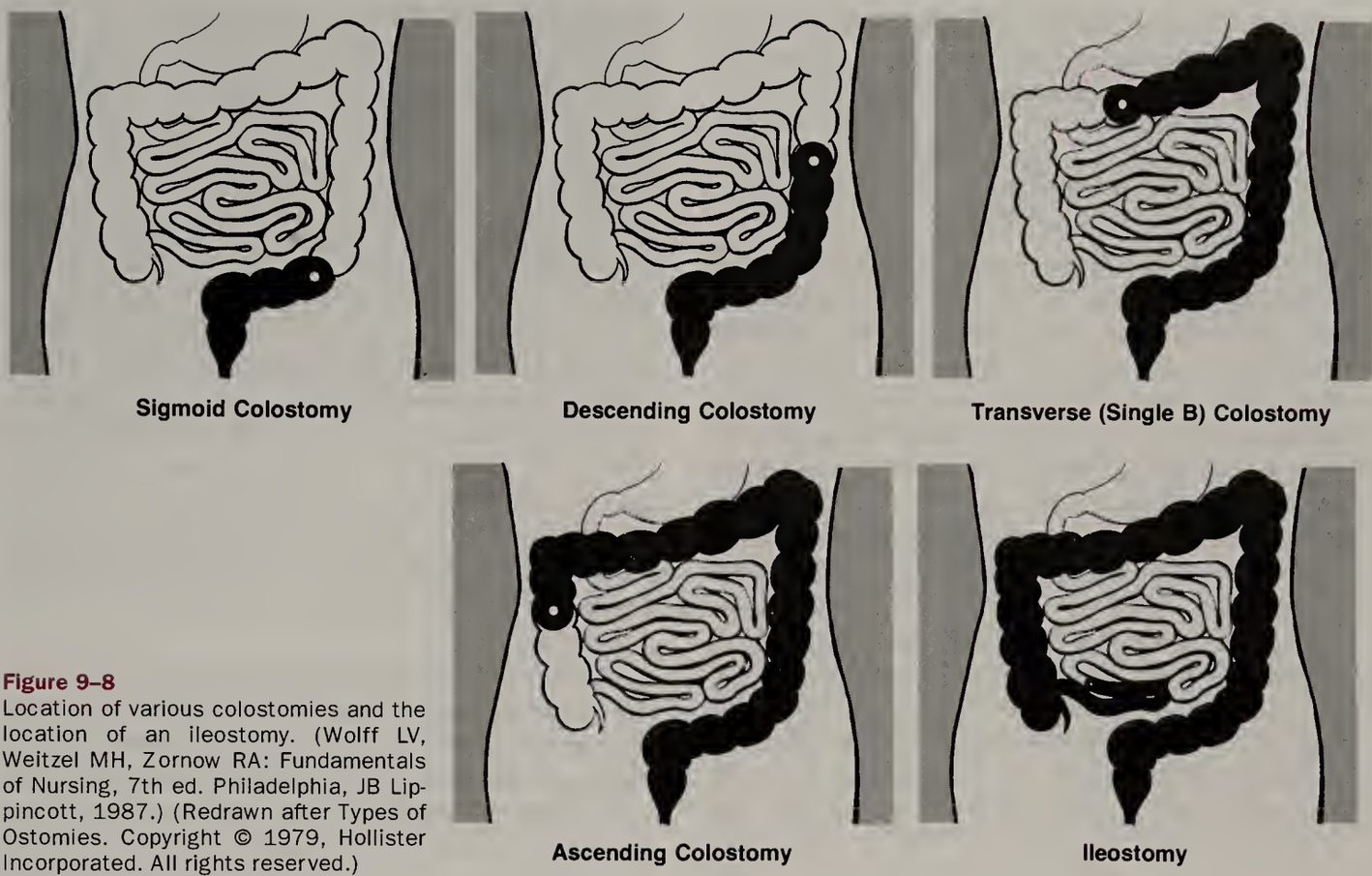


Figure 9–8
Location of various colostomies and the location of an ileostomy. (Wolff LV, Weitzel MH, Zornow RA: Fundamentals of Nursing, 7th ed. Philadelphia, JB Lippincott, 1987.) (Redrawn after Types of Ostomies. Copyright © 1979, Hollister Incorporated. All rights reserved.)

mucus. Some stoma patients (also called ostomy patient) have had their rectum and lower bowel removed; others have not. A patient who has an ostomy may require barium studies for further diagnosis or study of the progression of the disease.

The radiographer must recognize that an ostomy produces a major change in a patient's body image and that many persons with a new colostomy or ileostomy stoma will be going through the grieving process. This is particularly true of younger patients. They may be angry, depressed, in a stage of denial, or just beginning to accept the fact that they must learn to live with this handicap.

Caring for the patient with a new ostomy requires sensitivity and a matter-of-fact attitude. It is suggested that the radiography student who has never seen an ostomy should observe the diagnostic studies being performed for these patients until he can care for them easily.

The ostomy patient will have a dressing or drainage pouch in place over the area of his stoma (Fig. 9–9). The dressing must be removed by a radiographer wearing clean gloves, then placed in a plastic bag and disposed of in a receptacle intended for contaminated waste. The gloves are then removed, and hands are washed. The procedure for dressing change is discussed in Chapter 5. A drainage pouch should be removed and put aside in a safe place to be reused. Gloves are worn by the radiographer to do this. The patient may want to do this himself or direct the radiographer in his care. The pouch must be kept clean and dry.

A patient who has a colostomy or ileostomy and is going to have a barium study of the lower GI tract needs special instruction to be adequately prepared. If the hospital has an enterostomal therapist, the patient should be referred to this person for instruction. If not, the radiologist and the patient's physician should give the instructions before and after the procedure. All ostomy patients should be instructed to bring an extra pouch with them if they

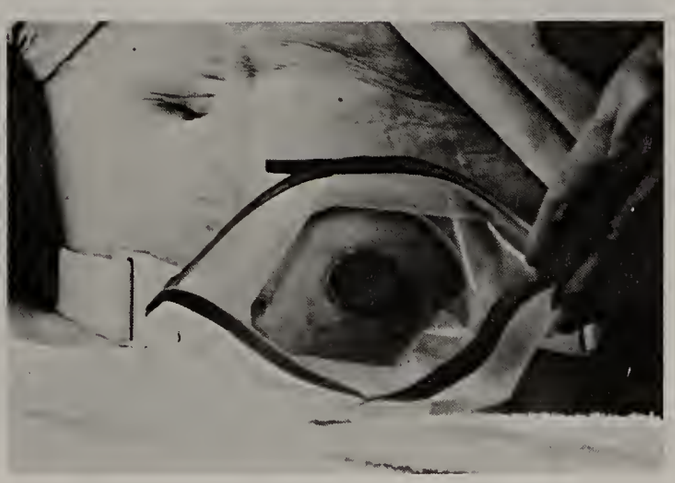


Figure 9–9
A colostomy with a drainage pouch in place.

are coming from outside the hospital. Dietary, laxative, and cleansing preparations will vary depending on the type and location of the ostomy.

ADMINISTERING A BARIUM ENEMA TO A PATIENT WITH AN OSTOMY

Ostomy patients will have barium studies for diagnostic purposes, and the procedure is somewhat different from that performed on a person with normally functioning bowels. The radiographer assisting with a barium examination for an ostomy patient must plan the procedure with the physician in charge of the patient before beginning to ensure the patient's comfort and safety. A cone-shaped tip with a long drainage bag that attaches to it following the procedure is frequently the instillation instrument of choice (Fig. 9–10). Occasionally a small catheter with an inflatable cuff is used. There are other ostomy tips used depending on the patient's situation and the preference of the physician. Some of these are the nipple tip and the double-barrel tip. If the patient has had the ostomy for some time, he may prefer to insert the tip himself.

The radiographer will lubricate the tip of the cone and hand it to the patient for insertion (Fig. 9–11). He then puts on clean disposable gloves so that he may assist the patient. The radiologist may prefer to insert the tip and tape it in place.

Once the cone or tip has been inserted, the procedure is the same as for other patients. The patient may be placed in various positions; however, he should not be placed into a prone position as this may cause injury at the stoma site. Barium must not be instilled until the physician who is conducting the examination is present to supervise the procedure. If the patient's rectum and lower bowel are present, barium may be instilled into the ostomy and also into the lower bowel through the rectum. Because they have lost portions of their intestines, a considerably smaller amount of barium suspension is needed for most ostomy patients.

When the examination is complete, the drainage bag can be attached to the cone and barium drained into it. When the drainage is complete, the patient whose physical condition permits may be taken to the lavatory with the

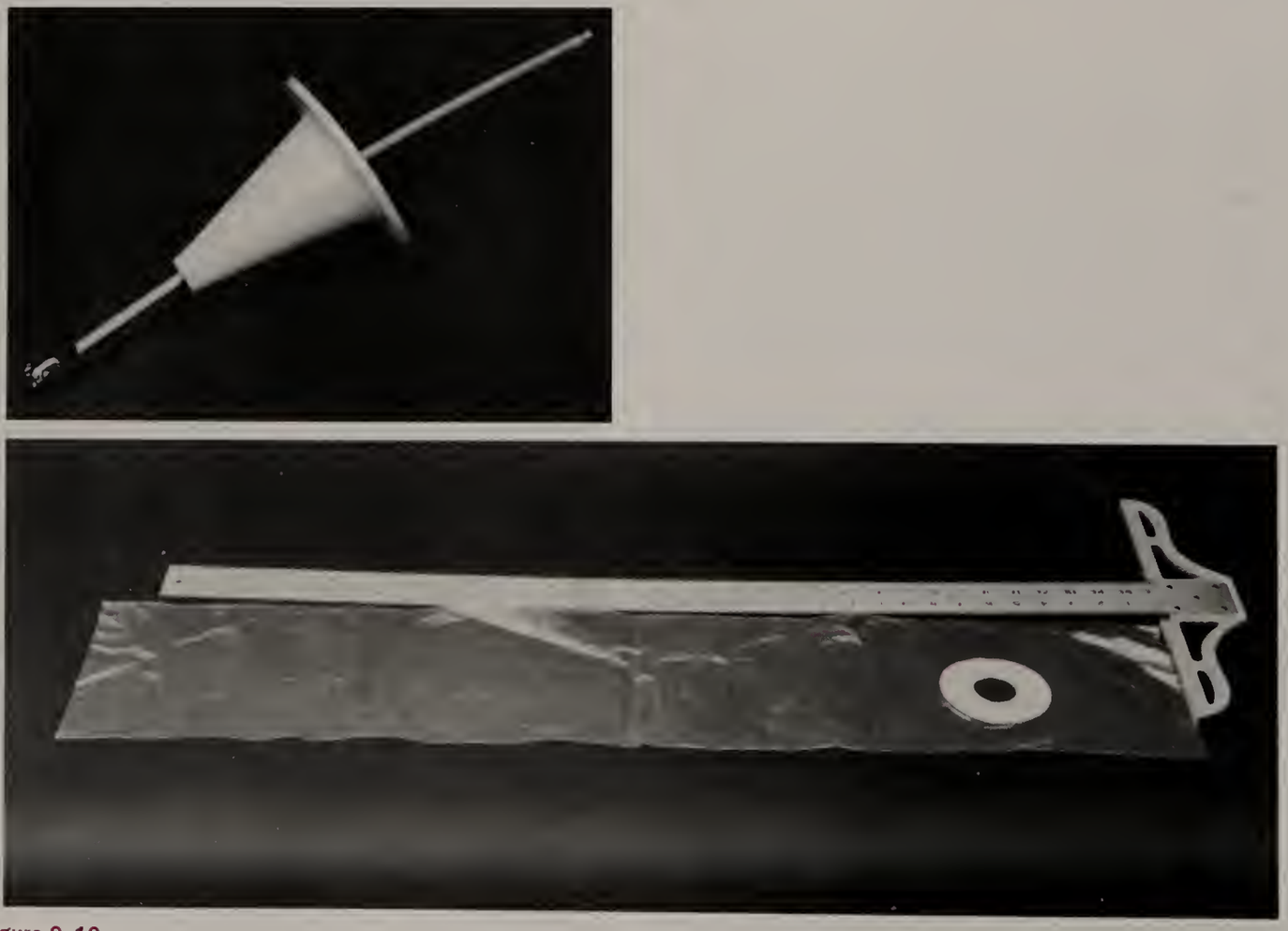


Figure 9–10
(**A**) Cone tip for colostomy patients. (**B**) Drainage bag used with cone tip.



Figure 9–11
The lubricated cone is gently placed over the stoma and is held in place with the hand. (Wolff LV, Weitzel MH, Zornow RA: Fundamentals of Nursing, 7th ed. Philadelphia, JB Lippincott, 1987.) (Reprinted with permission of Hollister Inc.)

drainage bag still in place; there the drainage bag may be cleansed and the ostomy pouch replaced.

The radiographer should give the patient as much assistance as needed. He should be offered a towel, a wash cloth, and any other articles he may need. Allow the patient privacy if he is able to be independent in his care.

Barium Studies of the Upper Gastrointestinal Tract and Small Bowel

Barium examinations of the upper GI tract and small intestine are called an *upper GI series.* They are performed to diagnose pathologic conditions of the pharynx, esophagus, stomach, duodenum, and small intestine. The patient is usually instructed to remain on a low-residue diet for 2 to 3 days prior to the examination and to go on a food fast for 8 hours prior to the examination. He must be instructed not to smoke or chew gum before the examination as this increases gastric secretion, which may cause dilution of the contrast agent. In most instances, medications that the patient routinely takes are restricted for 8 hours prior to the examination. Enemas are usually not required. The patient must be informed that the examination may take several hours; he should be encouraged to bring reading material to pass the time. An anticholinergic drug or glucagon is often prescribed and administered before or during the examination intravenously to reduce gastric motility. If the patient is an insulin-dependent diabetic, glucagon is contraindicated. If the patient receives an anticholinergic drug or glucagon, he must be observed for adverse reactions throughout the examination and for 30 minutes following the examination.

Adverse reactions from glucagon may include nausea, vomiting, hives, and flushing. Adverse reactions from anticholinergic drugs may include dry mouth, thirst, tachycardia, urinary retention, and blurred vision. If the patient is to receive these medications, he should have another person available to drive him home.

A water-soluble iodinated contrast agent is ordered by the physician if the patient has a possible pathologic perforation or obstruction of the upper GI tract and barium is contraindicated. In the event of a perforation or obstruction, barium may intensify the obstruction or pass into the abdominal cavity.

The radiographer should also inform his patient that he will be expected to drink 14 to 16 ounces of flavored barium. For some examinations, a thick suspension of barium is followed by a thin suspension of barium. The solution does not have an unpleasant flavor; however, the chalkiness may be difficult to tolerate. It may be less distasteful for the patient if he drinks the substance through a straw.

Some examinations of the upper GI tract require passage of a gastric tube prior to the examination. The use of gastric tubes is discussed in Chapter 10 and complex upper GI examinations are discussed later in this text.

After the barium is swallowed and passes through the digestive tract, fluoroscopic examination outlines peristalsis and the contours of the upper GI tract (Fig. 9–12). Spot films are taken as directed by the radiologist. Double contrast with air is often used; when this is done, the patient should be informed of this and warned that he will have a feeling of fullness. He must also be informed that during the examination, he will be positioned in an upright, supine, and side-lying position while the passage of barium is viewed fluoroscopically. If the passage of barium is delayed, or if a small bowel follow-through examination is also ordered, the examination will take a much longer time with intervals during which the patient simply waits, lying on the table. Occasionally, changing the patient's position may assist the contrast agent to pass through the upper GI tract.

INSTRUCTIONS FOLLOWING BARIUM STUDIES OF THE UPPER GASTROINTESTINAL TRACT

In the absence of contraindications, the radiographer must instruct the patient to increase his fluid and fiber intake for several days after an upper GI



Figure 9–12
Stomach filled with barium (radiograph, upper GI series).

series using barium. He may resume eating immediately following the examination unless another examination is to follow. The patient should also be informed that his stools will be light in color and that, if he does not have a bowel movement within 24 hours, he must notify his physician, who may wish to prescribe a laxative. The patient must be instructed not to allow himself to become constipated, because fecal impaction or bowel obstruction may result. If rectal or gastric bleeding occurs, he must seek medical treatment immediately.

Scheduling Diagnostic Imaging Examinations

Patients often present for medical treatment with vague symptomatology that requires multiple imaging and direct-view examinations before an accurate diagnosis can be made. During the medical diagnostic process, one patient may have a series of examinations, some of which are performed in the radiographic imaging department and some elsewhere.

If the radiographer is responsible for scheduling radiographic imaging examinations, he must inquire concerning other examinations that the patient may be expected to undergo. He must understand how to schedule so that all of the examinations may be successfully completed in as little time as possible. This will require critical thinking and thoughtful planning. Some scheduling considerations that the radiographer must remember are as follows:

1. All radiographic examinations or procedures that do not involve use of contrast media should be scheduled first.
2. Ultrasound examinations must be scheduled to precede GI examinations using contrast agents because contrast media in the GI tract will interfere with ultrasound.
3. Radioisotope scans of the liver and spleen must be completed before barium studies.
4. Thyroid scans must be done prior to any examination using iodinated contrast agents as they will interfere with this test for many weeks.
5. Examinations that involve administration of intravascular contrast agents should precede barium studies because the intravenous agents are less dense than barium.
6. Barium studies of the lower GI tract must precede upper GI examinations.
7. Examinations that require the patient to fast for 8 hours or more should be performed early in the morning. This is especially important when scheduling patients who have diabetes mellitus, pediatric patients, and elderly patients.

Summary

There are two types of contrast agent, positive and negative. The most commonly used positive agents are barium sulfate and iodinated preparations. The most commonly used negative agents are air and carbon dioxide.

Studies using barium and barium in combination with air are frequently conducted in the radiographic imaging department to diagnose pathological conditions of the upper and lower gastrointestinal tracts. Correct preparation for these examinations is essential for a successful outcome. It is the radiographer's professional responsibility to teach the patient the correct methods of preparing for barium studies and for the care and precautions he must take following these or any diagnostic imaging procedures. It is the radiographer's

professional obligation to instruct other members of the health care team in the correct preparation of patients for diagnostic imaging examinations.

The problem-solving process should be used as an outline for the radiographer's teaching presentations. Evaluation of the teaching plan can be in the form of patient repetition of directions given by the radiographer to make certain that he has assimilated the instructions and is able to carry them out.

Preparation for examinations of the lower GI tract using barium as a contrast agent usually requires that the bowel be cleansed with enemas. The types of cleansing enemas with which the radiographer must be familiar are saline, oil-retention, tap-water, and SS enemas. The tap-water and SS enemas are the kinds most often prescribed before lower GI examinations. The radiographer must be able to perform the cleansing enema correctly and be able to instruct a patient to administer these to himself at home if this is necessary. The hazards of the enema procedure must be kept in mind, and care must be taken to prevent serious illness or injury to the patient.

The patient with an ostomy may also require a barium enema. The procedure and the tip used varies for these patients. The radiographer must be sensitive in his care of ostomy patients because they are often in the process of grieving over the recent alteration in body image. A radiographer who is not accustomed to seeing this type of stoma should work with a specially trained technologist or simply observe the procedure until he feels comfortable enough to relate to the ostomy patient in a therapeutic manner.

Barium studies of the upper GI tract are frequently done to diagnose pathology of the pharynx, esophagus, stomach, duodenum, and jejunum. The preparation before and after these studies varies somewhat from that of the lower GI series. The radiographer must familiarize himself with this information so that he can correctly instruct the patient and keep him as comfortable and anxiety-free as possible during the procedure.

Scheduling for a series of diagnostic imaging examinations requires careful planning so that the studies can be completed in as brief a time as possible. Imaging examinations must also be scheduled so that they will not conflict with other diagnostic procedures that may be prescribed. The radiographer should be knowledgeable concerning which diagnostic imaging examinations will interfere with other tests and must schedule in a manner that is safe and efficient for the patient. The very young, the elderly, and the patient with diabetes mellitus must be scheduled to accommodate their dietary restrictions and frailties.

Chapter 9, Pre–Post Test

1. List and differentiate between the two types of contrast agent.

____ **2.** Under which circumstance is barium not the contrast agent of choice?
- **a.** There is a possible perforation of the GI mucosa.
- **b.** The patient is a diabetic.
- **c.** There is an emotional problem.
- **d.** There is a potential diagnosis of paralytic ileus.

3. Explain the radiographer's obligations to other members of the health care team when a hospitalized patient is scheduled for an upper and lower GI series.

____ **4.** Barium is a relatively nontoxic contrast agent; therefore, no special precautions need to be taken.
- **a.** True
- **b.** False

____ **5.** The amount of solution prescribed for a cleansing enema prior to barium studies of the lower GI tract is usually
- **a.** 10 mL
- **b.** 1000 mL
- **c.** 500 mL
- **d.** 900 mL

____ **6.** The only safe soap to use for a cleansing enema is
- **a.** Liquid detergent
- **b.** Oatmeal soap

c. Nonperfumed soap
d. Castile soap
e. Hypoallergenic soap

_____ **7.** When upper and lower GI series are scheduled, the radiographer must schedule the upper GI series first.
a. True
b. False

_____ **8.** Following a barium study, the radiographer must instruct the patient in follow-up care. These instructions will include
a. Description of the appearance of his stools
b. Instructions to call the patient's physician if he does not have a bowel movement within 24 hours
c. Need for increased fluid intake and fiber in the diet if not contraindicated
1. a and b
2. a, b, and c
3. a and c
4. b and c

_____ **9.** The radiographer must recognize that the patient with an ostomy has suffered a change in his body image and may be going through
a. The grieving process
b. The process of self-examination
c. The aging process
d. The self-actualization process

_____ **10.** The type of cleansing enema prescribed for a pediatric patient would probably be
a. An SS enema
b. A tap-water enema
c. An oil-retention enema
d. A saline enema

11. List five subjects that must be included when instructing a patient who is to receive an upper GI series.

○ *Laboratory Reinforcement*

1. Demonstrate the administration of a cleansing enema in the school laboratory using a mannequin as the patient.

2. Using a classmate as a patient, explain how he should prepare prior to receiving a barium enema for diagnostic purposes.

Critical Thinking Problems

1. The physician has ordered the following diagnostic examinations for his patient: a thyroid scan, an intravenous pyelogram, pelvic ultrasonography, and an upper and lower GI series. List them in the correct scheduling order.

2. Maybell Merrywether is a 78-year-old Caucasian female who has lived in the United States for her entire life. Ms. Merrywether was raised in a small Appalachian town and has had very little medical care during her life, as she has never been ill. She has seen a physician only two or three times and has never been hospitalized. Her education ended after the eighth grade. She never married and lives alone. Her only means of support is a small Social Security pension. Recently, Ms. Merrywether has had several episodes of epigastric pain and has had a bloody emesis and blood in her stools. Her physician has ordered an upper and lower Gi series to be scheduled this week. Today is Monday. Plan your instruction and schedule these examinations.

10

Caring for Patients Needing Alternative Medical Treatments

Nasogastric and Nasoenteric Tubes
Passage of Nasogastric and Nasoenteric Tubes
Nasoenteric Feeding Tubes
Removing Gastric Tubes
Transferring Patients With Nasogastric Suction
The Patient With a Gastrostomy Tube
The Patient Receiving Parenteral Nutrition or Who Has a Central Venous Catheter
Emergency Suctioning
The Patient With a Tracheostomy
The Patient on a Mechanical Ventilator
The Patient With a Chest Tube and Water-Sealed Drainage
Tissue Drains
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Explain the reasons for nasogastric and nasoenteric intubation and the radiographer's responsibilities when these tubes are in place.
2. Describe the precautions the radiographer must take if the patient has a gastrostomy tube in place.
3. Describe the patient care considerations for the radiographer working with a patient who requires parenteral nutrition or has a central venous catheter.
4. Describe the symptoms a patient will demonstrate if he is in need of suctioning, and explain the action the radiographer must take if this situation should occur.
5. Explain the precautions the radiographer must take when working with a patient who has a tracheostomy.
6. List the precautions the radiographer must take when working with a patient requiring mechanical ventilation.
7. List the patient care precautions the radiographer must take if the patient has a chest tube in place with water-sealed drainage.
8. Describe the patient care considerations for the radiographer if the patient has a tissue drain in place.

Glossary

Asphyxiation: severe hypoxia leading to hypoxemia, hypercapnea, loss of consciousness, and death
Barotrauma: injury due to pressure
Bolus: a concentrated mass of pharmaceutical preparation, *e.g.*, an opaque contrast medium given intravenously or swallowed
Cannula: a tube used to allow fluids, gases, or other substances into or out of the body
Cystostomy: surgical opening into the urinary bladder
Dyspneic: having shortness of breath or difficulty breathing
Esophageal varices: a complex of longitudinal, tortuous veins at the lower end of the esophagus, swollen as a result of portal hypertension
Fowler's position: the head of the patient's bed is raised 18 to 20 inches above the level with the knees also elevated
French scale or measurement: a system used to indicate diameter of tubes, catheters, or instruments; each unit on the scale is approximately 1/3 mm
Gastrostomy: the creation of an opening in the stomach to provide food and liquid administration
Hemostat: A clamplike instrument used to control flow of fluids or blood
Intima: the innermost coat of a blood vessel
Lavage: the process of washing out an organ, usually the stomach, the bladder, or the bowel
Nasogastric tube: a tube of soft rubber or plastic that is inserted through the nostril and into the stomach
Saline solution: a solution consisting of a percentage of sodium chloride and distilled water that is of the same osmolarity as body fluids
Semipermeable: permitting passage only of certain molecules
Stoma: an artificial opening from the bowel to the body surface
Suspension: solid particles mixed, but not dissolved, in a fluid or another solid
Suture material: an absorbable or nonabsorbable material used for surgical stitches
Symptomatology: combined symptoms of a disease
Technetium (Tc): a radioactive metallic element
Ulcerative colitis: a chronic, episodic inflammatory disease of the large intestine characterized by profuse watery diarrhea, bleeding, and infection

Nasogastric (NG) and nasoenteric (NE) tubes are inserted for therapeutic and diagnostic purposes. These tubes have a hollow lumen through which secretions and air may be evacuated or medications, nourishment, or diagnostic contrast agents may be instilled. The radiographer must be able to care for and transport patients with these tubes in place. He must also understand the purposes of gastric suction and be able to attach or discontinue it when the physician's orders require that this be done.

Studies are done in radiographic imaging that require the passage of NG or NE tubes prior to the examination. The radiographer will not insert these tubes, but he may be asked to prepare the patient if the tube is to be inserted in the diagnostic imaging department. He must know what type of equipment to assemble and how to assist with the procedure.

The radiographer will occasionally see a patient for an examination who has a gastrostomy tube in place. These tubes may be required for persons who are gravely debilitated and are unable to obtain nutrition in a normal physiologic manner. These patients must be cared for safely and with sensitivity.

Patients who are unable to take in nutrients through the gastrointestinal (GI) system, either partially or completely, may be nourished intravenously. This can be accomplished in the short term parenterally by peripheral intravenous means and in the long term by reliance on central venous catheters. The radiographer who cares for a patient with a central venous catheter must learn what precautions to take to prevent life-threatening complications.

Occasionally, it will be necessary for the patient who has vomited or who has an accumulation of blood or secretions in his mouth or throat to be suctioned while the radiographer is caring for him. The radiographer does not perform the suctioning procedure, but he must be able to assess a patient's need for suctioning and be able to prepare the equipment so that the procedure may be done quickly in order to prevent aspiration of fluid into the lungs or respiratory failure.

Patients with tracheostomy tubes in place may also need diagnostic imaging examinations. They will require proper care by the radiographer in order to prevent injury and to keep them comfortable while the examination is in progress.

Patients who are unable to maintain adequate respiration may require mechanical ventilation to support life. The radiographer is frequently asked to take radiographs of patients who are on mechanical ventilators; therefore, he must understand the precautions to take when working with these patients.

Chest tubes are inserted following surgical procedures, injury, or diseases of the lungs in order to permit drainage of fluid or air out of the pleural space. If air and fluid become trapped in the pleural space, pressure will build and create what

is called a *tension pneumothorax*. If this condition is not relieved, the resulting respiratory distress may produce a life-threatening situation. The radiographer must learn the precautions he must take when caring for patients with chest tubes in place with water-sealed drainage.

Following surgical procedures, a variety of tissue drains are placed in the areas of the body that poorly tolerate an accumulation of fluid. The radiographer must be able to recognize these drains and direct patient care in a manner that avoids dislodging the drains if they are present.

Nasogastric and Nasoenteric Tubes

NG tubes are made of polyurethane, silicone, or rubber. They are inserted through the nasopharynx into the stomach, the duodenum, or the jejunum. If a patient has an anatomical or physiologic reason why the nose cannot be used for passage, the tube may be inserted through the mouth over the tongue. NG tubes are used to keep the stomach free of gastric contents and air to assist in the healing process either before or after an operative procedure or during a disease process. They are also used for diagnostic examinations, for administration of feedings or medications, to treat intestinal obstruction, and to control bleeding.

NE tubes are made of the same materials as NG tubes and are inserted in much the same ways as NG tubes; however, they are allowed to pass on into the duodenum and small intestine by means of peristalsis. They are also used for decompression, diagnosis, and treatment purposes.

Two of the most common NG tubes are the Levin and the sump tube. Other NG tubes often seen are the Nutriflex, the Moss, and the Sengstaken-Blakemore esophageal-NG tube. The Levin tube is a single-lumen tube with holes near its tip (Fig. 10–1*A*). The sump tube is a double-lumen tube which is radiopaque. The opening of the second lumen is a blue extension off the proximal end of the tube (the end that remains outside) called a "pig tail" (see Fig. 10–1*B*). This end is always left open to room air for the purpose of maintaining a continuous flow of atmospheric air into the stomach, thereby controlling the amount of suction pressure that may be placed on the gastric mucosa. This is a means of preventing injury and ulceration of these tissues.

The Nutriflex tube is used primarily for feedings. It has a mercury-weighted tip and is coated with a lubricant that becomes activated when moistened by gastric secretions.

The Moss tube is a more complex triple-lumen tube. One lumen has an inflatable balloon to anchor it in the stomach. The second lumen is used for aspiration of fluid, and the third is for duodenal feeding (Fig. 10–2).

The Sengstaken-Blakemore (S-B) tube is also a triple-lumen tube (see Fig. 10–1*C*); two of the lumina have balloons. The balloons are inflated to exert pressure on bleeding esophageal varices. The third lumen is used for lavage and to monitor for hemorrhage. The balloon pressure must be maintained at all times, but if the patient becomes dyspneic, the balloon pressure must be relieved at once by cutting the balloon lumina with scissors. The radiographer must not attempt to care for a patient with an S-B tube in place without the patient's nurse on hand. Asphyxiation or aspiration of gastric contents into the lungs are possible without keen and continuous monitoring. The patient with this type of tube in place will usually be cared for in the intensive care unit, and portable radiographic films will be ordered.

Three of the most commonly used NE tubes are the Cantor, the Harris, and the Miller-Abbott. The Cantor and Harris tubes have a single lumen (see Fig. 10–1*D*); the Miller-Abbott tube is a double-lumen tube. One lumen of the Miller-Abbott tube is used for intestinal decompression; the other is for the introduction of mercury following insertion. Some single-lumen tubes are weighted with a metal tip. The progress of the tube may be followed in the diagnostic imaging department fluoroscopically. Radiographs are taken following passage of these tubes to establish correct placement.

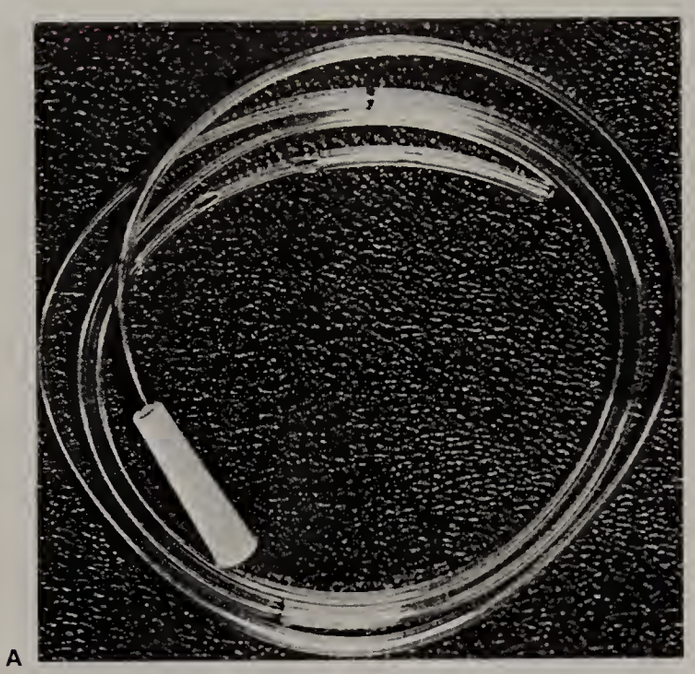
PASSAGE OF NASOGASTRIC AND NASOENTERIC TUBES

Radiographers are not responsible for inserting NG or NE tubes. A registered nurse usually inserts an NG tube; a registered nurse or a physician inserts the NE tube. The radiographer may be required to assist with the passage of the gastric tube and will frequently care for patients who have them in place.

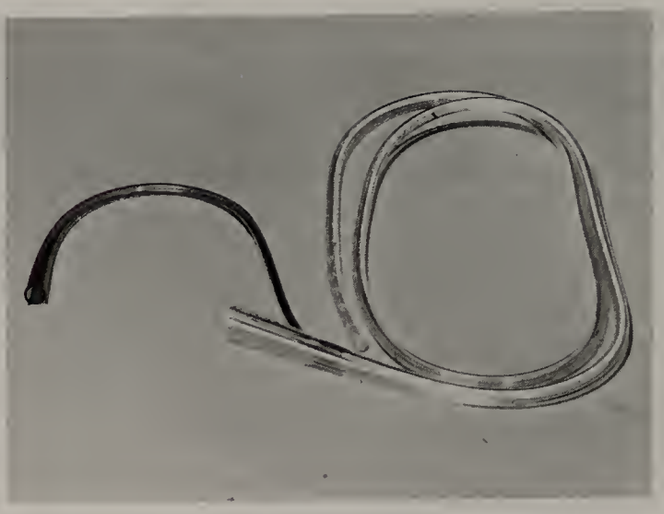
Patients with NG or NE tubes in place are often uncomfortable and may be very ill. While in the diagnostic imaging department, they should be informed of the treatment plan that will be followed and they must not be left unattended. Care must be taken to prevent accidental withdrawal of the tube after it has been inserted.

The placement of an NG tube must be ascertained before any medication, food, water, or con-

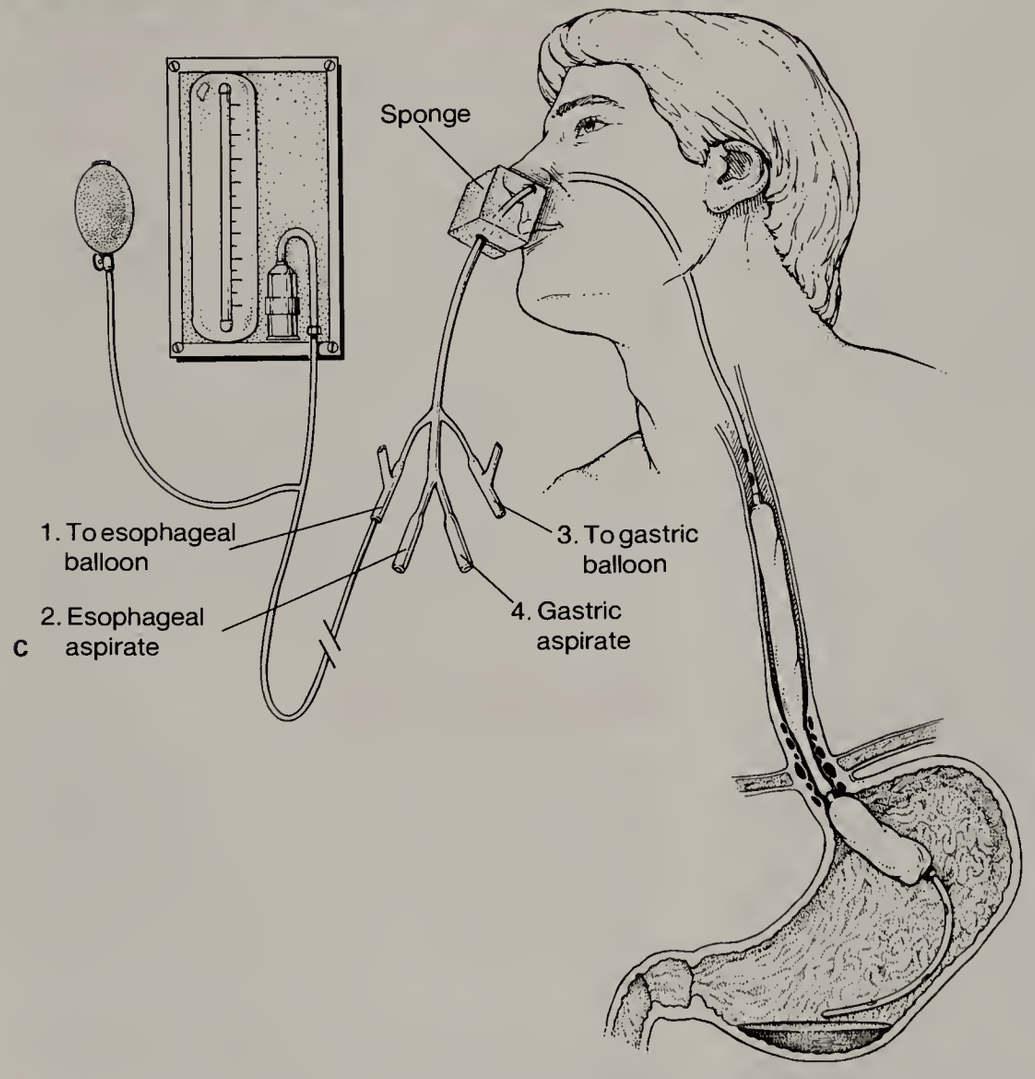
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A

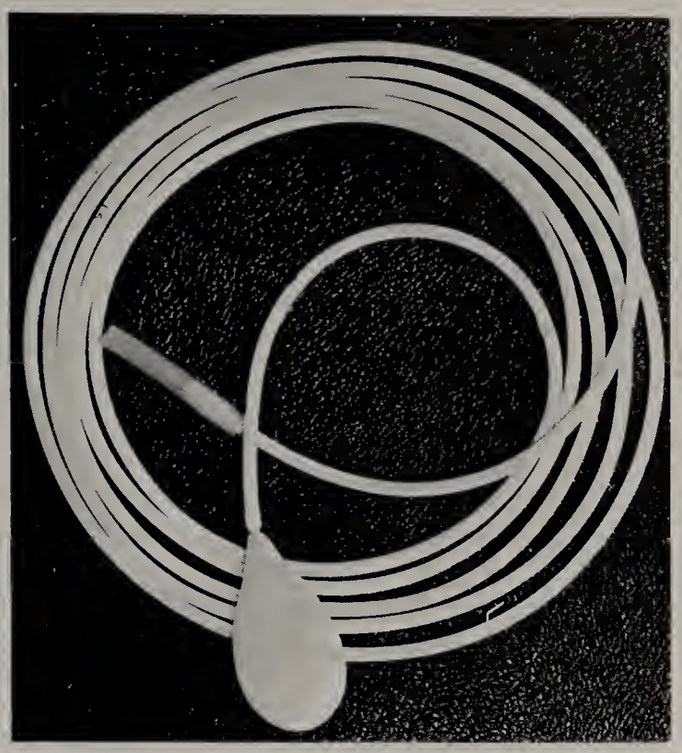


B



C

Figure 10–1
(**A**) A Levin tube. (**B**) A sump tube. (**C**) The Sengstaken-Blakemore tube. (**D**) The Cantor tube—a nasoenteric tube.



D

Figure 10–1 *(Continued)*

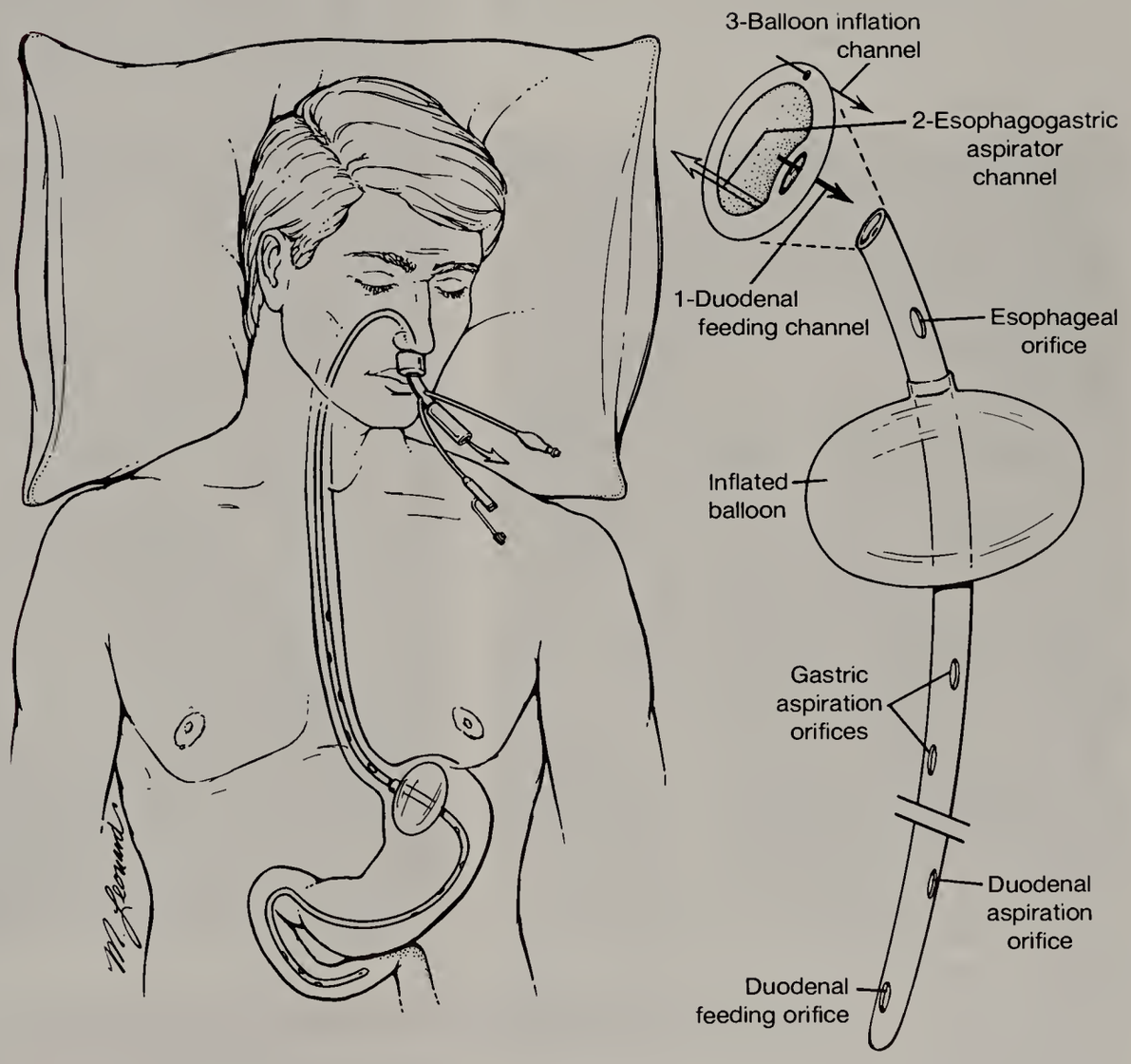


Figure 10–2
The Moss esophageal duodenal decompression and feeding tube has three chambers: the first anchors it in the stomach, the second is for aspiration, and the third for feeding. (Smeltzer SC, Bare BG: Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996.)

trast agent is administered into it. If this is not done, accidental administration of an agent into the pleural cavity may occur with adverse consequences for the patient.

The correct position of an NG or NE tube initially may be determined with a radiographic film or by fluoroscope. Obviously, a radiograph cannot be used each time it is necessary to know if the tube is correctly positioned. The other means of determining the correct placement of an NG or NE tube is by aspirating the tube with a syringe. The aspirant is then tested with litmus paper to measure its acidity. Gastric contents are acidic (pH approximately 3). The pH of intestinal secretions is less acidic (pH approximately 6 to 6.5). The pH of respiratory secretions is not acidic (pH 7 or greater) (Smeltzer and Bare, 1996).

If there is any doubt concerning the position of an NG or NE tube, nothing should be administered into it. If instillation of an agent has begun, it must be discontinued immediately. If the patient seems to have regurgitated gastric contents, the radiographer must summon assistance immediately and prepare to assist with suctioning. To reduce the risk of aspiration, the patient with an NG or NE tube should be placed in a semi-Fowler's position during and for 30 minutes following administration of any agent into the tube.

The materials needed for passage of an NG or NE tube are the following: a tube of the correct type and size (usually a 14- to 16-French lumen is used for an adult patient); rubber tubes (placed in a basin of ice prior to insertion to make the rubber more rigid and to facilitate passage); clean, disposable gloves; an emesis basin, a towel, a glass of water, and a drinking straw; a 20- to 50-mL aspirating, or bulb, syringe; water-soluble lubricant; wide hypoallergenic tape; a stethoscope; a tongue blade; a safety pin and rubber band; normal saline solution; and a suction machine, if suction is to be used.

This procedure is uncomfortable and frightening for the patient. If this procedure is to take place in the radiographic imaging department, the radiographer must explain to the patient what is to be done and for what purpose. The patient should be assured that if he concentrates on swallowing and breathing as the tube is inserted, the procedure will go smoothly and quickly.

The physician may swab the nasal passages and spray the oropharynx with tetracaine (Pontocaine) to promote the patient's comfort by anesthetizing the area and suppressing the gag reflex. A gargle with a liquid anesthetic may also facilitate the procedure.

The patient is placed in a Fowler's position with pillows supporting his head and shoulders. Tissues and an emesis basin should be close by for his use. The procedure is begun by the nurse or physician measuring the distance from the nose to the stomach externally (Fig. 10–3*A*). The Levin tube has black markings that indicate how far the tube has been inserted.

When the physician or nurse is ready to insert the tube, the distal end is lubricated with a water-soluble lubricant, and the patient is instructed to swallow as it is passed. A glass of water and a straw may be made available so that the patient has something to swallow if he is permitted to drink fluids. Placing several ice chips in the mouth also facilitates swallowing.

The tube should go down easily and with little force. When the tube is believed to be in the stomach, its position is verified by an initial radiograph (see Fig. 10–3*B*). If the tube is to be in place for a considerable length of time, its placement may be verified by attaching the end of the NG tube to a 20- to 30-mL syringe and withdrawing gastric fluid. The fluid is tested with litmus paper, which must test acidic to ensure that the tube is in the correct position.

When it is certain that the tube has reached the stomach, reassure the patient and make him comfortable. NG tubes are taped in place, but NE tubes are not taped, because their position is achieved through peristaltic action.

A safe and secure method of taping is the butterfly method. A piece of tape approximately 2 inches long is cut or torn lengthwise, and a second 2-inch piece is left intact. Wrap the intact piece of tape around the tubing. At the front of the tubing, crisscross the two pieces of tape and place them over the bridge of the nose (see Fig. 10–3*C*). Another piece of tape may be placed over the first two so that they will remain in place (see Fig. 10–3*D*).

Patients with gastric tubes in place are very uncomfortable and may be very ill. They should be reassured frequently and not left alone until they feel secure.

The radiographer must take care to tape the Levin tube securely so that it is not accidentally withdrawn. It should never be necessary to repeat passage of a gastric tube because of careless handling. There should be no pulling pressure on the tube. Patients with gastric tubes in place are not to eat or drink anything unless it is specifically ordered by the physician.

NASOENTERIC FEEDING TUBES

There are several narrow-lumen tubes that the radiographer may see that are inserted for the purpose of feeding patients. They are used for patients

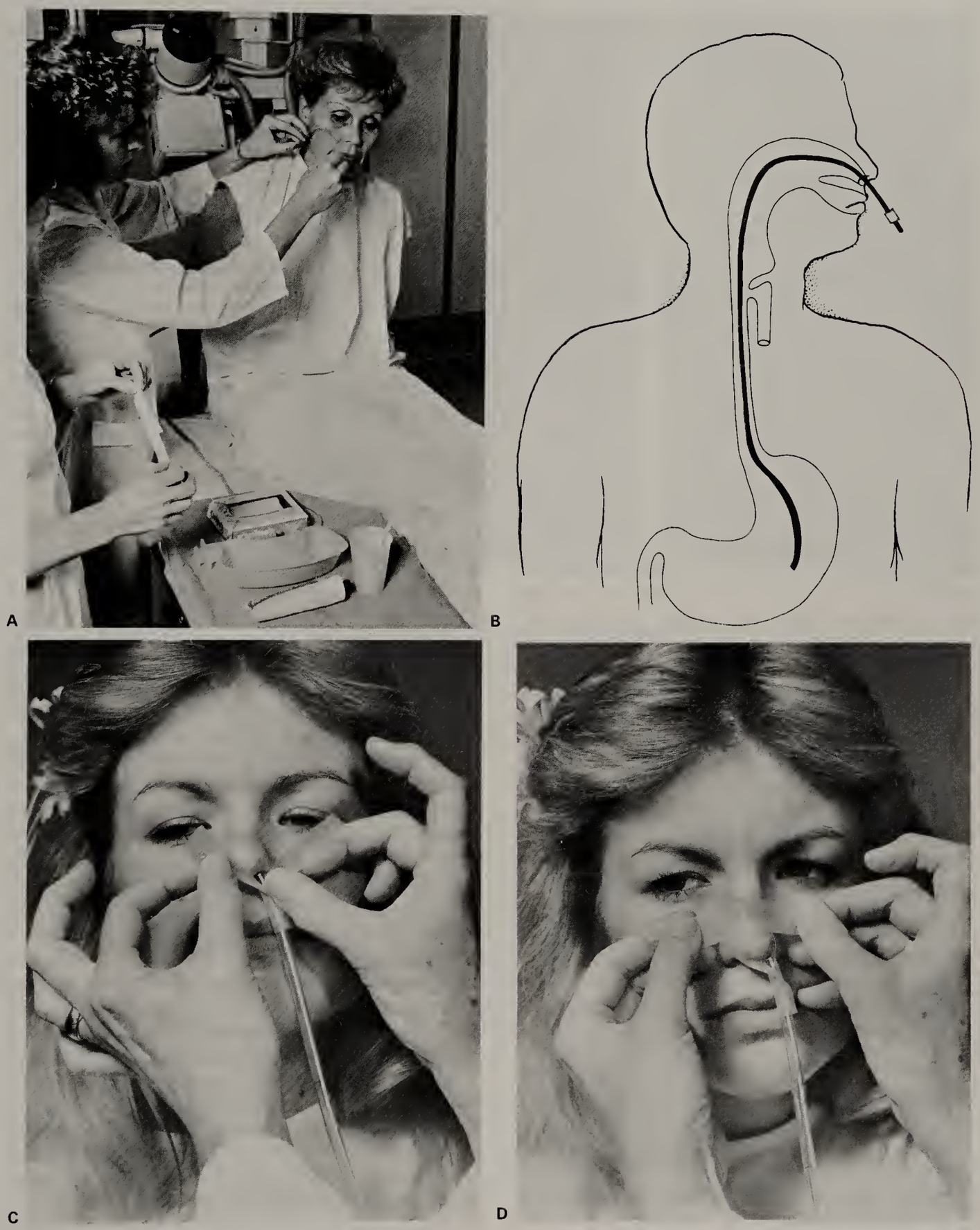


Figure 10–3
(**A**) Measure the distance from the nose to the stomach externally. (**B**) Position of the Levin tube in the stomach. (**C**) Cross the two pieces of tape and place them over the bridge of the nose. (**D**) Add a second piece of tape to reinforce the initial tape.

who are unable to obtain nourishment or take oral medications in a natural manner and who are expected to obtain nourishment by this method for some time.

Various forms of nutritional supplements may be prescribed depending on the patient's needs. The feedings may be given by continuous gravity drip, by bolus, or by a controlled pump method.

Patients may be discharged from the hospital with these tubes in place, so the radiographer may care for them either in the hospital, as outpatients, or in their homes. The radiographer's care of persons with feeding tubes in place does not differ from care of persons with NG or other NE tubes in place.

REMOVING GASTRIC TUBES

The Levin tube, the Sump tube, and other tubes simply positioned in the stomach are easily removed; however, the radiographer must never assume that simply because a radiographic examination that involved its use is complete, it is permissible to remove the tube. Unless the radiographer is ordered by the physician to remove the tube, it must remain in place. If the physician does order its removal, the radiographer may remove it.

Items needed to remove an NG tube are as follows:

An emesis basin

Tissues

Several paper towels

An impermeable waste receptacle (a plastic bag is best)

Clean disposable gloves, a face shield (or a mask and goggles), a gown

The procedure is as follows:

1. Don the protective gown.
2. Identify the patient and explain the procedure.
3. Wash your hands. Prepare the disposal bag by folding the large cuff downward.
4. If suction is attached to the tube, turn it off and disconnect it.
5. Gently remove the tape from the tubing.
6. Don mask, goggles, and gloves. Have paper towels prepared to receive the tube as it is removed.
7. Instruct the patient to take a deep breath.
8. Gently withdraw the tube, wrap it in paper toweling, and place it in the disposal bag.
9. If there is any resistance when the tube is being withdrawn, stop the procedure and call for assistance.
10. Make the patient comfortable, and remove your protective clothing and gloves. Correctly dispose of the contaminated waste.

NE tubes are not removed by the radiographer. The physician or registered nurse may remove the tube, or it may be allowed to be passed through the intestinal tract and removed rectally.

Transferring Patients With Nasogastric Suction

NG and NE tubes are used before or after surgical procedures that involve the digestive system and for illness of the GI system to keep the stomach and bowel free of gastric contents and for gastric decompression. The tube may be attached to a suction apparatus that is either portable or piped into the room from a central hospital unit (Fig. 10–4). The suction is maintained either continuously or intermittently as the patient's needs demand. When the radiographer is responsible for transferring a patient who is having either continuous or intermittent gastric suctioning, he must verify the physician's orders before making the transfer. If it is permissible to discontinue the suction, he must know the length of time that it can be interrupted safely. If it is for only a short time, he must be certain that suction can be reestablished in the diagnostic imaging department. This can be accomplished by taking the patient's portable suction machine with him or by using the suction available in the department. The radiographer must also know the amount of suction pressure that is required so that he can adjust the pressure accurately. The amount of pressure ordered varies, and the radiographer can determine the correct level by reading the physician's orders or by asking the nurse in charge of the patient to do this. The maximum amount of suction that can be used is a pressure equal to 25 mm Hg for an adult patient. More than this can damage the gastric mucosa.

If the suction must be discontinued for a period of time, the radiographer may do this. If the tube is

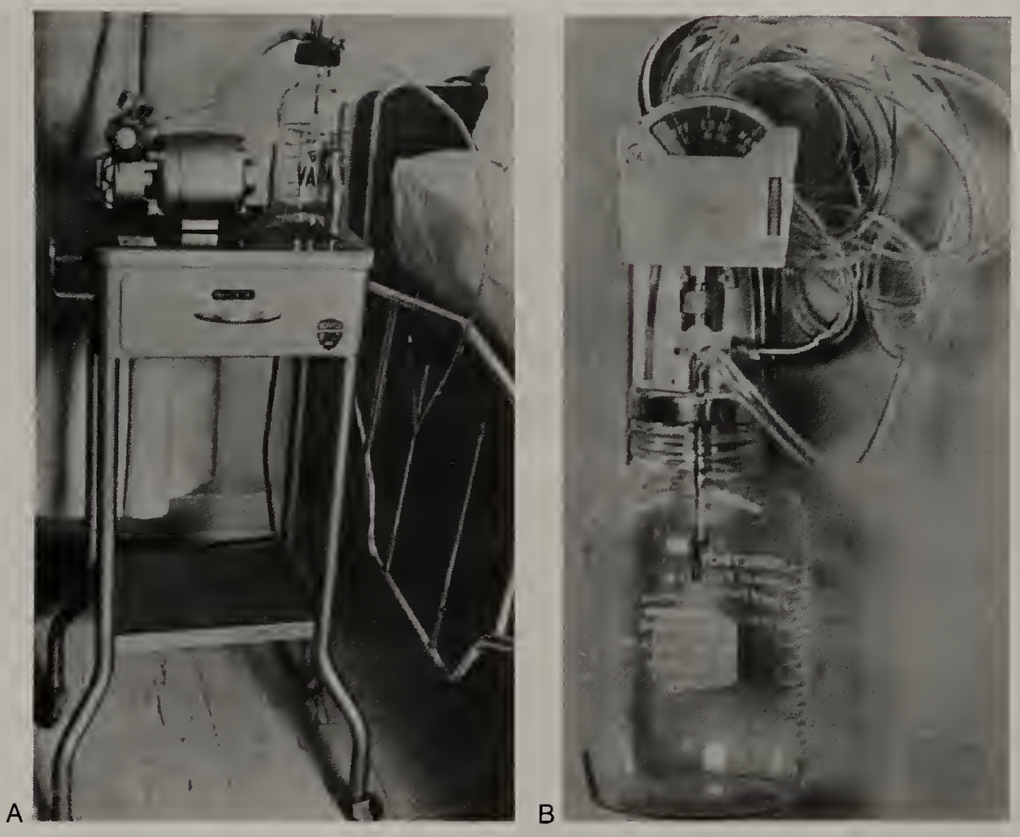


Figure 10–4
(**A**) A portable, electrically operated suction machine. The pressure control valve and the pressure indicator are located above the motor. The drainage runs into the vacuum bottle on the right. The tubing at right is connected to the gastric tube. (**B**) Suction equipment is often used in radiology departments, and suction may be piped to the department from a central area in the hospital. This particular model is activated by turning the valve at the top (*right*), just below the pressure gauge. The suction is regulated by adjusting the valve (*center*) above the vacuum collecting bottle.

a single-lumen tube, the radiographer will need the following materials: a pair of clean, disposable gloves, a clamping device, a package of sterile gauze sponges, and two rubber bands.

The procedures for discontinuing suction are as follows:

1. Explain the procedure to the patient, then wash your hands, open the package of sponges, and don the gloves.
2. Turn off the suction; clamp or plug the gastric tube with the clamp or stopper (Fig. 10–5*A*), and place one gauze pad over the end of the tube. Secure it with a rubber band.
3. Cover the connecting end of the suction tubing or the adapter with the other sponge, and secure it with a rubber band. This gauze covering will keep both ends of the tubing clean while not in use (see Fig. 10–4*B*).
4. Secure the suction tubing on the machine so that it will not fall onto the floor, and make certain that the NG or NE tube will not be dislodged during the transfer.
5. Then proceed with the transfer by wheelchair or gurney as required.
6. If the suction is to be restarted in the diagnostic imaging department on arrival, set the suction pressure gauge, turn on the suction, and reattach it to the tubing. This procedure is repeated when transferring the patient back to his room.

If the NG tube is a double-lumen tube, it must never be clamped closed with a hemostat or regular clamping device, because this may cause the lumens to adhere to each other and destroy the double-lumen effect. To prevent leakage from this type of tube, the barrel of a piston syringe may be inserted into the suction-drainage lumen (the blue pigtail); it is then pinned to the gown with the barrel upward to prevent reflux drainage (see Fig. 10–5*C*).

The Patient With a Gastrostomy Tube

A gastrostomy is the surgical creation of an opening into the stomach. It is through this opening that a tube is placed from the inside of the stomach to the external abdominal wall for the purpose of feeding a patient who cannot tolerate oral food intake (Fig. 10–6). This can be a temporary or a permanent provision. The tube can be sutured in place or may be held in place with a crossbar that holds the tube against the wall of the stomach.

The patient with a newly applied gastrostomy tube has an unhealed surgical incision and will

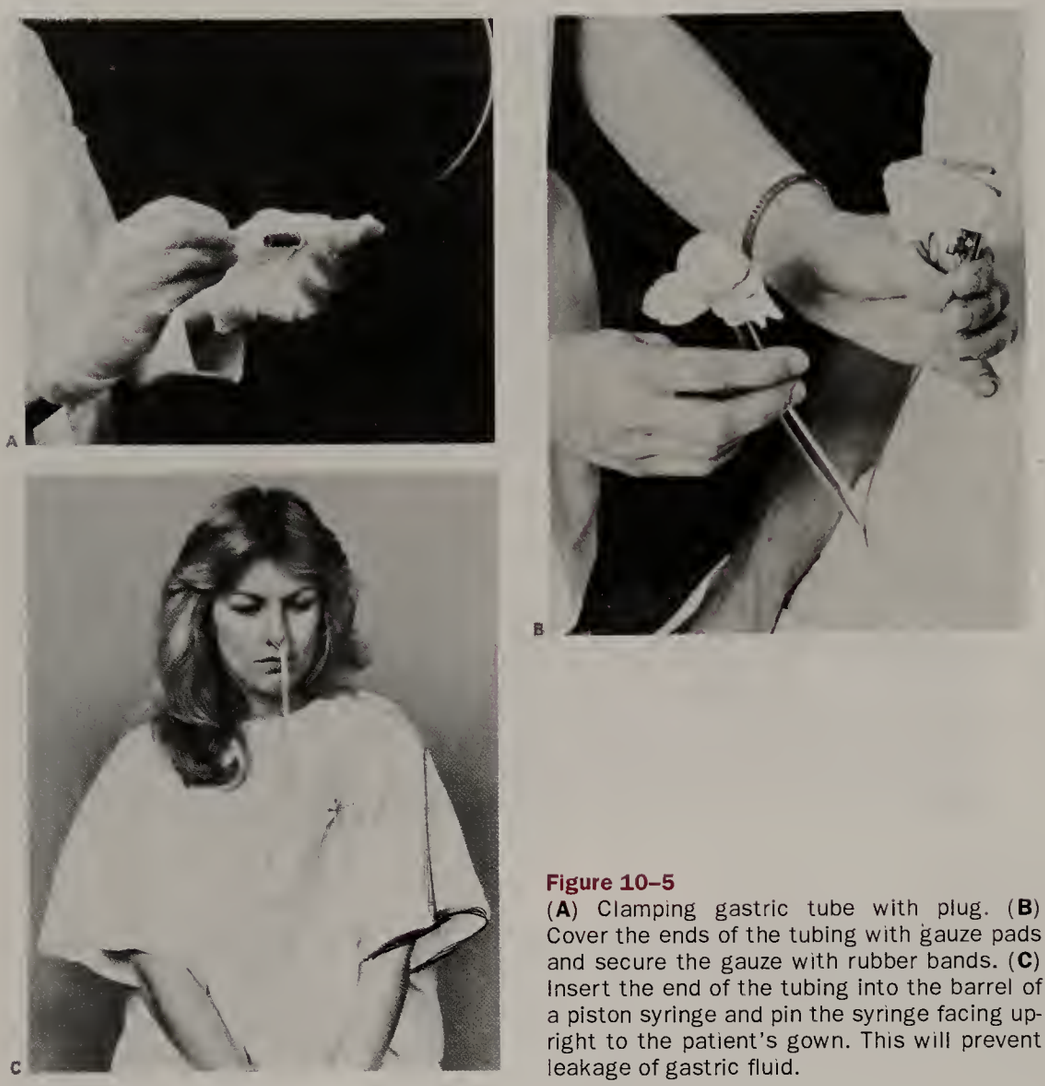


Figure 10–5
(**A**) Clamping gastric tube with plug. (**B**) Cover the ends of the tubing with gauze pads and secure the gauze with rubber bands. (**C**) Insert the end of the tubing into the barrel of a piston syringe and pin the syringe facing upright to the patient's gown. This will prevent leakage of gastric fluid.

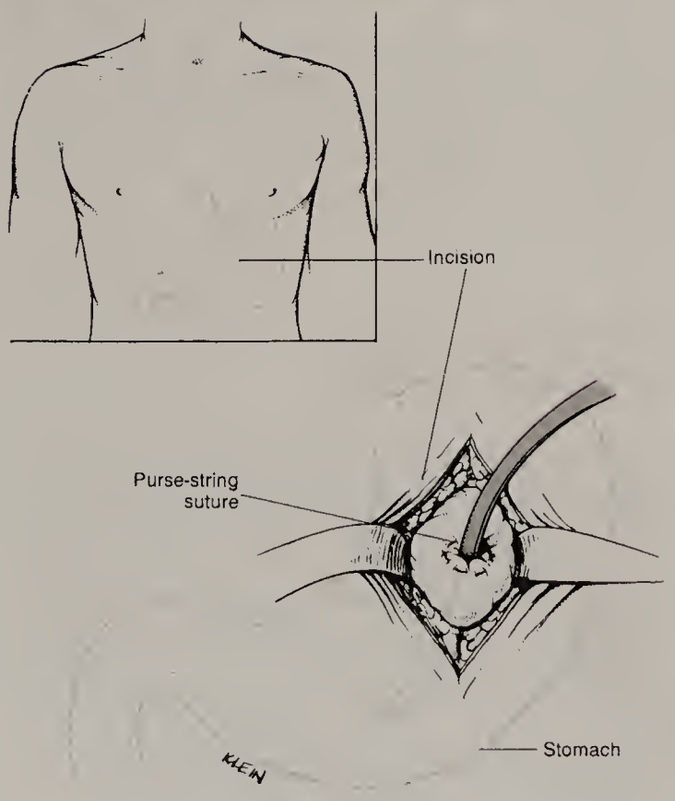


Figure 10–6
A gastrostomy tube.

have a dressing in place. An older gastrostomy may or may not have a dressing applied. The tube is closed off following feeding with a clamp or a plug-in adapter to prevent leakage of gastric fluid or food. The tube is then coiled and kept in place with tape or a small dressing.

The radiographer caring for a person with a gastrostomy tube in place must be aware of the potential for infection. If the operative area around the gastrostomy tube is not healed, sterile gloves must be worn if there will be contact with the open area to prevent introduction of microorganisms that may result in infection. The potential for dislodging the tube is also present. Care must be taken to prevent this. There must be no tension placed on the tube.

The radiographer must also be sensitive to the feelings of the patient with a gastrostomy. He may be grieving due to the change in his body image or because of a chronic illness. The radiographer must communicate with him in a sensitive and thoughtful manner. The patient who is able should be allowed to direct care of the tube.

The Patient Receiving Parenteral Nutrition or Who Has a Central Venous Catheter

Central venous catheters and implanted ports are being utilized with increasing frequency for patients who must have long-term medication administration, frequent blood transfusions, hyperosmolar solutions, or total parenteral nutrition. The radiographer must be aware of their presence and purpose and familiar with the precautions he must take if they are in place.

When a patient does not have an adequate nutritional intake and cannot tolerate nourishment by means of the GI tract, he may be ordered to receive partial or total nutrition by an intravenous route. Partial parenteral nutrition is used when the patient is able to supply a part of his nutritional requirements by natural means. A large-gauge catheter is inserted into a large peripheral vein in the arm, and a parenteral solution containing a combination of lipid emulsion and amino acid/dextrose solution is administered as needed to satisfy the patient's nutritional needs. Vitamins and minerals are often added to these solutions. Care of patients receiving peripheral intravenous therapy is discussed in Chapter 12.

When the patient requires total nutritional support by the parenteral method, it is delivered through a central vein. Total parenteral nutrition (TPN) solutions are hyperosmotic. This means that they are highly concentrated and would damage the intima of a peripheral vein; therefore, a large vein in the central venous system is utilized. Because fluid imbalance may result from TPN administered too rapidly, administration is controlled by a pump or an infusion controller. Intravenous pumps are discussed in Chapter 12.

There are several types of central venous catheters. The tunneled type is inserted into the subclavian or internal jugular vein and then advanced into the superior vena cava or the right atrium. The exit site is on the anterior chest. Most central venous catheters have more than one lumen and several access ports at the exit site (Fig. 10–7).

The Hickman and Broviac catheters are two commonly used tunnel-type central venous catheters. Two other commonly used central venous catheters are the peripherally inserted central (PIC) and the Groshong. The PIC catheter may be peripherally inserted into the patient's arm and advanced until its tip lies in a central vein.

Another alternative central venous catheter is an implanted port. These are meant for patients who have long-term illnesses that require frequent intravenous medication or transfusions. The port is made of plastic, titanium, or stainless steel. It is implanted into the subcutaneous tissue, usually in the chest, and sutured in place (see Fig. 10–7). The port is not visible but can be felt as a small, hard surface under the subcutaneous tissue. A catheter from the port is then inserted into the subclavian or internal jugular vein. A needle, called the *Huber needle,* is inserted to access the central vein through the port.

The radiographer who cares for a patient with a central venous catheter or port in place must use

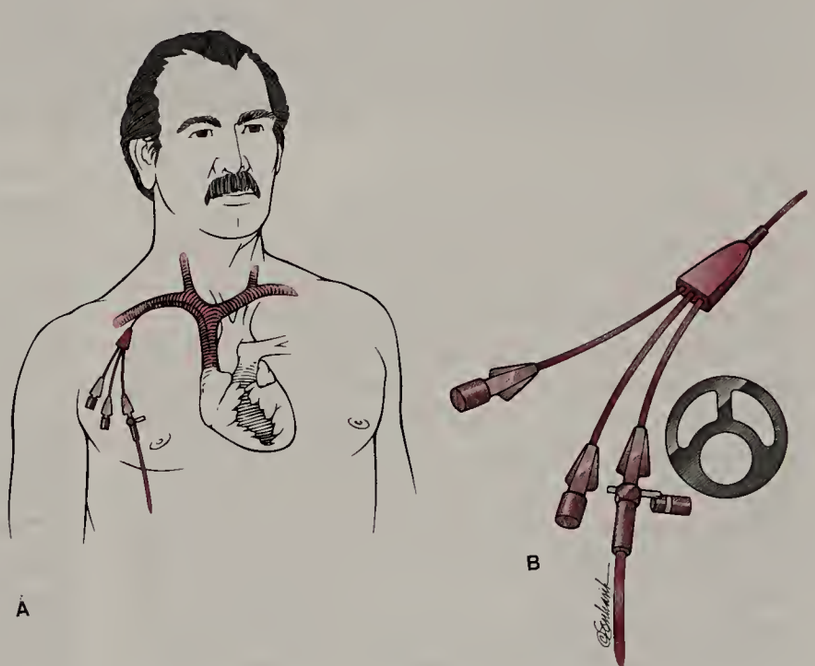


Figure 10–7
Subclavian triple lumen catheter used for total parenteral nutrition and other adjunct therapy. (**A**) The catheter is threaded through the subclavian vein and placed in the vena cava. (**B**) Each lumen is an avenue for solution administration; these are secured with Luer-Lok caps when not in use. (Smeltzer SC, Bare BG: Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996.)

great care to prevent infection at the insertion site. If a dressing around the catheter must be removed, he must receive a physician's order to do so. He must wash his hands for 2 minutes and don clean gloves to remove the dressing. If a dressing is to be reapplied, he must use the hospital protocol for applying dressings to central venous catheters. Dressings are usually removed and reapplied with both the health care worker and the patient wearing masks if the insertion site is in the upper thoracic area. If the patient does not wear a mask, he must turn his head so that he is not breathing on the site. The dressing must be removed carefully to avoid dislodging or moving the needle.

Emergency Suctioning

Occasionally an infant, a child, an unconscious patient, or a very weak and debilitated patient will be unable to clear emesis, sputum, or other drainage from his nose, mouth, nasopharynx, or oropharynx by coughing or swallowing. The radiographer caring for a patient in these circumstances must place the conscious person into a semi-Fowler's position and assist him to clear his airway. If the patient has a potential spinal cord injury and is in a back brace and a collar and begins to vomit, he must be log rolled to his side with his face directed downward. No movement of the head or neck should be allowed. If the airway is not cleared quickly, the patient may need to be suctioned. Signs that indicate that a patient may need to receive nasopharyngeal or oropharyngeal suctioning are as follows:

1. Profuse vomiting in a patient that cannot voluntarily change his position.
2. Audible rattling or gurgling sounds coming from the patient's throat.
3. Signs of respiratory distress.

Persons with these symptoms may require mechanical suctioning to remove the secretions in order to prevent aspiration or respiratory arrest.

Suctioning is an emergency procedure. It is not within the scope of the radiographer's practice to perform suctioning procedures because there are many instances in which suctioning may be contraindicated. The need for suctioning must be determined by a health care professional who has been educated for this and who is familiar with the patient's condition. Some contraindications for suctioning may be head and facial injuries, bleeding esophageal varices, nasal deformities, trauma, cerebral aneurisms, tight wheezing, bronchospasm, and croup.

The radiographer must be able to determine that his patient may need to be suctioned, to call for the physician or the registered nurse to do this if necessary, and to assist with the procedure. The radiographer is responsible for checking the emergency suctioning equipment in his department each day in order to be certain that it is in good working order and that all necessary items for suctioning are available. The items necessary for suctioning the oropharynx or nasopharynx are as follows:

1. A wall outlet or a working portable suction machine
2. Adapters for wall outlets
3. Clean and sterile gloves
4. Tubing
5. Sterile disposable suction sets that contain suction catheters of various sizes and either a Y- or thumb-control connector
6. Sterile containers for sterile solution
7. Sterile water or sterile normal saline solution
8. Tongue depressors padded with gauze
9. An oxygen source and oxygen-administering equipment
10. Packets of sterile, water-soluble lubricant
11. Gowns, masks, and goggles

Catheters for emergency suctioning may vary in size from a 10- to an 18-French lumen for adults (22 inches long) and 5- to 8-French lumen (15 inches long) for children (Fig. 10–8*A*). Pressure settings will vary depending on the patient's age and will usually be higher than those used for NG suctioning. Sterile technique is recommended for nasopharyngeal and oropharyngeal suctioning because the respiratory tract is easily infected. Introducing new microorganisms into the respiratory tract must be avoided. Maintenance of sterile technique is discussed in Chapter 5.

Before suctioning begins, the radiographer should wash his hands and assemble the necessary equipment for the physician or nurse. The patient should be placed in a semi-Fowler's position with his head turned toward the side if he is alert and has a functioning gag reflex. An unconscious patient or a child should be placed in a lateral (side-lying) position with no pillow. Adequate lighting must be available. (A portable gooseneck lamp



Figure 10–8
(**A**) A suction catheter. (**B**) Activating the suction.

may be used). A towel is then placed over the patient's chest.

After the patient is prepared, the person who will perform the suctioning will put on gown, mask, and goggles and will open the sterile packet containing the catheter and the connector. He will then put on sterile gloves, pick up the catheter, and connect it to the suction adapter. He must keep the hand that will touch the suction catheter sterile; the other hand becomes contaminated. The radiographer may pour a small amount of normal saline into a sterile container, turn on the suction machine, and adjust the pressure as directed by the physician or nurse. The suction pressure for adults is approximately 110 mm Hg to 150 mm Hg on a wall-mounted outlet. Wall outlets are usually more powerful than portable machines. For infants, the requirements vary from 50 mm Hg to 95 mm Hg for wall-mounted outlets. For older children, the setting for wall outlet suction varies from 100 mm Hg to 120 mm Hg.

The person doing the suctioning may test the suction by placing the catheter tip into the sterile water and drawing a small amount through the tubing. This also moistens the catheter tip and thereby lubricates it.

The patient should be encouraged to breathe slowly as the catheter is positioned. The catheter

tip is advanced into the patient's oropharynx or nasopharynx. Suctioning must not begin until the catheter is in place. The suction is activated by placing the thumb over the opening on the connector (see Fig. 10–8*B*). The actual suctioning should not take more than 10 seconds. Suctioning for longer periods compromises the patient's oxygen supply. The mucosa may also be damaged by suctioning.

Care must be taken not to snag or irritate mucous membranes during the procedure. The catheter is withdrawn in a gentle rotating motion. The catheter tip is then placed into the sterile water or saline and the solution is passed through the catheter to cleanse it. A padded tongue blade may be used to keep the tongue depressed during oropharyngeal suctioning.

If further suctioning is needed, a period of 3 minutes is allowed for the patient to rest between catheter insertions. This is particularly important for infants and children. The patient often receives oxygen between suctioning and should be suctioned no more than two times during one session. If the patient is able, he should be asked to cough and deep breathe between suctionings.

If both oropharyngeal and nasopharyngeal passages are to be suctioned, a fresh catheter is used for each. Sterile, water-soluble lubricant is applied to the tip of a catheter to be inserted into the nasal passages. During this procedure the radiographer should reassure the patient. If he fights the procedure, it may have to be discontinued.

After suctioning has been completed, the used disposable equipment should be placed into a plastic bag, which should be sealed and disposed of in the proper waste receptacle. The drainage tubing and collecting bottle from a portable suction machine should be cleaned and replaced. Clean, disposable gloves must be worn by the radiographer while he is cleaning and disposing of this equipment because he may come into direct contact with the patient's secretions during the process. Sterile supplies should be replenished immediately. If the patient's condition permits, the radiographic imaging procedure may continue.

The Patient With a Tracheostomy

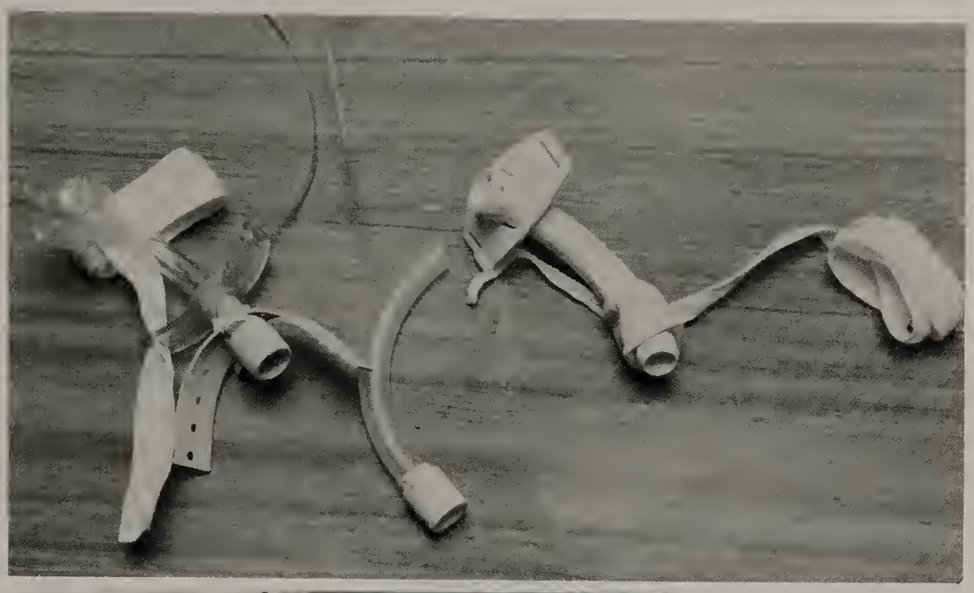
A tracheostomy is an opening into the trachea created surgically either to relieve respiratory distress caused by an obstruction of the upper airway or to improve respiratory function by permitting better access of air to the lower respiratory tract. This may be done as either a temporary or a permanent measure. Patients requiring this procedure may have suffered traumatic injury or may be paralyzed, unconscious, or suffering from a disease that interferes with respiration.

Once the surgical incision is made and the opening exists, a tracheostomy tube is inserted into the opening. Tracheostomy tubes are equipped with an obturator in order to ensure safe insertion; the obturator is removed as soon as the tube is in place (Fig. 10–9*A*).

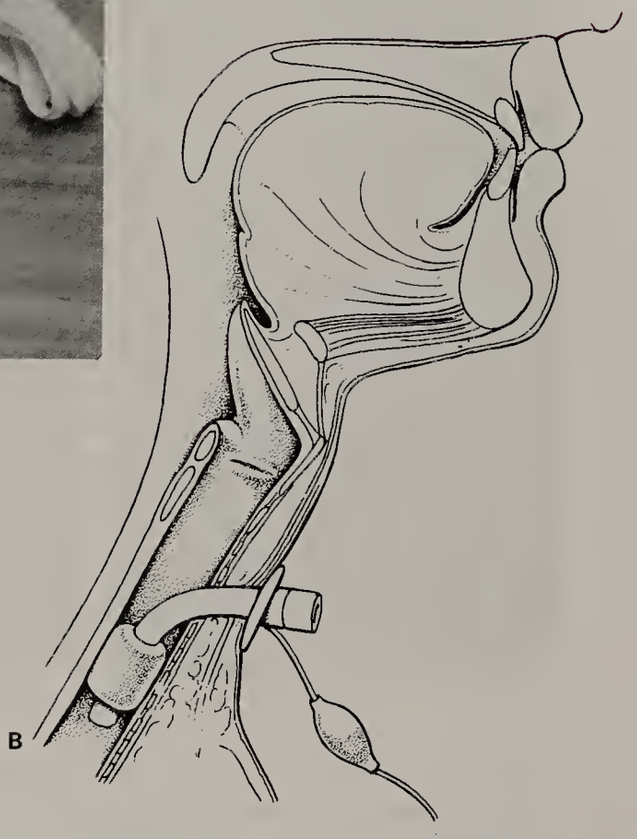
There are several types of tracheostomy tube. They are usually made of plastic but may be metal. They have a cuff that helps seal the tracheostomy to prevent air leaks and aspiration of gastric contents (see Fig. 10–9*B*). Most tracheostomy tubes have an inner cannula that is locked into place (see Fig. 10–9*C*). The tracheostomy tube is held in place at the back of the neck with ties or tapes. Tracheostomy tubes used for infants and small children do not usually have the cuff, because they fit tightly enough without one.

Patients with newly inserted tracheostomy tubes are very fearful. They are unable to speak because the opening in the windpipe prevents air from being forced from the lungs past the vocal cords and into the larynx. They are afraid of choking because they are unable to remove secretions that accumulate in the tracheostomy tube. These secretions must be suctioned out by a registered nurse (see Fig. 10–9*D*). If a patient with a new tracheostomy is brought to the diagnostic imaging department, he should be accompanied by a nurse qualified to care for him. Sterile suction catheters, suctioning equipment, and oxygen-administration equipment must be prepared before the patient arrives in the department. The semi-Fowler's position is usually most comfortable for these patients, and the radiographer should provide bolsters or pillows in order that the best position for the patient may be maintained.

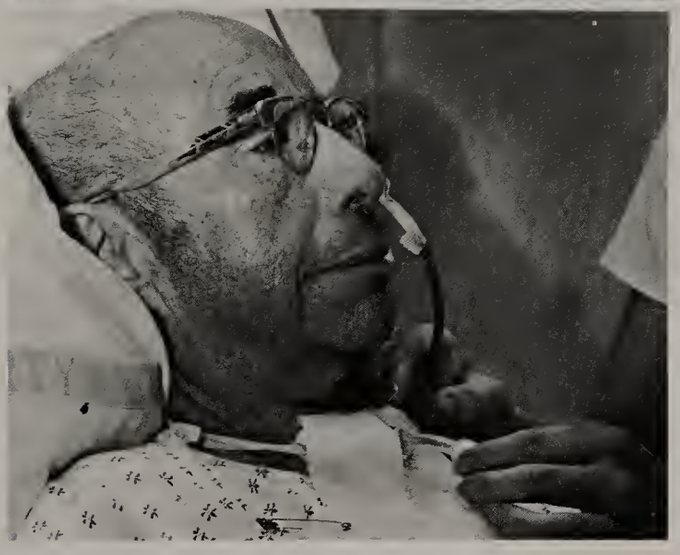
The radiographer caring for the patient with a tracheostomy must plan his care with the patient's nurse and the patient before any diagnostic imaging procedure is begun. The tracheostomy tube must not be removed and the tapes holding it in place must not be untied for any reason, because the tracheostomy tube may be dislodged and may not be able to be replaced immediately. The radiographer must explain all procedures that the patient will receive in order to alleviate anxiety. A pencil and a writing pad should be provided for the patient on which he may write any comments or responses that he wants to make. If the patient appears to be breathing noisily or with difficulty,



A



B



C



D

Figure 10–9
(**A**) Two types of tracheostomy tubes. Tube on right with obturator removed. Inner cannula is beside tube. (**B**) Tracheostomy tube placement. (Brunner LS and Suddarth DM: Lippincott Manual of Nursing Practice. Philadelphia, JB Lippincott, 1986.) (**C**) Removing the inner cannula from a tracheostomy tube. (**D**) Nurse suctioning a tracheostomy tube.

the radiographer must immediately stop working and allow the nurse to suction the patient or otherwise relieve his discomfort.

The Patient on a Mechanical Ventilator

The radiographer is frequently called to the intensive care unit of the acute care hospital to take radiographs of patients who are being ventilated mechanically. Patients who continue to need mechanical ventilation may be transferred to extended care facilities or to their homes, and the radiographer may be sent there to radiograph a ventilator patient. Because mechanical ventilators support life, it is of great importance that the radiographer understand the precautions he must take in caring for a patient whose breathing is supported by mechanical means.

A patient who cannot breathe spontaneously or whose respiration is inadequate to oxygenate his blood is a candidate for mechanical ventilation. The need for this may be the result of a pathological condition that alters gas exchange, oxygen perfusion, or both. These are called gas exchange disorders. Examples of these might be pulmonary emboli or severe respiratory infections.

The need for mechanical ventilation may be the result of a disease process that affects the mechanics of breathing by interfering with the neurological or neuromuscular functions related to breathing. These are called extrapulmonary disorders. Examples of extrapulmonary disorders that may require mechanical ventilation to support respiration are cerebral vascular accidents and Guillain-Barré syndrome.

There are two general classifications of mechanical ventilators, positive-pressure and negative-pressure ventilators. Negative-pressure ventilators are most likely to be seen in the home, as they are simple to use. They exert a negative pressure on the chest wall. When this occurs, air rushes into the negatively pressurized space to refill it and it is again removed. Two types of negative-pressure ventilators are the Drinker Respirator Tank, or iron lung, and the Body Wrap, or tortoise shell. Both are cumbersome and somewhat difficult to use; however, they have the advantage of not requiring an artificial airway for use.

Positive-pressure ventilators are the more commonly used type. There are three general categories of positive-pressure ventilators: pressure-cycled, time-cycled, and volume-cycled. They inflate the lungs by exerting positive pressure on the lungs, stopping inspiration when a preset pressure is attained. The lungs are then allowed to expire passively. All positive-pressure ventilators require an artificial airway, either an endotracheal tube or a tracheostomy.

The volume-cycled ventilator is the most often used at present. The machine stops inspiration when it has delivered a predetermined volume of gas in spite of the amount of pressure needed to deliver it. Expiration is passive (Fig. 10–10).

The radiographer who is assigned to radiograph a patient who is on a positive-pressure ventilator must consult with the nurse assigned to care for the patient prior to beginning his work. He must identify with the nurse any special problems that he might have and plan the procedure carefully. The following precautions must be taken by the radiographer for a patient who is being ventilated by positive pressure:

1. Obtain as much assistance as necessary to move the patient safely.
2. Do not place tension on any intravenous tubing or on the tube to the ventilator.
3. Do not displace the endotracheal tube or tracheostomy tube.
4. Do not disconnect the power to the ventilator.
5. Do not disconnect the spirometer.
6. Have the patient's nurse stand by. Provide the nurse with a radiation protection garment.
7. If the patient becomes suddenly restless or confused or seems to be fighting the respirator, notify the nurse immediately.
8. Use meticulous medical aseptic technique when working with the patient to prevent infection. Don gloves if there is a possible contact with blood or body fluids.

If displacement or malfunction of any part of the equipment should occur, an alarm will sound on the machine. This may indicate a life-threatening problem that must be attended to immediately. The radiographer must know where the nurse is and seek assistance immediately.

The potential complications due to a positive-pressure ventilator equipment displacement or malfunction are as follows: cardiovascular compromise related to inadequate oxygenation; barotrauma or pneumothorax resulting from excessive ventilator pressure; or infection resulting from ex-

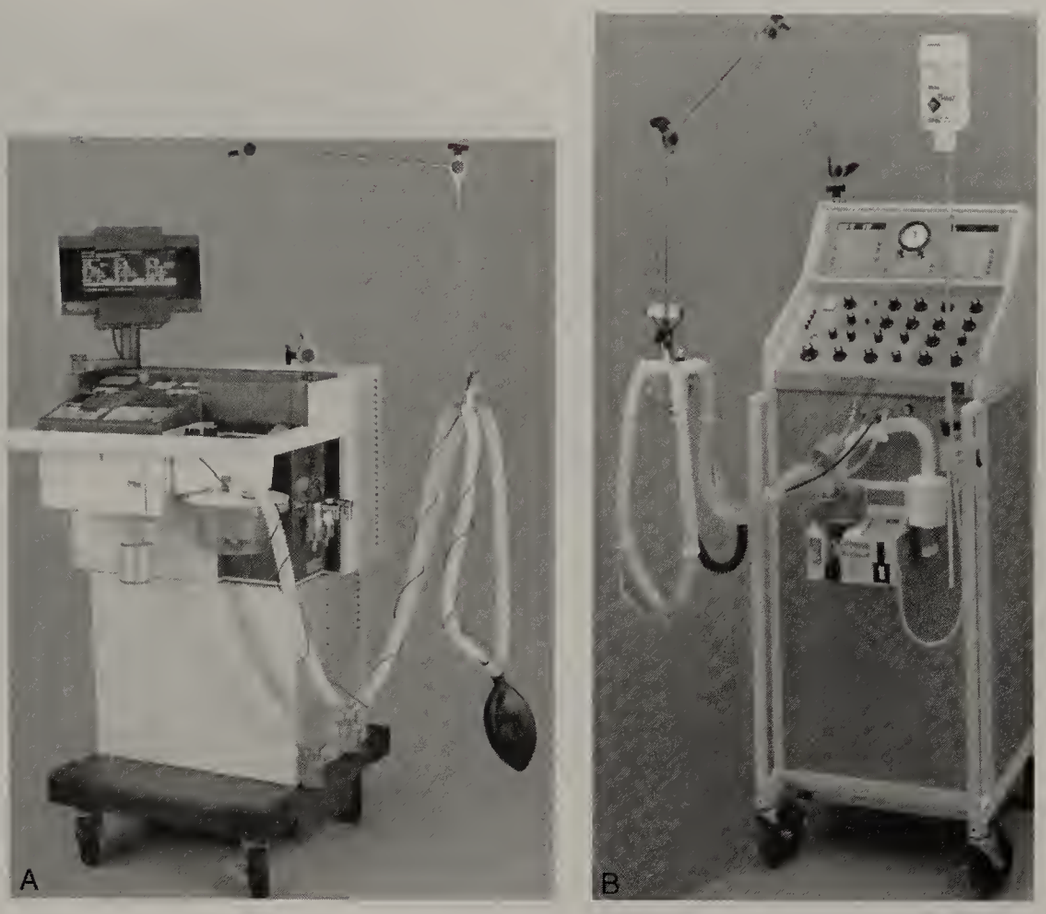


Figure 10–10
Two commonly used brands of volume-controlled ventilators. (**A**) Puritan-Bennett 7200A. (courtesy of Puritan Bennett Corp) (**B**) Bear 3 Adult (courtesy of Bear Medical Systems, Inc).

posure to microorganisms introduced into the pulmonary system.

The patient who is on a positive-pressure ventilator is unable to communicate because of the endotracheal tube or a newly acquired tracheostomy. This is extremely frustrating for the patient. Having the radiographer explain what he intends to do for the patient goes a long way toward relieving this frustration, as does providing the patient with a means to give written feedback if he is able to write.

The Patient With a Chest Tube and Water-Sealed Drainage

The pressure in the pleural cavity is normally lower than atmospheric pressure, but disease or injury can alter this. The result of increased pressure in the pleural cavity is collapse of the lung, which is called *pneumothorax*. A condition created by a collection of blood or fluid in the pleural cavity that prevents the lungs from expanding normally is called a *hemothorax*.

A thoracotomy, the surgical creation of an opening into the chest cavity, is performed to diagnose or treat diseases or injury to the lungs or pleura. Following a thoracotomy, one or more chest tubes are placed in the pleural cavity and attached to water-sealed drainage to remove air and fluid from the intrapleural space. This is done to reestablish the correct intrapleural pressure and to allow the lungs to expand normally.

A water-sealed drainage system is established by connecting the chest tube that originates in the pleural cavity to a clear tube that ends in a chamber containing sterile water or sterile normal saline solution. The tube leading from the chest tube remains below water level at all times to maintain the seal. When the patient inspires, air and fluid from the intrapleural spaces are drawn into the drainage tube and emptied into a chamber prepared to receive it. Since the fluid in the drainage chamber is heavier than air, it cannot be drawn back into the tube on inspiration, nor can air from the atmosphere enter because of the water seal.

There are several variations on the water-sealed system. There may be one, two, or three chambers present. Additional chambers, also with water seals, are needed for drainage from the patient's pleural cavity and for suction regulation if suction is also attached to the chest tube. If two chest tubes are coming from the pleural cavity, a Y con-

nector joins the two tubes near the patient's body and continues to the water-sealed drainage apparatus. There are a number of commercial water-sealed drainage systems on the market; most of these are disposable (Fig. 10–11).

When the radiographer is caring for a patient with a chest tube with water-sealed drainage, he must remember the following:

1. Keep the tubing from the pleural cavity to the drainage chamber as straight as possible. If it is long, loosely coil it on the patient's bed, and do not allow it to fall below the level of the patient's chest.
2. All connections must be tightly taped to the tubing and stoppers must fit tightly into receptacles.
3. A heavy sterile dressing and tape is kept at the bedside of the patient so that if the tubing is accidentally dislodged from the pleural cavity, the dressing can be taped to the open area immediately.
4. Do not empty water-sealed chambers or raise them. The water seal must remain below the patient's chest at all times.
5. Do not clamp chest tubes.
6. If a water-seal chamber is continuously bubbling, notify the patient's nurse immediately as this may indicate a leak in the system. There should be a steady rise and fall of the water as the patient breathes.
7. Immediately report to the patient's nurse rapid, shallow breathing, cyanosis, or a complaint from the patient of a feeling of pressure on his chest.
8. The drainage tube from the chest should be long enough to allow free patient movement. If the patient must be moved for radiographic exposure, do not allow tension to be placed on the chest tube or the patient to be positioned in a way that causes the tubing to be kinked or sealed off.

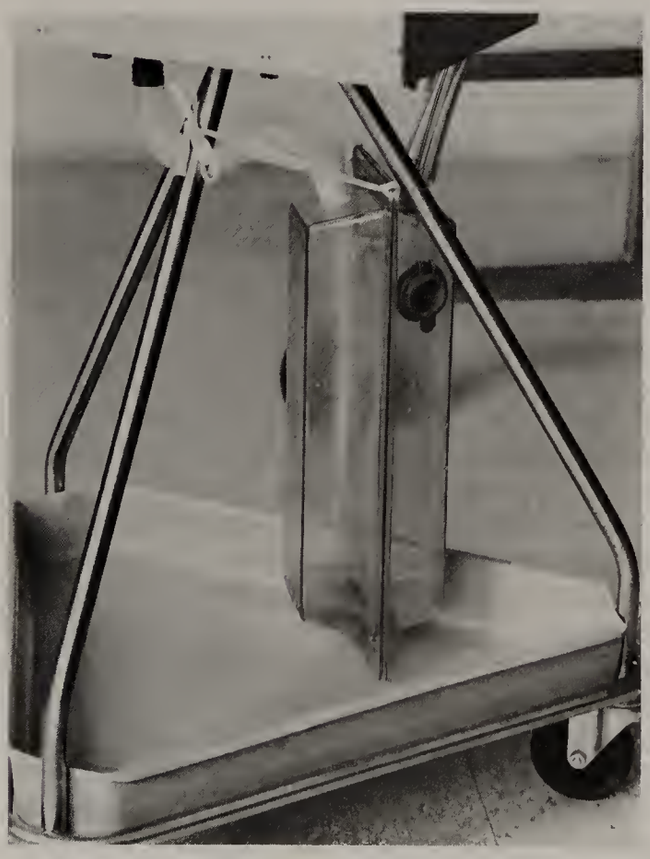


Figure 10–11
A disposable water-sealed pleural drainage set.

Tissue Drains

Tissue drains are placed at or near wound sites or operative sites when large amounts of drainage are expected. This drainage interferes with the healing process because it is reabsorbed by the body too slowly. In some circumstances, it may produce infection or result in formation of a fistula.

The Hemovac, the Jackson-Pratt, and the Penrose drains are three of the most common postoperative tissue drains. They are often placed in areas where the surgical procedure calls for large amounts of tissue dissection or in areas with an increased blood supply, such as the breast, the neck, or the kidney. They will also be found in the abdominal area. One end of the tube or drain is placed in or near the operative site, and the other end exits through the body wall. They are removed by the surgeon when the drainage diminishes.

The Penrose drain is a soft rubber tube, which is kept from slipping into the surgical wound or beneath the body wall by a sterile safety pin (Fig. 10–12*A*). It is allowed to drain into the surgical dressing.

The Jackson-Pratt and Hemovac drains are plastic drainage tubes that maintain constant, low, negative pressure by means of a small bulb, which is squeezed together and slowly expands to create low-pressure suction (see Figs. 10–12*B* and *C*). The drainage goes from the tubing into the bulb.

Other types of drains are placed into the hollow organs of the body and may be sutured in place and attached to collecting bags. Some of these are the T tube, which may be placed into the common



Figure 10–12
(**A**) Penrose drain. (**B**) Jackson-Pratt drain. (**C**) Hemovac drain. (Patrick ML, Woods SL, Craven RF et al: Medical-Surgical Nursing. Philadelphia, JB Lippincott, 1986.)

bile duct; the cecostomy tube, which is placed in the cecum; and the cystostomy tube, which is placed in the kidney.

All these drains must be identified during the radiographer's assessment of the patient; he must plan care to prevent any tension on these drains, which might dislodge them partially or completely. Infection control must also be considered. The presence of a tissue drain indicates that the patient has an opening directly into the body where infection may be easily introduced. If the care that the radiographer must give to his patient includes touching an area in which a drain is inserted, he must use surgical aseptic technique to prevent introduction of new microorganisms into the wound. This will require hand-washing and donning sterile gloves (see Chapter 5). If the radiographer may come into contact with drainage from these areas, he must wear gloves and wash his hands correctly after their removal.

Summary

Nasogastric (NG) and nasoenteric (NE) tubes are inserted into the stomach and small intestine for varying medical purposes. They are used for gastric decompression, for diagnosis of diseases of the GI tract, for treatment of diseases of the GI tract,

and for feeding persons who are unable to swallow food in the normal manner. Mechanical suction often accompanies NG and NE intubation. The radiographer must be prepared to assist with passage of an NG tube and to transfer patients who have NG or NE tubes in place, including those who need suction.

Before transferring a patient who has a gastric tube in place and is receiving continuous gastric suction, the radiographer must learn whether it is permissible to discontinue the suction and, if so, for how long. The patient should be moved carefully. If the suction is continuous, it must be restarted, at the same pressure as was used in his room, as soon as the patient reaches the radiographic imaging department.

The sump gastric tube is a double-lumen tube designed to maintain a continuous flow of atmospheric air into the stomach. This tube must never be clamped with a regular clamp or hemostat, since such clamping may destroy the double-lumen effect of the tube.

The gastric tubes most often used in the diagnostic imaging department are the Levin tube and the Cantor tube. The Levin tube enters the stomach, and the Cantor, the small intestine. The radiographer must learn to assist with their passage and care.

Levin tubes may be removed by the radiographer if he receives a physician's order to do so. It should be gently withdrawn and wrapped in several thicknesses of paper toweling, placed in an impermeable bag, and disposed of with the contaminated waste. If the tube is not easily removed, the physician should be called to remove it. Nasoenteric tubes are not removed by the radiographer. Either a registered nurse or the physician removes it, or it is allowed to pass through the intestinal tract and is removed rectally.

Gastrostomy tubes are surgically inserted directly into the stomach for the purpose of providing a means of nourishing a person unable to take food or fluids by mouth for an indefinite period of time. The radiographer caring for a patient with a gastrostomy tube in place must take precautions not to dislodge the tube or to introduce infection at the insertion site. The radiographer must also understand that a person with a recently inserted gastrostomy tube may be grieving the alteration in his body image and must, therefore, be treated with sensitivity.

Patients who are unable to receive nutrients through the GI tract may need to be nourished by partial or total parenteral nutrition (TPN). Partial parenteral nutrition is delivered by the peripheral intravenous route. TPN is delivered by the central venous route. This is because the nutrients in the TPN formula may injure the intima of small blood vessels. There are many other reasons for the utilization of central venous catheters; therefore, the radiographer must be able to recognize their presence and take the necessary precautions if they are in place.

The radiographer will not perform nasopharyngeal or oropharyngeal suctioning procedures, but he must be able to assess the patient's need for suctioning. He is responsible for having the equipment prepared and for assisting with the procedure. When it is required, it is usually an emergency procedure done to prevent aspiration of secretions into the lungs or respiratory arrest.

The patient with a tracheostomy may require radiographic imaging examination. The radiographer must understand that these patients may be extremely apprehensive. They are unable to speak and unable to clear their tracheostomy tube of secretions that accumulate. A nurse who is able to suction a tracheostomy should accompany the patient who has a new tracheostomy to the diagnostic imaging department. It is the radiographer's responsibility to stop whatever he is doing for the patient at any time the patient needs to be suctioned.

Mechanical ventilators are used to support respiratory function when a disease process or an obstruction prevents normal respiration. Mechanical ventilators support life when no other means is available; therefore, the radiographer must understand the precautions necessary when he is caring for a patient who is ventilator dependent. Most patients are on positive-pressure ventilators, which require an artificial airway for their use. This may be either a tracheostomy or an endotracheal tube. The radiographer must use caution to prevent dislodging or displacing the artificial airway when caring for the patient. He must never disconnect the ventilator from its power source and must obtain adequate assistance when radiographing a ventilator patient to prevent other life-threatening problems.

The radiographer must be able to care for patients who have chest tubes that are connected to water-sealed drainage. He must remember to keep the tubing coiled at the patient's chest level, to keep all connections tightly sealed, to maintain the water seal at all times, not to lift the water-sealed bottle above the patient's chest level, not to clamp or kink the drainage tube, and to notify the patient's nurse immediately if the patient is in respiratory distress or if there is continuous bubbling in the water-sealed chamber.

There are various tissue drains used for the purpose of removing excessive fluid from an operative site to hasten the healing process and prevent infection. The radiographer must be aware of the presence of a tissue drain in any patient for whom he is caring. If a tissue drain is present, the radiographer must not allow tension to be placed on the drain that might dislodge it. He must also take appropriate infection-control precautions when caring for the patient who has a drain in place.

Chapter 10, Pre–Post Test

1. When the radiographer is caring for a patient who has an NG tube in place in his department, he needs to
   1. Find out if the tube is to be reconnected to suction; if so, the amount of pressure needed
   2. Take care not to dislodge the tube
   3. Remove the tube before the patient leaves the department
      - **a.** 1 and 2
      - **b.** 1, 2, and 3
      - **c.** 2 and 3
      - **d.** none of the above

2. The items that must be on hand for patients who may need suctioning in the diagnostic imaging department are
   1. A wall outlet or portable suction machine
   2. A rectal tube
   3. Sterile gloves of all sizes
   4. An oily base lubricant
   5. A hemostat
   6. Sterile, disposable suction sets (or sterile basins and suction catheters)
   7. Sterile normal saline solution
   8. An oxygen source
      - **a.** Items 1, 2, 3, 4, and 8
      - **b.** Items 2, 3, 5, 7, and 8
      - **c.** Items 2, 4, 5, 6, and 8
      - **d.** Items 1, 3, 6, 7, and 8

3. The radiographer should place an alert patient whose swallowing reflex is intact into which position in preparation for nasopharyngeal or oropharyngeal suctioning?
   - **a.** Prone
   - **b.** Sims'
   - **c.** Semi-Fowler's
   - **d.** Lateral

4. The following are two points to remember when caring for a patient with a new tracheostomy in place:
   - **a.** He may need to be suctioned, and he will be talkative.
   - **b.** He will be anxious, and he will be unable to speak.
   - **c.** He will be in the stage of denial, and he will express his anger.
   - **d.** He will be unconscious, and he will be accompanied by a nurse.

5. List the precautions the radiographer must take when caring for a patient who has a central venous catheter in place.

6. List the precautions the radiographer must take if he is sent to the intensive care unit to radiograph a patient who is receiving positive-pressure ventilation.

7. When caring for a patient who has a chest tube with water-sealed drainage, what must the radiographer remember?

a. The water seal must be maintained at all times.
b. Continuous bubbling into the water-sealed chamber is an indication that all is well.
c. The tubing may be clamped if necessary.
d. Most patients with chest tubes complain of respiratory distress.

8. Signs and symptoms that indicate a patient's need for oropharyngeal suctioning are
   1. Audible rattling and gurgling sounds from the patient's throat
   2. Gagging
   3. Breathing with difficulty
      a. 1 and 2
      b. 1, 2, and 3
      c. 2 and 3
      d. none of the above

9. If a radiographer is caring for a patient who has a tissue drain in place, he must
   a. Disregard these drains, because they are not his concern
   b. Prevent tension on the drain and use surgical aseptic technique if in direct contact with the drain
   c. Measure intake and output from the drain
   d. Remove the drain because it will impede the success of the radiograph

10. List three reasons why a patient might have NG or NE intubation, and explain the radiographer's responsibilities if such a tube is in place in a patient to whom he is assigned.

11. Explain the radiographer's patient care responsibilities if his patient has a recently placed gastrostomy tube.

12. When disconnecting a sump gastric tube (a tube with a double lumen), the radiographer must
    a. Clamp the tube with a regular clamp and then place sterile gauze over each end
    b. Clamp the tube closed with a hemostat
    c. Increase the amount of suction pressure
    d. Place a piston syringe in the open end of the gastric tube or place the "pig tail" over it
    e. Decrease the amount of suction pressure

○ *Laboratory Reinforcement*

1. Using a mannequin, demonstrate in the school laboratory how to disconnect a Levin tube and then a sump tube.

2. Simulate in the school laboratory the preparation the radiographer would make for nasopharyngeal suctioning, including preparing the required equipment.



Critical Thinking Problems

1. You are sent to the critical care unit of Acute Care General Hospital, where you are working. Your assignment is to take AP and lateral radiographic exposures of the chest. Your patient is an 88-year-old Asian male who has been diagnosed as having had a cerebrovascular accident and is now believed to have atelectasis in the right lung. The patient is comatose, has an endotracheal tube in place, and is on a positive-pressure ventilator. Design a care plan for this patient.

2. You are working the evening rotation at Gross Creek General Hospital. A 15-year-old male is brought into the emergency room with a suspected fracture of the cervical vertebrae. His score on the Glasgow Coma Scale is a 5. You are requested to go to the emergency suite to take radiographs of his spine. As you begin your work with this patient, you note that he makes loud, gurgling sounds in his throat each time he takes a breath. How will you proceed?

11

Pharmacology for Radiographers

Drug Standards
Controlled Drugs
Drug Sources, Names, and Actions
Pharmacokinetics
Drug Absorption
Drug Distribution
Metabolism/Biotransformation
Drug Excretion
Pharmacodynamics
Adverse Drug Reactions
Drug Incompatibility
Routes of Drug Administration
Enteral Routes
Parenteral Routes
Topical Routes
Drug Classification
Drugs Used to Treat Infections
Drugs That Act on the Central Nervous System
Drugs That Act on the Peripheral Nervous System
Drugs That Act on the Respiratory System
Drugs That Act on the Gastrointestinal System
Drugs Used to Treat Anemia
Drugs Used to Treat Osteoporosis
Drugs Used to Treat Endocrine Disorders
Fluids, Electrolytes, and Nutrients
Vitamins and Minerals
Intravascular and Iodinated Contrast Media
Precautions for Elderly and Pediatric Patients
Patient Assessment and Care
Summary
Pre–Post Test
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. List the precautions and restrictions all health care professionals must take when administering drugs.
2. Explain the legal accountability of all health care workers who administer drugs.
3. Discuss drug standards and methods of controlling drugs with a potential for abuse.
4. Explain how drugs are named and the sources of drugs.
5. Define pharmacokinetics, pharmacodynamics, and adverse drug reaction.
6. Describe the processes involved in drug absorption, distribution, metabolism, and excretion.
7. Define and discuss the routes of drug administration.
8. Explain the manner in which drugs exert their action on the body.
9. Differentiate between drug action and drug effect, drug agonists, and drug antagonists.
10. Identify common drugs in each category that the radiographer may work with in radiographic imaging and the body systems affected by those drugs.
11. Explain the properties of iodinated contrast agents and the adverse reactions that may result from their administration.
12. List the items to be included in the patient assessment prior to administration of a contrast agent.

Glossary

Adipose: fatty
Affinity: an attraction
Akathisia: a pathological condition in which the person cannot sit still; gross feelings of restlessness
Alopecia: loss of hair; baldness
Anaerobic bacteria: an organism that lives and grows in the absence of molecular oxygen
Analgesic: a drug that relieves pain
Anaphylactic reaction: an unusual or exaggerated allergic reaction of an organism to foreign protein
Anemia: a decrease in the hemoglobin level in the blood below normal level or a pathological variation in the shape of the red blood cells
Anorexia: loss of appetite
Antecubital: in front of the elbow or at the bend of the elbow
Antidote: a drug or substance that opposes the action of a poison
Antigen: any substance that is capable of inducing a specific immune response and reacting with the products of that response
Antimuscarinic: inhibiting the stimulation of the receptor beyond the ganglion of the parasympathetic receptor
Antipyretic: an agent that reduces fever
Arrhythmia: an irregularity in or loss of rhythm of the heart beat
Ataxia: failure of muscular coordination; irregularity of muscular action
Benign: (of a tumor) noncancerous and posing no immediate threat to the organism
Bioavailability: degree to which a drug or substance becomes available to target tissue after administration
Bradykinesia: abnormal slowness of movement, sluggishness of physical and mental responses
Carcinogen: a substance that causes cancer
Cholestatic: stoppage or suppression of bile flow due to factors within or outside the liver
Coagulation: the process of transforming a liquid into a solid (*e.g.*, blood into solids or thrombi)
Congestive heart failure: an abnormal condition in which there is circulatory impairment caused by a cardiac disorder that results in an accumulation of blood in the lungs
Crystalluria: the excretion of crystals in the urine, causing irritation of the kidney
Detoxification: reduction of the toxic properties of a substance
Diuretic: an agent that increases secretion of urine
Dopaminergic: having the effect of dopamine (a sympathetic catecholamine)
Drug dependence: an emotional or physical state resulting from interaction of body and drug; produces a compulsion to take the drug continuously to avoid the discomfort of its absence
Dyscrasia: an abnormal blood or bone disorder
Dyspepsia: a feeling of epigastric discomfort
Dystonia: impaired muscle tone
Dysuria: difficult and painful urination
Edema: an abnormal accumulation of fluid in the interstitial spaces of body tissues
Emulsion: (oil based) a mixture of two immiscible liquids, one being dispersed throughout the other in small droplets
Endometrial cancer: a malignant cell growth in the lining of the uterus
Enteric coated: a covering added to oral medications that is designed to be absorbed in the intestinal tract
Epidermis: the outermost nonvascular layer of the skin
Epistaxis: a nosebleed
Euphoria: a feeling of elation or well-being
Extrapyramidal: a clinical disorder marked by abnormal involuntary movements, alterations or muscle tone, or postural disturbance
Extravasation: discharge or escape, as of blood, from a vessel into the tissue
Gingival hyperplasia: an overgrowth of gingival tissue (the gums of the mouth)
Gynecomastia: excessive development of mammary glands in a male, even to a functional state
Hemophilia: a hereditary blood disease in which blood fails to clot and abnormal bleeding occurs
Hepatic: pertaining to the liver
Hepatotoxic: toxic to liver cells
Hirsutism: abnormal hairiness, especially in women
Homocystinuria: a congenital error in sulfur amino acid metabolism due to an absence or deficiency in the liver enzyme, cystathionine synthase
Hyperkalemia: abnormally high potassium concentration in the blood
Hyperkinesia: increased muscular movement and physical activity
Hypertrophy: an abnormal increase in the size of an organ or body structure not caused by tumor growth
Hypokalemia: abnormally low potassium concentration in the blood; may result from potassium loss by renal secretion or gastrointestinal tract
Hyponatremia: deficiency of sodium in the blood
Hypotension: an abnormally low blood pressure
Iodination: the incorporation or addition of iodine in a compound
Ionic strength: pertains to atomic weight of a substance; the number of positively or negatively charged particles
Intravascular: inside a blood vessel
Intrinsic: of internal origin
Lacrimal: pertaining to the ducts through which tears flow
Lupus-like syndrome: a group of symptoms that includes renal, nervous system, skin, and joint involvement
Metabolic acidosis: an abnormal increase in hydrogen ion concentration in the body resulting from accumulation of acid or loss of base
Metabolite: any substance produced during metabolism
Milieu: surroundings or environment
Multiple myeloma: a progressive, malignant tumor originating in the cells of the bone marrow
Narrow-angle glaucoma: elevated pressure in the eyes caused by obstruction of the flow of aqueous humor; narrow angle occurs between the iris and the cornea
Nephrotoxic: destructive to kidney cells
Neuroleptic: modifying psychotic behavior
Neurotoxicity: capable of harming nerve tissue
Neurotransmitter: a substance that is released from the axon terminal of a presynaptic neuron on excitement and that travels across the synaptic cleft to either excite or inhibit the target cell
Neutropenia: diminished number of neutrophils in the blood

Oliguria: a decreased capacity to form and pass urine
Optic neuritis: inflammation of the nerves of the eye
Ototoxicity: having a damaging effect on the eighth cranial nerve or on the organs of hearing and balance
Paradoxical excitement: a condition in which stimulation should not exist but does; or sedation is expected, but hyperactivity results instead
Parotitis: inflammation of the parotid gland
Penicillinase: an enzyme produced by bacteria that inactivate penicillin
Pericardial effusion: a collection of blood or fluid in the pericardium of the heart
Peripheral: an outside surface
Peripheral neuritis: an inflammation of a nerve ending
Pharmacokinetic: the study of the movement of drugs in the body; includes the processes of absorption, distribution, localization in the tissue, and excretion
Pheochromocytoma: a tumor, usually located in the adrenal medulla, that causes excessive amounts of epinephrine and norepinephrine to be produced resulting in hypertension, severe headaches, postural hypotension, and other medical problems
Phlebitis: inflammation of a vein
Psychotic: displaying symptoms of impairment in perception of reality; perceptions are grossly incorrect in reference to external reality
Receptors: a molecule on the surface or within a cell that recognizes and binds with specific molecules, producing some effect in the cells
Schizophrenia: a psychiatric disorder wherein the patient displays symptoms of grossly distorted perceptions of reality, withdrawal from social interaction, and disorganized thought processes
Sickle-cell disease: a hereditary, chronic form of anemia characterized by crescent-shaped red blood cells; a problem among African Americans
Suspension: temporary cessation, as of pain or a vital process
Systemic: pertaining to or affecting the body as a whole
Systemic alkalosis: an abnormal condition of the body fluids where in the pH level is greater than 7.44 with a deficiency of acid or an overabundance or retention of bicarbonate
Tardive dyskinesia: involuntary repetitious movements of the face
Teratogenic: an agent or influence that causes physical defects in the developing embryo
Thrombocytopenia: an abnormal decrease in the number of blood platelets
Tinnitis: a noise sensation heard in the ears; frequently called "ringing"
Toxicity: exerting deleterious effects on an organism or tissue
Transdermal: entering through the skin
Urticaria: a skin eruption characterized by red, raised patches that itch (also called hives); usually the result of an allergic reaction
Vertigo: dizziness

Pharmacology is the study of drug actions on and interactions with living organisms. Drugs are chemical substances that are not required for normal sustenance and that produce a biological effect in an organism. *Pharmacology* comes from the Greek word *pharmacon*, meaning drug or poison. All drugs are—or can be, if misused—poisons (Agins, 1995).

The radiographer's position description states that, "In agreement with state statute(s) and/or where institutional policy permits, [the radiographer] prepares, identifies and/or administers contrast media and/or medications as prescribed by a licensed practitioner" (JRCERT, 1994). Legal and ethical implications and a grave professional responsibility come with this change in position description for the radiographer. The radiographer who administers drugs (medications) is expected to know the safe dosage, safe route of administration, limitations of the drug, toxic reactions, side effects, potential adverse reactions, and the indications and contraindications for its use. He must also understand the potential hazards of any drug that is incorrectly or unsafely administered. If drug administration errors occur because of lack of knowledge, the person who administers the drug is legally liable.

Pharmacology and its clinical application is a scientific discipline unto itself and cannot be covered adequately without combining theoretical knowledge with clinical coursework. Chapters 11 and 12 in this text introduce the radiographer to pharmacology and give him the information necessary to practice the skills of medication administration in a formal classroom setting with a licensed instructor. Any radiographer who plans to administer drugs as a part of his practice is advised to enroll in a recognized pharmacology course and learn the pharmacologic basis of patient care in depth, as do all health care practitioners who participate in drug administration.

Drug therapy is a highly complex and ever-changing aspect of patient care. Health care professionals who prescribe medications must spend years becoming proficient in this aspect of patient care. The radiographer is not licensed to dispense drugs. He cannot enter a hospital pharmacy and select a drug. He is legally liable if any drug he selects from a dispensary results in adverse effects. If a drug error is made by a radiographer, he must document the incident completely and fill out an institutional incident report according to the policy of the facility in which he is employed.

Drug Standards

The federal government has established standards for control of drug safety. These standards are strictly enforced. The properties that are regulated are as follows:

1. *Purity:* The type and acceptable amount of extraneous material that may safely be added to the active ingredient of a drug
2. *Bioavailability:* the amount of a drug that becomes available for activity in the targeted tissue
3. *Potency:* the strength or power of the drug needed to achieve the desired effect
4. *Efficacy:* the effectiveness of each drug used in treatment
5. *Safety and toxicity:* determined by the number and severity of adverse effects reported after use of the drug; these standards are monitored and refined constantly

Controlled Drugs

Drugs that have potential for abuse are dealt with in a special manner in the United States. They are labeled "controlled substances" and are divided by the United States Food and Drug Administration into five groups called "schedules." Schedule I drugs have the highest potential for abuse and are not used in medical care. Schedule II drugs are used for medical purposes but are kept locked up in a special cupboard, and each dose is signed out individually on a controlled-substance sheet prior to use. The radiographer who is requested to procure such drugs for patient care must learn his particular institution's routine for handling controlled substances. In many health care institutions, only registered nurses and physicians may administer these drugs. Schedule III and IV drugs are also controlled, and methods for handling these drugs vary from state to state and institution to institution. The drug schedules for controlled substances are as follows:

Schedule I: Drugs in this category are not recognized for medical use because of their high abuse potential.

Examples: Heroin, lysergic acid diethylamide (LSD), marijuana derivatives, methaqualone, mescaline

Schedule II: A written prescription by a licensed physician is required to obtain these drugs. No telephone renewals are accepted except in an emergency, in which case a written prescription must follow within 72 hours. These drugs have a high abuse potential.

Examples: Codeine, morphine, meperidine, oxycodone, amphetamine, secobarbitol

Schedule III: Prescriptions must be rewritten after 6 months or five refills. Prescriptions may be telephone ordered. Drugs in this category have a lesser potential for abuse.

Examples: Barbituric acid derivatives, codeine of less than 1.8 grains per dL, benzphetamine, butabarbital, methyltestosterone, ethylestrenol

Schedule IV: Prescriptions are required to be rewritten after 6 months or five refills. These drugs have some potential for abuse.

Examples: Benzodiazepines, chloral hydrate, meprobromate, paraldehyde, phenobarbital, propoxyphene

Schedule V: Drugs in this category may be dispensed as any nonnarcotic prescription drug. Some may be purchased without a prescription.

Examples: Antitussives, antidiarrheals, codeine expectorants

Drug Sources, Names, and Actions

Drugs come from many natural and synthetic sources. They are produced from animal sources; for instance, hormones and heparin come from animal sources. Many come from plant sources, as do digitalis and atropine. Some are produced from microorganisms, as are some antibiotics. Minerals are the source of calcium, iron, and other dietary supplements. Most drugs are made from synthetic materials in laboratories. In recent years, drugs have begun to be genetically engineered; epogen, a new drug used to treat some anemias, is but one example of such a drug.

The same drug may be sold under many different proprietary or trade names. The *trade name* is assigned to a drug by a particular manufacturer. This name is copyrighted and cannot be used by another manufacturer. The same drug may be manufactured by another company and be given a different trade name.

The *chemical name* of a drug presents its exact chemical formula and always remains the same. A drug's *generic name* is the name given to the drug prior to its official approval for use—like the chemical name, it remains unchanged. Generic names of drugs begin with lower-case letters. Trade names begin with capital letters. Drugs are also given *official names;* frequently, the official and generic names are the same. The official name is used in an official publication such as the *United States Pharmacopeia.* For instance, a drug frequently used as a preprocedure drug in radiologic imaging is parenteral diazepam. Diazepam is the generic name for Valium, and the chemical formula is *7-chlorl-1,3-dihydro-methyl-5-2H-1,4-benzodiazepin-2-one.* The radiographer must be able to identify drugs by their trade name and their generic name. It is not essential to learn the chemical formula of each drug.

A drug does not have the capacity to change cellular structure, but acts to either increase or decrease the rate and range of a normal or abnormal physiological process going on within the cells of the body. Drugs are administered for a number of reasons. They may be given for relief of undesired symptoms, to prevent disease, to cure disease, and to diagnose disease. The radiographer will be involved in administering drugs primarily for diagnosis of disease or pathological conditions. Occasionally, he may administer a drug to relieve anxiety or pain prior to or during a diagnostic procedure.

Drugs are absorbed, distributed, metabolized, and then excreted from the body. As this process takes place, the drug reaches a point where it has its intended effect. This is called the *onset* of action. As it continues to be absorbed, it reaches a peak concentration level. This is the time during which the drug attains its maximum therapeutic response. The time during which the drug is in the body in an amount large enough to be therapeutic is called its *duration of action.* As the drug is excreted, the concentration level subsides to a point at which there is little or no intended effect.

Pharmacokinetics

The radiographer must understand how drugs interact with body tissues. The processes that control absorption, distribution, metabolism, and excretion of drugs by the body are called *pharmacokinetics.* Individuals process drugs differently depending upon their age, nutritional status, ethnicity, existing pathological conditions, immune status, state of mind or psychological factors, sex, weight, environmental factors, and the time of day.

DRUG ABSORPTION

A drug must advance from its dosage form into a form that makes it biologically available for passage into the systemic circulation. Tablets or dry powders must be reduced to liquid form before they can be absorbed and begin their journey. Drugs taken by mouth in liquid form are processed more quickly than tablets and capsules. In other words, a drug must be absorbed and taken via the bloodstream to its intended site in order to act. This is called *bioavailability,* or becoming bioavailable.

The amount of time needed to absorb a drug and the extent to which it becomes bioavailable depends upon the route of administration, gastrointestinal (GI) motility, dosage form, interaction with food, and interaction with other drugs. Food in the stomach generally delays gastric emptying time and the time it takes a drug to become bioavailable. Combining a drug with another drug may reduce or increase the amount available for absorption.

Drug absorption varies from person to person and is dependent upon the absorptive surface available. A damaged or absent intended drug surface will alter the length of time it will take a drug to reach its intended site. Drugs may be absorbed by either passive or active transport or by *pinocytosis,* a form of active transport.

A drug must be made up of the same components as those at its intended absorption site. A fat-soluble (lipid-soluble) drug is unable to penetrate a water-soluble site and a water-soluble drug cannot penetrate a lipid site. Lipoid (lipid) tissues are highly impenetrable. The central nervous system, which includes the brain and the spinal cord, is composed of these highly impenetrable lipoid tissues. The capillaries of the brain have tight junctions, and the intercellular spaces are without the pores present in other cells of the body. This construction, the *blood–brain barrier,* makes the brain less easily penetrable by chemicals that might damage it. Only lipid-soluble drugs may pass this barrier. The placenta is also composed of lipoid tissue; however, it is believed that the fetus is exposed to and can be damaged by all drugs and toxins ingested by the mother.

Drugs move to their site of absorption and then must penetrate the cell membrane at that site. This is accomplished by varying methods. One method is passive transport, which requires no cellular energy. The drug simply moves across a cell mem-

brane from an area of lower concentration to one of higher concentration. When the concentration equalizes on both sides of the cell membrane, the transport is complete.

Active transport is another method of drug absorption. This method requires energy from the cell and a carrier, which is usually a protein, to move a drug particle from an area of low concentration to an area of high concentration. Active transport is necessary to move some drugs and electrolytes, such as sodium and potassium, from outside to inside a cell.

Pinocytosis is a type of active transport in which a cell engulfs a drug particle, forms a protective coat around it, and transports it across the cell membrane. Fat-soluble vitamins are transported in this manner.

Drugs taken orally are usually absorbed in the small intestine, which has a large surface for absorption. If a portion of the small intestine has been removed or is scarred, the ability to absorb a drug is reduced.

The quantity of blood flow to absorption surfaces affects the rate at which a drug is absorbed. For instance, a drug is absorbed much more rapidly when it is administered intramuscularly in the deltoid muscle than in the gluteal muscle because the blood flow is greater in the deltoid.

A person who is in severe pain or in a state of acute stress may have decreased ability to absorb a drug. The cause is not certain; however, it is theorized that it is because there is a change in blood flow, decreased GI motility, and gastric retention due to autonomic nervous system activity resulting in pyloric sphincter contraction.

First-Pass Effect

It is important for the radiographer to recognize what is called the *first-pass effect* of drugs taken by mouth (orally). When a drug is taken by mouth and swallowed into the stomach, it goes from the small intestine to the mesenteric vascular system, and then to the portal vein, and from there into the liver, before it is transported into the systemic circulation. Because of this travel throughout the gastric and hepatic circulation, a portion of the drug is metabolized en route and becomes inactive. The partial metabolism of a drug before it reaches the systemic circulation is called *a first-pass effect.* This effect requires, in the case of many drugs taken orally, that they be given in larger doses so that a portion of the drug will remain to perform its intended effect. Drugs that can be administered by a sublingual, vaginal, or parenteral route avoid the first-pass effect by going directly into the systemic circulation; however, these methods of administration may be contraindicated for other reasons.

Warning: The dosages of most drugs given by oral route will generally be much larger than those given by parenteral routes, as they are susceptible to the first-pass effect!

Some drugs, after absorption, are moved from the bloodstream into the liver and then through the biliary tract, where they are excreted in bile to return to the small intestine and then back into the bloodstream. This is called *enterohepatic recycling.*

DRUG DISTRIBUTION

Following absorption of a drug into the body, it must be distributed to its intended site of action via the circulatory system. The rate and extent of distribution depends upon adequate blood circulation, protein binding, and the drug's affinity for lipoid or aqueous tissues. Drugs move quickly to body organs that have a rich blood supply such as the heart, liver, and kidneys. They reach muscles and fatty tissues more slowly.

As a drug travels through the circulatory system, it may come into contact with plasma proteins and bind to them or remain free. A drug that is bound to a plasma protein becomes inactive. Only the free drug is able to act on the cells; however, as the free drug acts, there is a decrease in plasma drug levels, which allows a portion of the bound drug to be released and become active. This slow release allows blood levels of the drug to remain somewhat constant. This differs for each drug and for each patient, depending upon his health status and other characteristics. Drugs do not always distribute well throughout the body. Pathological conditions such as abscesses and other infective material impair or impede drug distribution.

When two or more drugs are present and competing for a limited number of plasma-binding sites, the drug with the strongest affinity for the site acquires it. This leaves a greater amount of one drug free to act. This may result in a toxic level of that drug.

Lipid-soluble drugs are stored in lipid tissues. Fat is not soluble; therefore, lipid-soluble drugs are not present in the blood as such. Highly lipid-

soluble drugs remain stored in fatty tissues, where they are released very slowly, with sometimes less than the intended therapeutic effect. Drugs that are intended to penetrate the blood–brain barrier must be highly lipid soluble and bind minimally with plasma proteins in order to achieve their intended effect.

Because of the nonselective nature of the placenta, most drugs are able to pass that barrier and affect the developing fetus. The toxicity of drugs to the fetus during the first trimester of pregnancy makes it mandatory that the pregnant mother receive no medications without the explicit orders of her physician. Only drugs that are absolutely necessary to maintain the optimum health of the mother should be given. This is important for the radiographer to remember as he cares for female patients of childbearing age.

Warning: All female patients of childbearing age must be screened to ascertain their potential for pregnancy before receiving any drug.

METABOLISM/BIOTRANSFORMATION

The manner in which drugs are inactivated in the body is called *metabolism* or *biotransformation* (these terms are used interchangeably). There are several ways that the body metabolizes drugs, but most often the drug is transformed into one or more inactive metabolites and then excreted by the kidneys. In some instances, a drug is transformed into another active metabolite that continues to have an effect on body function. Some drugs remain inactive until they are biotransformed into an active metabolite. The kidneys can excrete only water-soluble substances; therefore, an important aspect of drug metabolism is the transformation of lipid-soluble substances into water-soluble metabolites. The liver is the center for most drug metabolism. Enzymes present in the liver enact chemical changes that biotransform drugs.

Age, overall health, time of day, emotional status, the presence of other drugs in the body, genetic variations, and disease states may alter the rate of drug metabolism. For instance, an infant has a reduced rate of metabolism because of the immaturity of his hepatic enzyme system. An individual with liver or heart disease also has a reduced rate of metabolism. The elderly person has a decreased blood supply and a decreased number of liver enzymes, which decreases his ability to metabolize drugs. An altered metabolic state may allow a drug to accumulate in the body and produce an adverse reaction. Conversely, rapid metabolism of a drug may interfere with the intended effect. Drugs administered orally are significantly metabolized by the first-pass effect through the liver, which also affects their metabolism.

DRUG EXCRETION

Excretion of drugs from the body takes place chiefly in the kidneys, where drugs may be eliminated unchanged or in their biotransformed state. The bowels, the lungs, and the skin are responsible for a small amount of drug elimination. Adequate elimination requires a functioning circulatory system. Renal disease or dysfunction may lead to accumulation of a drug in the body resulting in a toxic reaction.

Drugs are cleared from the body at variable rates. A drug with a rapid clearance rate will necessitate more frequent administration. Drugs with slower clearance rates have a greater incidence of toxicity due to their potential for higher concentration levels if the dosage is not carefully monitored.

Half-life

The time it takes for a 50% decrease in a drug's presence in the body is called its half-life. This is determined by the time it takes a drug to transform into water-soluble metabolites and to be eliminated from the body. In order for a drug to have its intended effect, it must reach a steady-state concentration in the body. Four or five drug half-lives are required for this to occur. Drugs have variable half-lives. In order for a steady-state concentration to be maintained, the same amount of a drug must be taken in as is eliminated in each 24-hour period. A prescribing physician treating a particular illness must determine the amount of drug needed to maintain a steady-state in the body in order to obtain the drug's intended effect. A larger dose may be given initially to obtain a therapeutic effect more quickly than it would otherwise take to reach a steady state. When the intended therapeutic level is reached, the dosage is reduced to maintain a steady state.

A drug's removal from the body is called its *clearance rate*. If a drug has a rapid clearance rate, it must be administered more frequently to maintain the therapeutic level. If it is slow to clear, it will need to be administered less frequently. This is an important consideration, because a drug with a slow clearance rate that is given too often may accumulate and reach a toxic level.

Pharmacodynamics

The study of the change in normal physiological function of the body due to a drug is called *pharmacodynamics.* Pharmacodynamic effects may cause alterations in blood pressure, heart rate, urinary output, and response of the central nervous system, as well as changes in all other body systems. Usually a primary site of action is targeted by drugs administered systemically; however, all body tissues are affected in some way by the drug. The particular area for which the drug is intended and that receives the maximum effect of the drug is called the *drug receptor.*

Drug receptors have an affinity for a particular drug. This means that there is a tendency for the drug to attach at that particular area. A drug must have the ability to effect a particular outcome when it is bound to its intended receptor. A drug that attaches to a receptor and possesses both an affinity for the site and the ability to produce intrinsic activity at that site is said to be an *agonist.* If a drug attaches to a receptor and prevents the agonist from responding in its intended manner, it is said to be an *antagonist.* The molecular structure of each drug determines the affinity for a receptor. Very small changes in a drug molecule can leave the drug's affinity to a receptor unchanged while drastically changing the pharmacological action of the drug.

Many drugs have more than one effect on the body. A drug given at the recommended dosage will have the intended effect; however, if given in a larger dose, it may have undesirable effects. The relationship between the dosage at which the intended effect of a drug is obtained and the amount that produces an unwanted effect or an adverse effect is called the *therapeutic index.*

Adverse Drug Reactions

Any person who participates in drug administration must be aware of the potential harm that may result from drugs. They can produce many adverse or unintended effects. Some adverse effects occur almost immediately following drug administration, and some take weeks or months of administration before an untoward reaction is produced. When an unintended effect is expected to occur and is essentially not harmful, it may be termed a *side effect.* An effect that is harmful is called an *adverse reaction.*

Immediate adverse reactions to drugs can include drowsiness, gastric distress, and allergic or hypertensive reactions that may range from mild urticaria to severe anaphylactic shock. Some drugs are disease-producing themselves and may produce blood dyscrasias, hepatic disease, GI ulcerations, bleeding, or thrombosis. Since drugs are tested extensively before they are permitted to be marketed, most adverse reactions have been documented and it is known that these reactions may occur. The therapeutic or diagnostic purpose of a drug are weighted against the risk factors prior to administration. If the need outweighs the risk, it is prescribed by the physician with caution.

The patient is educated regarding the potential adverse effects of the drug prior to its administration and instructed to notify the physician if adverse reactions occur. Particular care must be given to pregnant women and nursing mothers. It is the responsibility of all health care workers who administer drugs to understand and educate their patients about any drugs that they administer.

If a drug is administered and it has an unexpected or exacerbated effect the first time the patient receives it, this is called an *idiosyncratic reaction.* This type of reaction is often genetic or familial in nature.

Drugs that have a mind-altering effect may produce a *dependency reaction.* This dependence may be physiological or psychological in nature. A drug that creates a physiological dependence has an unpleasant effect, called a *withdrawal effect,* if it is not received. A drug to which a psychological dependence is developed may lead to drug abuse patterns.

Tolerance to a drug that is received continually for a length of time creates a change in the response to that drug. Usually, the drug received is needed in increasingly larger doses to attain the desired effect. The drugs to which one develops a dependent or tolerant reaction are the narcotic, analgesic, sedative-hypnotic, and antianxiety drugs and the amphetamines. Tachyphylaxis is a rapid development of tolerance to a drug.

If a drug adversely affects the fetus, causing abnormal development, it is said to have a *teratogenic effect.* Some drugs may be cancer producing. These are called *carcinogens.* Drugs that adversely affect the kidneys are called *nephrotoxic.*

Warning: Drugs must be stored according to manufacturer's directions. If a drug has a sediment or is discolored, it must not be used.

Drug Incompatibility

Drugs must never be mixed in the same syringe without being certain of their compatibility. Many drugs, when combined with another, can either become inactivated or form a toxic compound. Some drugs must always be given individually.

Warning: Before mixing two drugs for administration, a drug compatibility chart or a pharmacist must be consulted if any uncertainty exists about the drugs' compatibility. Never assume that related drugs can be combined, as this may not be the case.

Medical personnel who use drugs and equipment from an emergency cart in departments where medical care is rendered must have special education in emergency drug use. These drugs, if used incorrectly, can have lethal effects. Although emergency drugs are listed in this text, the explanations given here are not adequate to qualify a radiographer to administer them. Health care institutions must have on their staffs persons specifically trained in emergency drug procedures and equipment use.

The radiographer has an obligation to know the location of the emergency cart, how to gain access to it when it is needed, and how to summon the emergency team in a timely manner. In a department with limited staff, the radiographer may be responsible for maintaining the completeness and currency of the drugs and equipment on the emergency cart. If this is the case, he must be educated to do this, and the maintenance must be done on a daily basis and after each use.

Warning: During an emergency is not the time to update emergency drugs and equipment since every minute lost in this pursuit is life threatening for the patient!

Routes of Drug Administration

ENTERAL ROUTES

The enteral route is broken down into oral, sublingual, and rectal subroutes. Drugs taken by mouth can be immediately absorbed by the oral mucosa if they are placed under the tongue (the sublingual route) or on the buccal area at the inside of the cheek (the buccal route). Medications given at these sites are absorbed into the bloodstream immediately and are exempt from the first-pass effect of drugs that go into the stomach. Only very small amounts of nonirritating drugs that demand rapid action can be administered in this manner, as the area for absorption is small.

Drugs taken by mouth and swallowed into the stomach are said to be given orally or by the oral route (PO). This is often the most efficient and the most cost-effective method of drug administration. The oral route is used if the drug will not be destroyed by secretions in the gastrointestinal tract and when slower absorption and longer duration of drug activity are desired.

The drug taken by mouth disintegrates and dissolves in the stomach and then travels to the small intestine, where most absorption takes place. The large intestine plays a small role in absorption by absorbing water and electrolytes. If a person cannot swallow oral drugs, he may take them enterally by having them administered through a nasogastric or gastrostomy tube.

There are several valid reasons for not giving drugs orally. The drug may have an unpleasant taste, it may cause nausea and vomiting, it may be destroyed by digestive juices, there may be a danger of aspiration, the patient may be uncooperative, or a more rapid absorption may be desired. Drugs that are irritating to the gastric mucosa are sometimes given in an enteric-coated form so that they can be taken orally.

If a drug is to be administered in an enteric-coated form, the patient must be instructed not to chew the tablet before swallowing it as it can irritate the stomach or be rendered less effective. If the medication is in tablet form and is not scored, it should not be broken. The radiographer must request the correct dose from the pharmacy. Capsules should not be tampered with, because this may result in incorrect dosage.

Drugs may be administered by rectum if a patient is nauseated and unable to retain oral drugs. This method of administration has the advantage of avoiding the first-pass effect; however, it has disadvantages. Correct dosage is difficult to determine because absorption may be erratic. Lack of fluid in the rectum also makes the absorbability questionable.

PARENTERAL ROUTES

Parenteral routes of drug administration include intradermal, subcutaneous (SC), intramuscular (IM), intravenous (IV), intra-arterial, intrathecal,

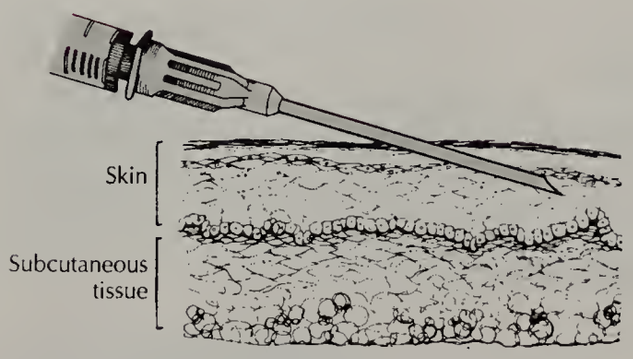


Figure 11–1
Intradermal injection.

and intra-articular. The physician administers drugs by intra-arterial (into the artery), intrathecal (within the spinal canal), and intra-articular (within the joint) routes. Administration of drugs via any of the parenteral routes requires use of surgical aseptic technique, since each is an invasive procedure. Techniques of administration are discussed in Chapter 12.

Intradermal administration of a drug is usually used for testing sensitivity to a drug or an antigen or for local anesthesia. It is administered between the layers of the skin just below the surface (Fig. 11–1). Very small doses of a drug are used at this site. If the drug is given to test for a sensitivity reaction, the patient must be monitored carefully for signs of an anaphylactic reaction.

Subcutaneous drugs are administered below the epidermis (Fig. 11–2). Absorption is through the capillaries at a fairly rapid rate. The dosage administered at subcutaneous sites should be no more than 1 to 2 mL.

Intramuscular absorption of drugs is variable, depending upon how the drug is formulated and also upon the muscle into which the drug is injected (Fig. 11–3). The deltoid, the gluteal, and the vastus lateralis are the muscles most frequently used for IM injections. Blood flow is more rapid through the deltoid than the gluteal muscles; however, the amount of drug that may be safely administered into the gluteal muscles is larger. The composition of the drug also affects the rate of absorption from the IM site. A solution absorbs most rapidly; suspensions and oil-based emulsions absorb more slowly.

Warning: Oil-based drugs and micro-fine crystalline solutions must never be injected intravenously or intra-arterially, as they may cause emboli. Cloudy or thick solutions are not for intravenous or intra-arterial administration!

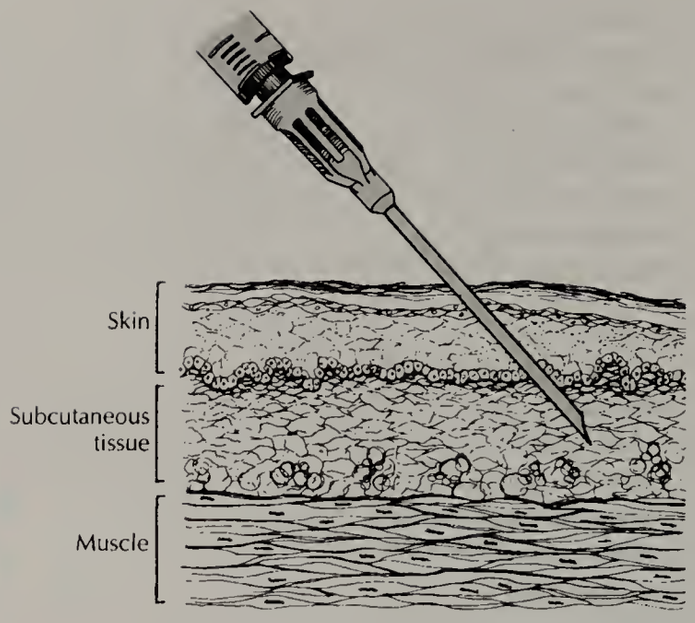


Figure 11–2
Subcutaneous injection.

Since there are no barriers to absorption, the intravenous route achieves the most rapid systemic response. This method is selected if rapid effect is desired or if a drug cannot be injected into body tissues without damaging them. This can be one of the most hazardous routes of drug administration because once a drug is injected directly into the circulatory system, the reaction is immediate. IV administration of drugs is discussed in Chapter 12.

Intra-arterial, intrathecal, and intra-articular sites for drug administration are used to achieve a high local concentration of a drug for pain relief,

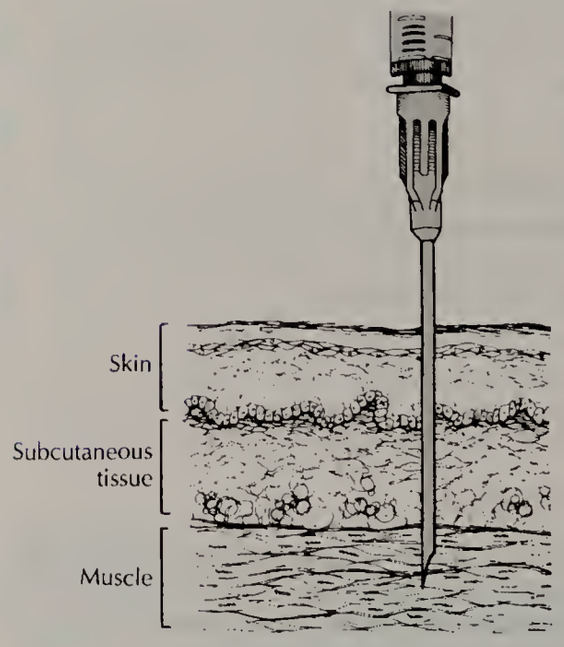


Figure 11–3
Intramuscular injection.

analgesia, or treatment of neoplasms or to inject contrast media for diagnosis. The radiographer will not administer drugs by these methods, but he will frequently assist when they are used to administer contrast agents.

TOPICAL ROUTES

Topical drug administration is used for local treatment of skin ailments, as well as systemic treatment. The skin, when unbroken, is slow to absorb drugs into the systemic circulation and is somewhat unreliable. The rate of topical absorption is accelerated if there is an open lesion or if the drug is applied to mucous membranes or to the area behind the ear (the postauricular area).

Drugs are considered to be administered by topical route if they are administered to the eyes, nose, throat, respiratory mucosa, or vagina and, in some cases, to the rectum. Drugs administered to the eyes or by inhalation to the respiratory mucosa are also absorbed systemically to some degree.

Some drugs are applied to the skin for intended systemic effect. When this is the case, the route is called *transdermal*. It is believed that drugs administered transdermally are absorbed slowly and a constant blood level of the drug is achieved. The radiographer may care for patients with transdermal patches applied at various areas of the body, generally the upper thoracic area.

Drug Classification

Drugs may be classified in several ways. They can be grouped according to their physiological effects on receptors, their physiological effects on specific body systems, or their overall physiological effects. This chapter provides a brief overview of the physiological effects of drugs on body systems and drugs used to treat specific conditions. Contrast agents are discussed, as are some drugs used in radiographic imaging, particularly those found on the emergency drug cart. *The drug descriptions that follow do not adequately explain the nature of these drugs to anyone who plans to participate in drug administration.*

Drugs used in radiographic imaging and elsewhere in the practice of medicine are constantly changing. New and better preparations are appearing on the market monthly, and the personnel administering them must be educated in their use prior to working with them. This is true of contrast agents as well as other drugs.

DRUGS USED TO TREAT INFECTIONS*

Antimicrobial Drugs

Antimicrobial drugs do not all react in the same way, nor do they all destroy the same types of microorganisms. They are chosen selectively for use by the physician according to their ability to inhibit or destroy particular bacteria, fungi, protozoa, viruses, or other parasites.

Although it is widely believed that anti-infective drugs can cure any infection without ill effects, this is not entirely true. There are continuing problems with administration of anti-infective drugs that remain unsolved. They are as follows:

1. *Tissue damage.* The GI mucosa becomes irritated when these drugs are taken by mouth, resulting in nausea, vomiting, and diarrhea. Local reactions at parenteral sites of injection may also occur. The most serious effects to body tissues are kidney damage and neurotoxicity. Neurotoxic symptoms can range from vertigo and deafness to convulsive seizures.
2. *Allergic reactions.* These may range from mild hypersensitivity to severe, life-threatening anaphylactic shock.
3. *Superinfections.* Use of anti-infective drugs destroys the pathogenic organisms but also inhibits the growth of natural flora of the body. In the absence of these natural inhabitants of the body, stronger microbes, or those that are not susceptible to these antimicrobial medications, grow uncontrollably and produce life-threatening infections.
4. *Misuse of anti-infective drugs.* Many people who have common upper respiratory infections (such as the common cold), which are caused by viruses unresponsive to these agents, request treatment with anti-infective drugs. This may result in a sensitivity to the drug prescribed, and when the drug is needed for treatment of a serious infection, an allergy to the drug requires that it be discontinued. Development of a resistance to the drug can also result, which renders it ineffective at a time when it is needed.

Antimicrobial drugs are sometimes used to prevent infection in susceptible patients. This is called *prophylactic use*. Some conditions that may require prophylactic use of antimicrobial drugs are bacterial endocarditis, neutropenia, HIV, and tuberculo-

**The drugs listed in each category were randomly chosen and do not indicate author preference or recommendation.*

sis. These drugs may also be prescribed prior to major surgery.

Antimicrobial drugs should be used in a concentration and dosage high enough to destroy or inactivate the infectious microorganisms. They should also be used over a long enough period of time for this action to result. If this is not done, resistant strains develop and treatment is not successful. There are many antibacterial agents that will not be mentioned in this brief synopsis that are used when other drugs are not effective.

Antimicrobial families of drugs include the following:

Penicillins, cephalosporins, monobactams, vancomycin, carbapenems (antibacterials): These bactericidal (bacteria-destroying) drugs are administered at dosages that vary depending on the patient's age, type of infection, and weight.

Aminoglycosides, tetracyclines, macrolides, sulfonamides, trimethaprim: These drugs are bacteriostatic (growth-stopping) and/or bactericidal.

Isoniazid, rifampin, fluoroquinolones: General bacteriostatic agents.

Penicillins

The penicillins are widely used in various forms to treat gram-negative, gram-positive, and anaerobic bacteria. Some forms of penicillin are used as broad-spectrum antimicrobials (effective against a wide range of microorganisms). An enzyme produced by many bacteria, called penicillinase, is able to inactivate many forms of penicillin and promotes resistance to it. Many strains of staphylococci are able to produce penicillinase. The newest agents in the penicillin group of drugs are combined with penicillinase inhibitors. They perform the same as the previously listed penicillins; however, they also are able to work against penicillinase-producing bacteria. The following are some of these:

Ampicillin + sulbactam (Unasyn)

Amoxicillin + clavulanic acid (Augmentin)

Pipericillin + tazobactam (Zosyn)

Many drugs in the penicillin group of antimicrobials are given parenterally. Some are given by mouth.

ADVERSE REACTIONS: Allergic reactions ranging from skin rashes to anaphylaxis; fever, pain, phlebitis, nausea, diarrhea, superinfection.

Cephalosporins

Cephalosporins are divided into three different groups, called generations, which are based upon their activity against particular bacteria. Several of the widely used drugs in each generation are as follows:

First Generation: act against gram-positive bacteria (*Staphylococcus,* group A and B hemolytic *Streptococci*) and gram-negative bacteria (*Escherichia coli, Klebsiella, Proteus mirabilis,* and *Haemophilus influenzae*). These drugs are not able to penetrate cerebrospinal fluid. Widely used drugs in this category are:

Cephalexin (Keflex, Keflet, Keftab): administered by mouth (PO)
Cefazolin (Ancef, Kefzol): administered parenterally
Cephalothin (Keflin): administered parenterally

Second Generation: act against gram-negative bacteria and some gram-positive bacteria. They are not able to penetrate the central nervous system. Widely used drugs in this category are:

Cefaclor (Ceclor): administered PO
Cefprozil (Cefzil): administered PO
Cefoxitin (Mefoxin): administered parenterally

Third Generation: have reduced gram-positive action; act against gram-negative bacteria such as *Salmonella, Enterobacter, Pseudomonas aeruginosa, serratia.* These drugs are able to enter the cerebrospinal fluid. Drugs in this category are:

Cefixime (Suprax): administered PO
Ceftriaxone (Rocephin): administered parenterally
Moxalactam (Moxam): administered parenterally

ADVERSE REACTIONS: Hypersensitivity, bone marrow suppression, nephrotoxicity, bleeding disorders, nausea, and vomiting.

Monobactams

This is a new class of antimicrobial drug having a narrow spectrum of activity. They act against gram-negative bacteria only. The drug representing this class is aztreonam (administered parenterally).

ADVERSE REACTIONS: Diarrhea, abdominal cramps, nausea, vomiting.

Vancomycin

This drug is used to treat methicillin-resistant *Staphylococcus aureus,* which is an increasing prob-

lem in hospitalized patients. It is active against gram-positive microorganisms. Vancomycin is administered intravenously except in treatment of *C. difficile,* when it is administered PO.

ADVERSE REACTIONS: Hearing loss is the most significant adverse reaction. The patient may have a sensitivity reaction.

Carbapenems

A broad-spectrum antibacterial which must be given with cilastatin. Administration is intravenous and PO. The drug in this category is imipenem.

ADVERSE REACTIONS: The most significant adverse reaction is seizures, which may occur in the elderly patient or patients with a history of seizures.

Aminoglycosides

Aminoglycoside drugs are both bacteriostatic and bactericidal and act against gram-negative organisms only. Widely used drugs in this category are:

Neomycin: administered parenterally

Gentamycin: administered parenterally

ADVERSE REACTIONS: Ototoxicity and nephrotoxicity. These drugs are not to be administered with other antibacterial drugs.

Tetracyclines

Tetracyclines are bacteriostatic and are true broad-spectrum antibacterial drugs. They are used to treat rickettsial infections, chlamydia, and inflammatory acne. Widely used drugs in this category are:

Doxycycline: administered PO

Minocycline: administered PO

ADVERSE REACTIONS: GI irritation; discoloration of teeth in children and depression of bone growth; renal and liver toxicity, suprainfections.

Macrolides

Macrolides are bacteriostatic in low doses and bactericidal in high doses. They are broad-spectrum antibacterial drugs used to treat diseases caused by gram-positive microbes such as Legionnaire's disease. Widely used drugs in this category are:

Erythromycin: administered PO and IV

Azithromycin: administered PO and IV

Clarithromycin: administered PO and IV

ADVERSE REACTIONS: GI distress, nausea and vomiting, thrombophlebitis when administered intravenously, anaphylactic reactions, cholestatic hepatitis. These drugs must not be mixed with other drugs.

Sulfonamides and Trimethaprim

Sulfonamides are most commonly used to treat urinary tract infections and chlamydia. Trimethaprim is frequently used in combination with sulfamethoxazole (TMP-SMX) to treat Shigella, systemic salmonellosis, and prostatitis. These drugs are administered PO.

ADVERSE REACTIONS: Nausea and vomiting, rash, crystalluria, toxic nephrosis, hypersensitivity reactions. In combination with SMZ, adverse effects are increased.

Fluoroquinolones

These drugs act against gram-positive and gram-negative microbes. They are used primarily to treat urinary tract infections. Widely used drugs in this category are:

Ciprofloxacin (Cipro): administered PO

Norfloxacin (Noroxin): administered PO

Lomefloxacin (Maxaquin): administered PO

ADVERSE REACTIONS: Nausea and vomiting, diarrhea, headache, drowsiness, seizures, visual disturbances.

Isoniazid (INH) and Rifampin

These drugs are used in combination or separately to prevent and treat tuberculosis. They are administered orally or parenterally.

ADVERSE REACTIONS:

INH: peripheral and optic neuritis, sensory and perceptual symptoms, dizziness, ataxia, stupor, hepatic dysfunction

Rifampin: liver toxicity, allergic reactions, anorexia, nausea and vomiting, superinfections

Antifungal Agents

Major fungal infections may be treated systemically or by topical route. Widely used drugs in this category are:

Amphotericin B: administered intravenously or intrathecally

Nystatin: administered PO or topically to mucous membranes

ADVERSE REACTIONS:

Amphotericin B: fever, chills, nephrotoxicity, anemia, pain, anaphylaxis, intra-alveolar hemorrhage; highly toxic

Nystatin: highly toxic systemically; topical administration can result in skin irritation, hypersensitivity when given PO

Antiviral Drugs

Antiviral drugs are used to prevent or treat viral infections including genital herpes simplex virus and AIDS-related infections. Drugs widely used in this class are:

Acyclovir (Zovirax): administered PO, IV, and as a topical ointment

Amantadine: administered PO

Stavudine (Zerit): used to treat persons with advanced HIV

Zidovudine (AZT and Retrovir): administered PO

Famciclovir (Famvir): used to treat acute herpes zoster

ADVERSE REACTIONS:

Acyclovir: irritation and local reactions at injection site, phlebitis, reversible renal impairment, blood dyscrasias. By oral route: vertigo, insomnia, depression, diarrhea, headache, fever

Amantadine: nausea and vomiting, insomnia, nervousness, urine retention. Must be used with caution if patient has glaucoma, is pregnant, or is breast feeding.

Retrovir: blood dyscrasias, bone marrow suppression, headache, nausea and vomiting, mouth ulcers, nosebleeds, acne, pruritis. Must be used with caution in pregnant and breast feeding women.

DRUGS THAT ACT ON THE CENTRAL NERVOUS SYSTEM

The central nervous system (CNS) consists of the brain and the spinal cord. The basic functional unit of the CNS is the neuron (nerve cell), which respond to stimulation by conveying electrical impulses. Neurons are arranged in chains separated by spaces called synapses (Fig. 11–4). As an electrical impulse reaches the end of a neuron, a synaptic vesicle releases a chemical called a *neurotransmitter.* Molecules of a neurotransmitter are able to cross

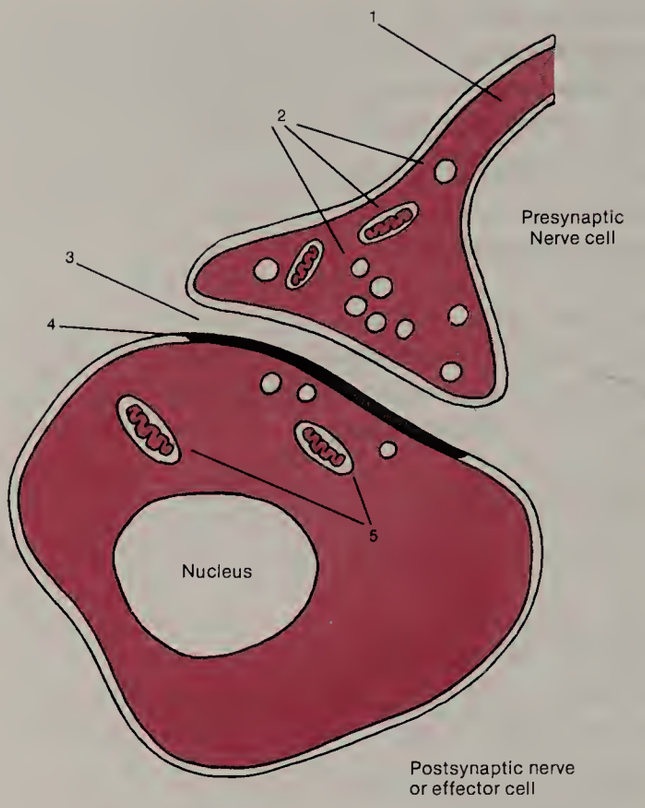


Figure 11–4
Steps in the synaptic transmission process. (*1*) Transport of substrate down the presynaptic axon. (*2*) Organelles and enzymes in the nerve terminal that synthesize, store, release, and actively re-uptake the transmitter chemical. (*3*) Synaptic contact zone, where extracellular enzymes catabolize the transmitter chemical. (*4*) Postsynaptic receptor that triggers postsynaptic response to the transmitter chemical. (*5*) Organelles within the postsynaptic cells that respond to receptor trigger. (Spencer et al.: Clinical Pharmacology in Nursing Management, 4th ed. Philadelphia, JB Lippincott, 1993.)

the synapse to receptors on the postsynaptic fiber and activate a new wave of electric current. It is in this way that the impulse travels to its intended destination in the brain.

The spinal cord functions as a pathway for carrying impulses to and from the brain. It is also the center for reflex actions of the body. Neurotransmitters are composed of acetylcholine, dopamine, norepinephrine, histamine, serotonin, endorphins, and enkephalins. They have inhibitory or excitatory potential. The inhibitory neurotransmitters increase negative responses; excitatory neurotransmitters decrease negative responses between the synaptic clefts.

Drugs that act on the CNS are broadly categorized as depressants and stimulants. CNS depression may range from mild to severe. The most severe CNS depression results in respiratory failure, coma, and death. Some CNS depressants are able to produce a selective depression if used in the prescribed range. There are CNS antagonists that are used to counteract severe depression resulting

from drug overdose. There are also CNS stimulants that produce hyperactivity and insomnia. The effects of CNS stimulants that are used less frequently for treatment are difficult to control.

Narcotic Analgesics

Narcotic analgesics are used for acute, severe pain and for chronic pain when other measures are not successful, as in persons with terminal malignant diseases. The drugs in this category are all controlled substances. They are generally not administered to children under the age of 12; when they are, they must be given by a person educated in pediatric medicine or nursing. Several of the currently used drugs in this category and their methods of administration follow.

Morphine sulfate: IM and PO

Fentanyl (Sublimaze): IM as a preanesthetic; IM or slow IV

Codeine sulfate: PO or IM

Hydrocodone bitartrate (Codone): PO

Meperidine hydrochloride (Demerol): IM, IV, or SC; slow IV in individualized dilution dosage

Hydromorphone hydrochloride (Dilaudid): PO, IM, or SC

Methadone hydrochloride (Dolophine): IM, SC, or PO

Nalbuphine hydrochloride (Nubain): IM, IV, SC

Oxycodone hydrochloride (Roxicodone, Supeudol): PO

Oxycodone with acetaminophen (Percocet): PO

Oxymorphone hydrochloride (Numorphan): PO

Pentazocine lactate or hydrochloride (Talwin): PO, IM

Propoxyphene hydrochloride (Darvon, Dolene): PO

Propoxyphene napsylate (Darvocet-N, Darvon-N): PO

ADVERSE REACTIONS: All opiates may result in tolerance and are addictive; may cause nausea, restlessness, hyperactivity, respiratory depression, hypotension, constipation, urticaria, hypersensitivity, depressed renal function, shock, death.

Narcotic Antagonists

Narcotic antagonists reverse the depressant effects of narcotic agonists. They are used to counteract severe depression resulting from an intake of an excessive amount of the drugs listed above and others. The following are examples of widely used drugs in this category:

Naloxone hydrochloride (Narcan): IV, IM, SC

Naltrexone (Trexan): PO

ADVERSE REACTIONS: Few adverse effects reported from naloxone; if given before detoxification, acute withdrawal symptoms may occur from naltrexone.

Sedative-Hypnotics

The sedative-hypnotic drugs have changed considerably in recent years. The older sedatives (barbiturates) altered normal sleep patterns, decreased REM sleep, and had a high rate of abuse. They were and continue to be used as antiseizure drugs. The benzodiazepines are currently the drugs of choice for insomnia. The drugs in this category are controlled substances. They must not be administered to children under the age of 12; if they are given in exceptional circumstances, it must be done by a person educated in pediatric medicine or nursing. Several of the commonly used drugs in this category are:

Pentobarbital sodium (Nembutal): PO, rectal, IM, IV; short-acting barbiturate

Secobarbital sodium (Seconal): PO, rectal, IV, IM; short-acting barbiturate

Amobarbital sodium (Amytal): PO, IM, IV; intermediate-acting barbiturate

Phenobarbital (Luminal): PO, IM, IV; long-acting barbiturate; used as an anticonvulsant drug; is a schedule IV drug

ADVERSE REACTIONS: Short- and intermediate-acting barbiturates have a high rate of dependence and abuse. They may produce agitation, confusion, somnolence, apnea, respiratory and circulatory collapse, bradycardia, syncope, nausea, vomiting, epigastric distress, tissue necrosis, physical and psychological dependence, tissue necrosis, hypersensitivity reactions, and death. Barbiturates must not be mixed with other medications for parenteral administration! Administer IV only if no other route is feasible. Do not give more than 5 mL in one IM injection site and give deep IM injections into a large muscle.

Nonbarbiturate, Nonbenzodiazepine Sedative-Hypnotic

Chloral hydrate: PO, rectal

ADVERSE REACTIONS: potential for dependence and dangerous withdrawal symptoms. Acute intoxication, nausea, vomiting, gastric irritation, ataxia, paradoxical excitement. These drugs must not be used with alcohol. The patient must not operate motor vehicles after administration!

Benzodiazepines

The group of benzodiazepines listed below are the current drugs of choice as hypnotics (used for treatment of insomnia). They do not suppress REM sleep and, if used as prescribed for short periods of time, are relatively safe.

Flurazepam (Dalmane): PO

Temazepam (Restoril): PO

ADVERSE EFFECTS: There is a potential for dependence to develop with all benzodiazepines. Extrapyramidal symptoms, apathy, sedation, depression, vivid dreams, visual and auditory disturbances, urinary retention or incontinence, constipation, bradycardia, tachycardia, cardiovascular collapse, hypertension and hypotension, blood dyscrasias. Not for use in children younger than 18 years old.

Antianxiety Drugs

The benzodiazepines are the most commonly used drugs for the treatment of anxiety. They are prescribed when symptoms of tremors, restlessness, dry mouth, tachycardia, dizziness, diaphoresis, irritability, and insomnia are present and affect the person's ability to carry on with the activities of daily life for a significant period of time. The benzodiazepines are used to prevent seizures during drug detoxification and for preoperative and pre-procedure sedation. These drugs are controlled substances as they may cause physical and psychological dependence. Several of the widely used antianxiety drugs are:

Alprazolam (Xanax): PO; has a short half-life; used for treatment of anxiety

Lorazepam (Ativan): PO, IM, IV; has a short half-life; used for treatment of anxiety and as preoperative and pre-procedure sedation

Chlordiazepoxide (Librium): PO, IM, IV; has a long half-life; used for anxiety and for acute alcohol withdrawal

Midazolam (Versed): IM, IV; has a short half-life; used as sedation preoperatively and prior to diagnostic procedures, and for the induction of general anesthesia

Diazepam (Valium): PO, IM, IV; *found on emergency drug carts;* has a long half-life; used to treat anxiety, seizure disorders, acute alcohol withdrawal, muscle spasm, and preoperative sedation, and as a hypnotic

Clonazepam (Klonopin): PO, IM, IV; has a long half-life; used to treat seizure disorders

ADVERSE REACTIONS: Potential for addiction; excessive drowsiness, restlessness, skin rash, nausea, bradycardia, tachycardia, urinary symptoms, extrapyramidal symptoms, cardiovascular collapse. Patients who have had these drugs are not allowed to operate motor vehicles.

Warning: When administering diazepam intravenously, administer into large veins; monitor for extravasation. Do not administer intra-arterially. May cause gangrene or arteriospasm. Do not mix in a syringe with other medications or solutions!

Antidepressant Drugs

Antidepressant drugs are used for treating clinical depressive disorders and the depressive state of bipolar disorder. Antidepressants have also been used with some success in older children with enuresis. When symptoms of depression are prolonged for more than a 2-week duration and prevent the afflicted person from performing his activities of daily living as well as obtaining pleasure from any life experiences, the physician must be consulted. The antidepressants are helpful; however, persons in states of severe depression must be monitored carefully as they may be a danger to themselves. Antidepressants must be used with caution for persons with renal, hepatic, and cardiovascular disease and only under care of their physician.

There are basically four categories of antidepressant drugs. There are the older drugs: the tricyclic antidepressants and the monoamine oxidase inhibitors (MAOIs). The newer antidepressants are the selective serotonin reuptake inhibitors (SSRIs) and the atypical antidepressants. The tricyclic antidepressants have side effects that make them somewhat unpleasant to take such as dry mouth, orthostatic hypotension, and sedation. The MAOIs

are infrequently used because they interact adversely with foods containing tyramine (aged foods) and a large number of other drugs. The SSRIs and the atypical antidepressants drugs have fewer side effects that make them unpleasant to take and are quite effective in treating depression, panic attacks, and other mental disorders. Some of the widely used drugs in each group are listed below:

Tricyclics

Amitriptyline (Elavil): PO

Imipramine (Tofranil): PO

Doxepin (Adapin, Sinequan): PO

ADVERSE REACTIONS: Cardiac toxicity, seizures, urine retention.

MAOIs

Phenelzine (Nardil): PO

Tranylcypromine (Parmate): PO

ADVERSE REACTIONS: Central nervous system stimulation; orthostatic hypotension; if taken with sympathomimetic drugs or foods containing tyramine, hypertensive crisis results.

SSRIs

Fluoxetine (Prozac): PO

Sertraline (Zoloft): PO

Paroxetine (Paxil): PO

ADVERSE REACTIONS: Skin rash, diarrhea, fever, chills, respiratory infections, palpitations, seizures, impaired renal function, impaired hepatic function, anorexia.

Atypical Antidepressants

Trazodone (Desyrel): PO

Bupropion (Wellburin): PO

Veniafaxome (Effexor): PO

ADVERSE REACTIONS: Sedation, CNS stimulation, seizures, headache, anxiety, tremor.

Warning: Do not use tricyclics, SSRIs, or atypical antidepressants with MAOIs or sympathomimetic drugs.

Antipsychotic Drugs

Antipsychotic drugs are used primarily for persons with schizophrenia and other psychotic illnesses. They are occasionally used to treat combativeness and severe agitation in persons with organic illnesses; however, they are considered to be chemical immobilizers (restraints) and must be used within the constraints of other immobilizers as discussed in Chapter 4. Several of the widely used antipsychotic drugs are listed below:

Chlorpromazine (Thorazine): PO, IM

Fluphenazine (Prolixin): IM, SC

Thioridazine (Mellaril): PO

Trifluoperazine (Stelazine): PO, IM

Haloperidol (Haldol): PO, IM

ADVERSE REACTIONS: The drugs listed above belong to a group of drugs called phenothiazines. All of these drugs have the potential for causing acute dystonia, parkinsonian symptoms, akathisia, and tardive dyskinesia. If these symptoms occur, they are often controlled by use of an antiparkinsonian drug or an anticonvulsant drug. Other potential adverse reactions are anticholinergic effects; orthostatic hypotension; seizures; sedation; blood dyscrasias; and neuroleptic malignant syndrome, which is potentially fatal.

Other Antipsychotic Drugs

There are some newer atypical antipsychotic drugs that are in use currently. They are:

Risperidone: PO

Clozapine: PO

ADVERSE REACTIONS:

Risperidone: May have extrapyramidal symptoms, tremor

Clozapine: Tremors, headache, drowsiness, fever, rash, urinary symptoms, seizures, blood dyscrasias. Persons on Clozapine therapy must have their blood tested weekly initially to monitor for blood dyscrasias.

Drugs to Treat Bipolar Disorder: Lithium

The drug most widely used to treat symptoms of mania is lithium. It is given PO.

ADVERSE REACTIONS: Nausea, vomiting, tremors, confusion, ataxia, seizures, tinnitus, oliguria, renal failure, death. Persons having lithium therapy must have their blood tested regularly to maintain

the lithium level in their system at a therapeutic level while avoiding toxicity.

Anticonvulsant Drugs

Seizure disorders are described in Chapter 7. There are several groups of drugs that can control seizures but none are able to cure the problem. The barbiturates and the benzodiazepines are two groups of drugs that are used to treat seizure disorders. Other groups of drugs widely used are as follows:

Hydantoins

Phenytoin (Dilantin): PO, IM, IV. *Found on emergency carts.*

Succinimides

Ethosuximide (Zarontin): PO

Other anticonvulsants

Carbamazepine (Tegretol): PO

Valproic acid (Depakene): PO

ADVERSE REACTIONS: Gastric upset, drowsiness, CNS depression, skin rash, hypotension, blood dyscrasias. All anticonvulsant drugs must be monitored carefully as they may become highly toxic. No anticonvulsant therapy should be stopped abruptly.

Specific Drug Reactions

Dilantin: Gingival hyperplasia, ataxia, hirsutism.

Tegretol: Take blood count regularly for blood dyscrasia.

Depakene: Liver function studies prior to therapy; not to be used with clonazepam; may cause seizures.

Antiparkinsonian Drugs

Parkinson's disease is a neurological disorder that manifests with symptoms of tremor, rigidity, bradykinesia, disturbed posture, and disturbances in balance; as the disease progresses, dementia, depression, and other psychological disturbances become evident. Unfortunately, this disease is relatively common among the elderly, so the radiographer will encounter patients in his practice with parkinsonian symptoms. It is a degenerative disease that decreases dopamine in the brain and increases availability of acetylcholine, thereby producing the symptoms listed above. Treatment is aimed at increasing dopamine availability in the brain and inhibiting acetylcholine by use of anticholinergic agents. Drugs widely used to treat Parkinson's disease are as follows:

Dopaminergic Agents

Levodopa (Larodopa, Dopar): PO

Carbidopa (Lodosyn): PO

Amantadine (Symmetrel): PO

Carbidopa (Sinemet): PO

ADVERSE REACTIONS: Nausea, vomiting, increased abnormal movements, psychiatric symptoms, cardiac arrhythmias.

Anticholinergics

Benztropine (Cogentin): PO

Trihexyphenidyl (Artane): PO

ADVERSE REACTIONS: Mental confusion, agitation, hallucinations.

Anesthetics

There are essentially three types of anesthetic agents: local, short-acting IV, and general inhalation anesthetics. Administering anesthesia requires years of specialized academic and clinical education. Persons without this education must not administer anesthetic drugs. If administered incorrectly, they are life threatening. A very brief list of some of the more widely used anesthetic drugs follows.

General Inhalation Anesthetics

Eflurane (Ethrane): nonexplosive, nonflammable, volatile liquid

Halothane (Fluothane): nonexplosive, nonflammable liquid

General Intravenous Anesthetics

Alfentanil (Alfenta): used as a primary anesthetic

Fentanyl and droperidol combination (Innovar): used for neuroleptanalgesia (a state of reduced sensory perception during uncomfortable diagnostic tests)

Ketamine (Ketalar): used for surgical, diagnostic, or therapeutic procedures

Local Anesthetics

Dibucaine (Nupercaine, nurpercainal): used for topical or spinal anesthesia

Lidocaine (Xylocaine): used for topical or regional anesthesia. *Found on emergency drug carts for treatment of cardiac arrhythmias.*

Tetracaine (Pontocaine): used for topical or spinal anesthesia

ADVERSE REACTIONS: All anesthetics may produce hypotension, cardiac arrhythmias, respiratory distress, interactions with other drugs, hypotension, shock, and circulatory failure.

Drugs Used to Treat Muscle Spasms

Drugs used to treat muscle spasms and spasticity of muscles are not necessarily interchangeable because they may work locally or by general depression of the CNS. Some of the drugs in this group, if used for a long period of time, create a physical dependence. Several that are widely used follow:

Dantrolene (Dantrium): PO, IV for use during surgical procedures for treatment of malignant hyperthermia; acts peripherally on the muscle itself

Baclofen (Lioresal): PO, not to be used if patient has impaired renal function or is under 12 years of age

Methocarbamol (Robaxin): PO, IM, IV

Cyclobenzaprine (Flexeril): PO; should not be used for longer than 3 weeks.

ADVERSE REACTIONS: CNS depression, sedation, dizziness. If used for long periods, drug must be withdrawn slowly as user may have severe withdrawal reaction.

DRUGS THAT ACT ON THE PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system has two branches, the voluntary, or somatic, nervous system and the involuntary, or autonomic, nervous system (ANS). The voluntary branch conveys information from the external environment to the CNS, which controls the responses of the musculoskeletal system. The individual in good health has control of these responses. The ANS controls the enervation of the smooth muscles and body organs such as the heart and the glands. The ANS is divided into the sympathetic and parasympathetic divisions. The sympathetic nerves originate in the thoracic and upper lumbar regions of the spinal cord. The parasympathetic nerves originate in the brain stem and sacral region of the spinal cord.

The two principal neurotransmitters responsible for transmission of nerve impulses through the autonomic nervous system are acetylcholine and norepinephrine. The nerve fibers that secrete acetylcholine are called *cholinergic fibers*. The nerve fibers that secrete norepinephrine are called *adrenergic fibers*. Both acetylcholine and norepinephrine act on the organs and tissues of the body to produce either excitatory or inhibitory effects depending upon the organ involved. Most organs of the body are controlled by either the sympathetic or parasympathetic system. Often when the sympathetic nervous system excites a particular organ, the parasympathetic system inhibits it.

When the sympathetic nerves are stimulated, an adrenergic response occurs. This response may produce the following reactions:

Dilation of blood vessels

Increase in heart rate

Decrease in gastric motility and sensation

Contraction of the gastric sphincters

Contraction of the urinary bladder sphincter

Constriction of the blood vessels of the skin

Secretion of adrenalin

When the parasympathetic nerves are stimulated, a cholinergic response occurs causing the following reactions:

Constriction of the pupils

Bronchial constriction

Decrease in heart rate

Increase in gastric motility and secretion

Relaxation of the urinary sphincter

Increased secretion from the salivary and lacrimal glands

Drugs may affect the autonomic nervous system by increasing release of a neurotransmitter, decreasing release of a neurotransmitter, mimicking a neurotransmitter, blocking receptors, or inhibiting breakdown of a neurotransmitter. Symptoms of diseases controlled by use of drugs acting on the ANS include ulcers, urinary retention, glaucoma, asthma, angina pectoris, congestive heart failure, bradycardia and tachycardia, nasal congestion, hy-

pertension, constipation, and diarrhea. Examples of drugs that are used for the purpose of affecting the autonomic nervous system follow.

Adrenergic Drugs

Adrenergic drugs produce effects that are in many ways the same as the stimulating effects of some drugs that act on the sympathetic nervous system. The most notable action of these drugs is to constrict blood vessels and to stimulate the heart. Many of the drugs in this category are used in cardiovascular, respiratory, and allergic emergencies.

Dopamine (Intropin): IV, used to treat hypotension and shock. *Found on emergency drug carts.*

ADVERSE REACTIONS: Cardiac arrhythmia, extreme hypertension; tissue necrosis if extravasation occurs; dyspnea; nausea and vomiting.

Epineprine (Adrenalin): IV, SC, inhalers; used as a bronchodilator and vasoconstrictor in acute asthma, anaphylactic shock, and hypersensitivity reactions. *Found on emergency drug carts.*

ADVERSE REACTIONS: Hypertensive headache, intracranial hemorrhage, cardiac arrhythmias, pallor, palpitations, anxiety, dizziness, dyspnea, pulmonary edema.

Ephedrine: IM, SC, IV, topical; used as a bronchodilator, for cardiac stimulation, hypotension, nasal decongestant.

ADVERSE REACTIONS: Extreme hypertension; intracranial hemorrhage; tachycardia; cardiac arrhythmias; anxiety, pallor, and circulatory collapse.

Levarterenol (Levophed): IV, used to treat hypotension and shock

ADVERSE REACTIONS: Bradycardia; headache; extreme hypertension; skin irritation and tissue necrosis, if extravasation occurs.

Albuterol (Proventil, Ventolin): PO, inhalation; used as a bronchodilator

ADVERSE REACTIONS: Anxiety, CNS stimulation, insomnia, tremor, vertigo, cardiac arrhythmias, tachycardia, pulmonary edema, bronchospasm, sweating and pallor, nausea, heartburn.

Isoproterenol (Isuprel): Sublingual, IV; potent bronchodilator used to treat shock and acute renal failure; for hypotension to promote perfusion to vital organs. *Found on emergency drug carts.*

ADVERSE REACTIONS: May be harmful in cardiogenic shock, tachycardia, palpitations, angina-type pain, flushing, tremors, headache, nausea, bronchial edema.

Antiadrenergic Drugs

Drugs are used to block the effects of nerve impulses transmitted by adrenergic fibers of the sympathetic nervous system. They cause increased peripheral circulation and decreased blood pressure. Alpha-1 receptor blocking agents dilate blood vessels and decrease peripheral vascular resistance. Alpha-2 blocking agents block sympathetic nervous system impulses in the brain. Beta-adrenergic blocking agents decrease heart rate, force of myocardial contraction, cardiac output, and renin release from the kidneys. Alpha- and beta-blocking agents are widely used and must be recognized by the radiographer.

Alpha-1 Adrenergic Blocking Drugs

Prazosin (Minipress): PO; used to treat hypertension and Reynaud's vasospasm

Terazosin (Hytrin): PO; used to treat hypertension

ADVERSE REACTIONS: Dizziness, headaches, vertigo, depression, tachycardia, orthostatic hypotension, dyspnea, nausea, urinary symptoms, blurred vision, epistaxis; syncope after first dose of prazosin.

Alpha-2 Adrenergic Blocking Drugs

Clonidine (Catapres): PO; used to treat hypertension, Tourette syndrome, migraine

ADVERSE REACTIONS: Vomiting, parotitis, sedation, nightmares, hallucinations, depression, orthostatic hypotension, tachycardia, bradycardia, impotence, rash, hyperpigmentation.

Methyldopa (Aldomet): PO; used to treat hypertension

ADVERSE REACTIONS: Sedation, weakness, bradycardia, aggravation of angina, nausea, blood dyscrasias, rash, gynecomastia.

Beta-adrenergic Blocking Agents

Atenolol (Tenormin): PO; used to treat hypertension, angina, myocardial infarction, migraine

Metroprolol (Lopressor): PO; used to treat hypertension and myocardial infarction

Propanolol (Inderal): PO, IV; used to treat hypertension, angina, cardiac arrhythmias. *Found on emergency drug cart.*

Nadolol (Corgard): PO; used to treat angina and hypertension

ADVERSE REACTIONS: Bradycardia, congestive heart failure, arrhythmias, vertigo, fatigue, bronchospasm, dyspnea, gastric pain, nausea, impotence, joint pain, rash, eye irritation.

Antimuscarinic Drugs

These drugs belong to a category known as classic anticholinergic drugs, which block activity at postganglionic parasympathetic receptor sites found on cardiac and other smooth muscle. Widely used drugs in this group are:

Atropine: PO, IV, IM, topical; used in treatment of gastric diseases as an antispasmodic, and to treat bradycardia by increasing heart rate; also used preoperatively to prevent salivary and bronchial secretions and in ophthalmology to relax pupil of eye. *Found on emergency drug carts.*

ADVERSE REACTIONS: Dry mouth, nausea, vomiting, blurred vision, urine retention, impotence, bradycardia, tachycardia, suppression of lactation.

Scopalamine: PO, SC, IM, IV diluted with water for injection; used to treat motion sickness and GI disorders, and as a preliminary to anesthesia.

ADVERSE REACTIONS: Tachycardia, dry mouth, blurred vision, CNS toxicity, delirium. Not for use in patients with wide-angle glaucoma.

Calcium Channel Blockers

Calcium channel blockers are drugs that inhibit the flow of calcium ions across the membranes of smooth muscle cells. Calcium is important in cardiac and smooth muscle contraction and in the generation and conduction of electrical impulses in the heart. By reducing calcium flow, the smooth muscle tone is relaxed, thereby reducing muscle spasm. These drugs have been used extensively to treat heart diseases caused by arterial spasms. Recently, there has been some question concerning the effectiveness of these drugs. Some of those that are widely used follow:

Verapamil (Calan, Isoptin): PO; comes in sustained release form; used to treat angina, cardiac arrhythmias, and hypertension

Nifedipine (Procardia, Adalat): PO; comes in sustained release form; used to treat angina and hypertension

Diltiazem (Cardizem): comes in sustained release form; used to treat angina and hypertension

ADVERSE REACTIONS: Peripheral edema, hypotension, arrhythmias, bradycardia, dizziness, nausea, flushing, rash; may cause heart block if patient is taking digitalis preparation.

Vasodilators

These drugs are used for severe hypertension. Tachycardia, renin release, and fluid retention are frequent adverse effects from these drugs; therefore, when they are prescribed, a diuretic or a beta-blocking agent is prescribed with them.

Hydralazine (Apresoline): PO, IM, IV; used for hypertensive crisis and severe hypertension

Minoxidil (Loniten): PO; used for severe hypertension

ADVERSE REACTIONS: SEE ABOVE.

Hydralazine: lupus-like syndrome

Loniten: pericardial effusion, hirsutism

Diuretics

These drugs are used to treat hypertension, congestive heart failure, pulmonary edema and other medical conditions that create an edematous state in the body. When diuretic therapy is begun, cardiac output decreases as blood volume is decreased. Diuretics are often used in combination with other cardiac and antihypertensive drugs. Some of the commonly used diuretics are:

Furosemide (Lasix): PO, IV; used to treat hypertension, congestive heart failure, and pulmonary edema. *Found on emergency drug carts.*

Thiazides (Esidrix, HydroDiuril, Hygroton): used to treat hypertension and other medical conditions that cause fluid retention

Acetozolamide (Diamox): PO; used to treat open-angle glaucoma

Hydrochlorothiazide (Dyazide, Maxide): PO; used to treat hypertension

Mannitol (Osmitrol): IV; used to treat the oliguric phase of renal failure, used in radiographic imaging to prevent nephropathy or acute renal failure. *May be found on emergency drug carts.*

ADVERSE REACTIONS: Hypokalemia, hyperkalemia, alkalosis, hyponatremia, vascular collapse.

Cardiac Glycosides

These drugs are all derived from the foxglove plant (*Digitalis purpurea*). There are several forms of the drug; however, they all basically perform the same function. That is, they all increase the force of cardiac contractility and slow the heart rate. The drugs in this group are:

Digoxin (Lanoxin): PO, IV; used to treat congestive heart failure and some cardiac arrhythmias

Digitoxin (Crystodigin): PO; used to treat congestive heart failure and some cardiac arrhythmias

ADVERSE REACTIONS: Fatigue, muscle weakness, dizziness, vertigo, stupor; cardiac toxicity, anorexia, nausea, vomiting, abdominal pain, diarrhea, gynecomastia, cardiac arrest.

Organic Nitrates

These drugs are used to relax smooth muscles of both arteries and veins; it is their ability to relax (dilate) veins that makes them useful in treating anginal pain. Venous capacity is increased, thereby reducing, temporarily, the amount of blood entering the heart. This has the effect of reducing the heart's workload. Organic nitrates may be very short- or long-acting drugs. Several of the most widely used are as follows:

Short Acting

Nitroglycerin (Nitrostat, Tridil, Nitrostat IV, Nitrolingual): sublingual, IV; used to treat sudden onset of anginal pain

Isosorbide dinitrate (Isordil, Sorbitrate): sublingual

Long Acting

Nitroglycerin (Nitroglycerin, Nirogard, Nitro-Dur, Transderm Nitro): PO, buccal, topical ointment, transdermal patch; used to prevent anginal pain; by buccal route, used to treat sudden-onset cardiac pain

Isosorbide dinitrate (Sorbitrate, Isordil): PO; used to prevent anginal pain

Pentaerythritol tetranitrate (Peritrate): PO; used to prevent anginal pain

ADVERSE REACTIONS: Headache, vertigo, faintness, hypotension, syncope, flushing, dermatitis, burning sensation at contact point.

Antiarrhythmic Drugs

All cardiac arrhythmias are the result of abnormalities or errors in electrical impulse formation or conduction. The arrhythmia that is generated creates a change, either in the heart's rate of contractility or in its rhythm. These changes may be life threatening. Several of the widely used antiarrhythmic drugs are:

Quinidine: PO, IM, IV; used to maintain normal cardiac rhythm and, in emergencies, to restore normal cardiac rhythm. *Found on the emergency drug cart.*

ADVERSE REACTIONS: Cardiac arrhythmias, heart block, hypotension, nausea, diarrhea, liver toxicity, vision changes, rash, ringing in ears, tremor.

Procainamide (Pronestyl, Procan): PO, IV; controls cardiac arrhythmias. *Found on emergency drug cart.*

ADVERSE REACTIONS: Lupus-like syndrome; hypotension, cardiac disturbances, nausea, depression, convulsions, psychosis.

Lidocaine (Xylocaine): IV, IM; used as a local anesthetic, and is the drug of choice for treating serious ventricular arrhythmias following myocardial infarction, cardiac surgeries, and diagnostic examinations. *Found on the emergency drug cart.*

ADVERSE REACTIONS: Cardiac arrhythmias, heart block, cardiac arrest, respiratory depression, hypotension, septic meningitis.

Bretylium (Bretylol): IV, IM; used to treat cardiac arrhythmias and ventricular fibrillation. *May be found on emergency drug carts.*

ADVERSE REACTIONS: Hypotension; transient hypertension; dizziness; syncope; nausea; pain; necrosis at injection site, if extravasation should occur.

Analgesics, Antipyretics, and Anti-inflammatory Drugs

Every drug in this category has the same effect, that is, they are all analgesic (reduce pain), antipyretic (reduce fever), and anti-inflammatory (reduce inflammation in tissues) agents. These drugs affect both the central and peripheral nervous systems. All inhibit cyclooxygenase (an enzyme: prostaglandin endoperoxide synthase). This action reduces the sensitivity of peripheral pain receptors and may interfere with pain impulses at subcortical brain centers.

This group of drugs is called NSAIDs, for *nonsteroidal anti-inflammatory analgesic drugs*. They are highly effective and widely used to relieve moder-

ate pain, especially pain related to myalgia (muscle pain), neuralgia (pain of nerve origin), and cephalalgia (headache that may be of histamine origin). They are also used to reduce fever, and to reduce inflammation in osteoarthritis, rheumatoid arthritis, bursitis, and rheumatic fever. Because they reduce platelet aggregation and decrease prothrombin formation, they are used to prevent venous emboli and cerebral ischemia associated with heart disease. Some of the most widely used NSAIDs are as follows:

Salicylates and aspirin: PO; used for all disease states mentioned above; most widely used of the NSAIDs (at low doses) for preventing platelet aggregation and prevention of thrombi

Indomethacin (Indocin): PO; most potent NSAID; not used as an analgesic; used to treat osteoarthritis, rheumatoid arthritis, patent ductus arteriosis in infants, and gout

Ibuprofen (Advil, Motrin, Nuprin): PO; used to relieve symptoms of dysmenorrhea, and other mild to moderate pain

Naproxen (Naprosyn): PO; approved for use in juvenile arthritis; also used for gout and arthritic conditions

Piroxicam (Feldene): PO; long-acting drug used to treat arthritic diseases

Sulindac (Clinoril): PO; used for chronic pain. ***Must not be used for children!***

Ketorolac (Toradol): PO, IM; used as a more potent analgesic. ***May cause severe GI problems.***

Relafan and Daypro: PO; newest of NSAIDs; used as long-acting drug for pain relief

ADVERSE REACTIONS: GI pain, nausea, dyspepsia, dysuria, renal impairment including renal failure, headaches, somnolence, tinnitus, dyspnea, bleeding, platelet inhibition, blood dyscrasias, peripheral edema, fatal anaphylaxis.

Warning: Use NSAIDs with extreme caution in elderly persons. Use in children only with physician in attendance!

Other Nonnarcotic Analgesics

Acetaminophen (Tylenol): PO; used to treat moderate pain without anti-inflammatory effects; the antipyretic of choice for small children

ADVERSE REACTIONS: The most severe adverse reaction is liver toxicity associated with large doses. May cause dizziness, excitement, disorientation, renal tubular necrosis.

Sumatriptan (Imitrex): SC, PO; used to treat migraine headaches

ADVERSE REACTIONS: Burning, dizziness, vertigo, hypertension, tachycardia, angina-like pain, diarrhea, confusion, anxiety, dyspnea, rash.

Anticoagulants

Frequently, drugs are used prophylactically to prevent thrombus formations prior to surgical procedures. These same drugs are used to prevent extension of thrombi following myocardial infarction, pulmonary embolism, venous thrombosis, and strokes. These drugs are called *anticoagulants*. The radiographer will see some of these drugs used in special procedures and in the operating room.

There are drugs that facilitate the dissolution of blood clots by converting plasminogen to plasmin, the body's natural anticoagulant. These drugs are called *thrombolytics*. Some are relatively new and are quite effective.

Agents used to prevent thrombus formation in persons who have the potential for developing myocardial infarction or cerebral emboli are called *antithrombotics*. The most effective and widely used of these is aspirin, as discussed in the previous section. Anticoagulant drugs that are widely used are as follows:

Heparin: IV, SC; must not be given to persons with pre-existing bleeding disorders; active ulcers; hemophilia; before or after brain, spinal cord, or eye surgery; contraindicated in pregnancy and for persons taking NSAIDs *Antidote: protamine sulfate.*

Warfarin (Coumadin): PO; used to prevent and treat emboli, used prophylactically for persons who have prosthetic heart valves *Antidote: phytonadione (vitamin K, Mephyton), PO, SC, IM; increases blood clotting ability.*

ADVERSE REACTIONS: Bleeding, hemorrhage, urinary tract bleeding, urticaria, alopecia, nausea, blood dyscrasias, osteoporosis, suppression of renal function.

Antilipemic Drugs

A common cause of stroke and myocardial infarction is atherosclerosis. This is caused by deposits of fatty plaques that eventually cut off circulation to the heart or the brain, resulting in a life-threaten-

ing illness. In recent years, drugs have been developed that have been relatively successful in preventing formation of atherosclerotic plaques. They are called *antilipemics* and *vasodilators*.

Antilipemic drugs decrease hyperlipoproteinemia by altering production, metabolism, and removal of lipoproteins from the bloodstream. Some of the most widely used antilipemic drugs are:

Nicotinic acid (niacin): PO; used to treat hypercholesterolemia

Lovastatin (Mevacor): PO; decreases hepatic synthesis of cholesterol

Gemfibrozil (Lopid): PO; decreases hepatic production of triglycerides

Cholestyramine (Questran): PO; increases oxidation of cholesterol and decreases blood cholesterol

Simvastatin (Zocor): PO; reduces total cholesterol

ADVERSE EFFECTS: GI upset, headache, rash, hepatotoxicity, blood dyscrasias. Nicotinic acid: hyperglycemia.

Peripheral Vasodilators

Peripheral vasodilating drugs are of questionable use in dilating atherosclerotic vessels; however, a newer type of drug that affects the cellular components of the blood improves blood flow by decreasing blood viscosity. Some of the commonly used peripheral vasodilators are:

Nylidrin hydrochloride (Adrin, Arlidin): PO; used to treat Raynaud's disease and diabetic vascular disease

Isoxsuprine hydrochloride (Vasodilan): PO; used to treat arteriosclerosis obliterans

ADVERSE REACTIONS: Hypotension, tachycardia, chest pain, nausea, dizziness, rash.

DRUGS THAT ACT ON THE RESPIRATORY SYSTEM

Respiratory disorders range from acute, life-threatening diseases to brief, minor ailments. The range between these extremes is great. It is not within the scope of this test to discuss all illnesses and medications available for these disorders; however, a brief overview is relevant for the radiographer as he will be caring for many persons with these disorders.

The acute, life-threatening diseases most commonly seen in the acute care hospital setting are asthma and chronic obstructive pulmonary disease (COPD). Medications widely used to treat these diseases are:

Epinephrine and ephedrine: used to treat asthma, as discussed earlier under adrenergic drugs

Xanthine derivatives: Theophylline: PO, IV; used for relief or prevention of symptoms of bronchial asthma, bronchospasm, and COPD

Theo-Dur: PO; a long-acting theophylline preparation used as a bronchodilator

Aminophylline: PO, IV; dilates bronchial smooth muscles; use is the same as for theophylline preparations

ADVERSE REACTIONS: Loss of appetite, epigastric pain, tachypnea, respiratory arrest; if blood levels are high, may produce seizures, brain damage, death.

Nasal Decongestants

There are many drugs used to relieve allergic rhinitis, sinusitis, colds, and flu. Some of the most widely used of these drugs are:

Phenylephrine (Neo-Synephrine): PO, topical; used as nasal decongestant, ophthalmic vasoconstrictor, and to treat shock

Phenylpropanolamine (Propagest): PO; used as a nasal decongestant

Pseudoephedrine (Sudafed): PO; used as a nasal decongestant

ADVERSE REACTIONS: Fear, anxiety, drowsiness, tremors, hypertension, arrhythmias, cardiovascular collapse, tachycardia; with prolonged abuse, symptoms of paranoia, nausea, vomiting, necrosis, and sloughing when given IV.

Antitussives, Expectorants

These drugs may be used as expectorants to render a cough more productive by increasing respiratory secretions. Expectorants do not contain opiates when they are used to suppress cough. They may or may not contain opiates such as codeine or hydrocodone when they are used to affect the cough center in the CNS.

Expectorant

Guaifenesin (Robitussin): PO

Narcotic Antitussive

Hydrocodone bitartrate, codeine: PO

ADVERSE REACTIONS: May create dependency with prolonged use.

Nonnarcotic Antitussives

Benzonatate (Tessalon): PO

Dextromethorphan (Pertussin, Benalyn DM, St. Joseph Cough): PO

ADVERSE REACTIONS: Respiratory depression with overdose.

Antihistamines

Histamine is a compound discharged from the mast cells of the body into the bloodstream when particular stimuli influence it to be released. Stimuli such as an antigen/antibody response, tissue injury, extreme cold, and some drugs produce histamine release. Once released into the bloodstream, histamine acts on the body to contract smooth muscles; increase capillary permeability to fluids resulting in an outflow of fluid into the body tissues; dilates cerebral blood vessels producing severe headache; stimulates secretion of gastric fluid in large amounts of high acidity; and stimulates sensory nerve endings causing pain and itching. These are the events of an anaphylactic reaction. When this type of event occurs, an antihistamine drug is administered.

There are many antihistamines on the market. Some are strong CNS depressants and produce a sedative effect. The newer drugs are not as sedating. Antihistamines are used to treat anaphylactic shock; upper respiratory disorders; acute urticaria; edema; hypersensitivity reactions; motion sickness; and nausea. They are also used as over-the-counter sleep medications. Some of the more widely used antihistamines are:

Diphenhydramine hydrochloride (Benadryl): PO, IM, IV, topical; used for anaphylactic reactions and many other uses. *Found on emergency drug carts.*

Dimenhydrinate (Dramamine): PO, IM, IV, rectal; often used to prevent motion sickness

Chlorpheniramine maleate (Chlor-Trimeton): PO, SC, IM, IV; used to treat symptoms of colds and allergies

Promethazine hydrochloride (Phenergan): IM, IV, PO; very potent antihistamine with pronounced sedative effects; used as sedative and in motion sickness

Meclizine hydrochloride (Antivert): PO; used as an antiemetic. **Not for use in pregnant women.**

Hydroxyzine hydrochloride (Atarax, Vistaril): PO, IM; used as an antianxiety and antiemetic drug; also used as an antihistamine

ADVERSE REACTIONS: Must be used with caution in patients with hypersensitivity to these drugs, narrow-angle glaucoma, prostatic hypertrophy, peptic ulcer, and bladder neck obstruction and in pregnant women. *Not for use in patients with asthma!* Drowsiness, dizziness, dry mouth, hypotension, paradoxical excitement, hyperirritability, blurred vision, urinary retention. Patients must be warned not to operate motor vehicles following administration of antihistamines.

DRUGS THAT ACT ON THE GASTROINTESTINAL SYSTEM

The drugs in this category are used to treat gastric ulcers, gastroesophageal reflux, constipation, and diarrhea. The etiologies of gastrointestinal diseases are multiple and range from moderate to severe; some are even life threatening. Gastric ulcers may be caused by the *Helicobacter pylori* bacteria. If this is the causative organism, the ulcers are treated with a combination of antimicrobial drugs for 14 days. The drug descriptions listed in this text will be very brief and will not include drugs used to treat neoplasms and other serious illnesses.

Drugs Used to Treat Peptic Ulcer Disease

Cimetidine (Tagamet): PO; used to modify the acidity of the gastric secretions

Rantidine (Zantac): PO, IV, IM; used to modify acidity of gastric secretions

Famotidine (Pepcid) and nizatidine (Axid): PO; used to modify gastric secretions

ADVERSE REACTIONS: Interferes with action of several commonly used drugs such as lidocaine and quinidine, among others, to cause toxicity; must be used with caution in persons with renal and hepatic disease. Not for use in pregnant women or children.

Sucralfate (Carafate): PO; protects lining of stomach with coating to prevent further damage

Drugs Used to Treat Gastroesophageal Reflux

Cisapride (Propulsid): PO; used to accelerate gastric emptying of liquids and solids

Metoclopramide (Reglan): PO, IV; used to stimulate upper GI tract motility and accelerate emptying time

ADVERSE REACTIONS: Hypertension, hypotension, tachycardia, bradycardia, parkinsonian symptoms, confusion, suicidal ideation, seizures, visual disturbances, nausea, urinary incontinence, hepatotoxicity, jaundice, blood dyscrasias, tardive dyskinesia, neuroleptic malignant syndrome. Use in pregnant women, the elderly, and children must be supervised by a physician.

Antacids

These drugs may be purchased over the counter to treat symptoms of heartburn and indigestion. Several of the widely used preparations are listed below:

Amphogel: PO; contains aluminum hydroxide

Di-Gel: PO; contains magnesium hydroxide and aluminum hydroxide

Gelusil: PO; contains magnesium hydroxide and aluminum hydroxide

Gelusil-M: PO; contains magnesium hydroxide and aluminum hydroxide

Maalox suspension: PO; contains magnesium hydroxide and aluminum hydroxide

Mylanta: PO; contains magnesium hydroxide and aluminum hydroxide

Sodium bicarbonate: PO, IV; used to relieve gastric hyperacidity; used in cardiac arrest to reduce acidosis. *Found on emergency drug carts.*

ADVERSE REACTIONS: Diarrhea

Aluminum derivatives: intestinal impaction, anorexia, weakness, impaired reflexes, depression, tremors, bone pain

Magnesium derivatives: profound diarrhea, dehydration, nausea, vomiting, impaired reflexes, hypotension, respiratory depression, bradycardia, renal stones

Sodium bicarbonate: systemic alkalosis, sodium overload, rebound hypersecretion

Drugs Used to Treat Constipation

There are four types of drugs that are used to relieve or prevent constipation. They are classified as either *cathartics* or *laxatives*. Cathartics cause evacuation of the bowel by increasing peristalsis, usually by irritating the intestinal mucosa. Laxatives promote bowel evacuation by increasing the bulk of the feces, by softening the stool, or by lubricating the intestinal wall. Laxatives are generally less harsh than cathartics. There are saline and irritant, or stimulant, cathartics and bulk-forming and surfactant laxatives. Examples of those widely used follow:

Saline Cathartics

Magnesium citrate solution: PO

Magnesium hydroxide (Milk of Magnesia): PO

Irritant Cathartics

Castor Oil: PO

Cascara sagrada: PO

Bulk-Forming Laxatives

Methylcellulose: PO

Psyllium preparations (Metamucil, Serutan): PO

Surfactant Laxatives (Stool Softeners)

Docusate sodium (Colace, Doxinate): PO

Docusate potassium (Dialose): PO

ADVERSE REACTIONS: All cathartics may create dependence and electrolyte imbalance; should not be used in undiagnosed abdominal pain.

DRUGS USED TO TREAT ANEMIA

Anemia, which may be either a disease or a symptom of disease, manifests as a decrease in the number of red blood cells (RBCs, erythrocytes), a decrease in the hemoglobin content of the RBC, or a change in the size of the RBCs. The causes are varied: blood loss, hemolysis (breakdown of RBCs); bone marrow dysfunction; a deficiency in iron, vitamin B_{12}, or folic acid—the essential cofactors in maintaining a normal RBC count. The symptoms vary depending upon the severity of the disease and may range from mild fatigue to severe hypoxia, tachycardia, angina, cardiac arrhythmias, and heart failure.

Treatment is dependent upon the severity of symptoms and the cause. Iron deficiency, a common cause of anemia, is treated by replacement of iron if the condition is not severe. Drugs used to treat anemia include the following:

Ferrous sulfate: PO; used to treat mild iron-deficiency anemia

ADVERSE REACTIONS: Nausea, heartburn, constipation, diarrhea; may aggravate gastric ulcers; to be taken with food.

Iron dextran: IM; used when unable to ingest oral product

ADVERSE REACTION: Anaphylaxis.

Warning: Iron can be extremely toxic in children and some adults. May result in gastric necrosis and pulmonary and hepatic failure. Antidote: Desferoxamine.

Vitamin B_{12}: IM; used for treatment of pernicious anemia; treatment is lifelong; no significant adverse reactions. Patient must report for therapy as this is a life-threatening illness.

Folic acid: PO; used to treat folic acid deficiency

DRUGS USED TO TREAT OSTEOPOROSIS

Osteoporosis is a disease that results in the deterioration of the substance of bones. It is associated with pain, loss of stature, and deformities. Fractures of the fragile bone occur very easily, sometimes as the result of very little or no direct trauma. It is a problem of postmenopausal women, sedentary or immobilized persons, and persons on long-term steroid therapy. Drug therapy is not totally effective but may slow the process of body deterioration. At present, the most widely used drugs to treat this condition are:

Estrogen replacement therapy: PO, IM, vaginal, transdermal patch; currently the most effective method of prevention for menopausal women

ADVERSE REACTIONS: Nausea, headaches, hypertension, endometrial cancer (without added protesterone), fluid retention, gallstones, jaundice.

Calcium preparations (Os-Cal, Kalcinate, calcium chloride): PO

Calcium chloride: given by slow injection to treat tetany and in CPR to increase cardiac contractility. *Found on emergency drug carts.*

ADVERSE REACTIONS: Anorexia, nausea, vomiting, constipation, severe tissue necrosis when extravasation occurs, bradycardia, peripheral vasodilatation, drop in blood pressure (IV).

Vitamin D: PO; used with calcium preparations for treatment of osteoporosis, rickets, and osteomalacia; increases effects of calcium

ADVERSE REACTIONS: Hypercalcemia, the symptoms of which are anorexia, nausea, abdominal pain, apathy, poor memory, depression, disorientation, coma.

Calcitonin (Calcimar, Miacalcin): SC, IM; used to prevent loss of bone mass in osteoporosis and Paget's disease

ADVERSE REACTIONS: If made with salmon, must be skin tested for allergic reaction prior to administration; nausea, vomiting, flushing of face or hands, urinary frequency, local inflammatory reaction at injection site.

DRUGS USED TO TREAT ENDOCRINE DISORDERS

Endocrinology is a medical specialty area for treatment of a wide range of diseases that include diabetes mellitus, thyroid dysfunction, sexual dysfunction, and the autoimmune diseases. The endocrine system is composed of the hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, ovaries, and testes. All of these glands produce hormones that work with the nervous system to regulate body functions. It is highly complex and beyond the scope of this text to consider this aspect of medicine; however, the radiographer will work with persons with diabetes mellitus and who are taking corticosteroid preparations on a daily basis. For that reason, several of the widely used preparations will be presented here very briefly.

Cortisone (Cortone): PO, IM; used to treat inflammatory and allergic disorders and as replacement therapy for adrenal insufficiency

Dexamethasone (Decadron): PO; used to treat inflammatory and allergic disorders. *May be found on emergency drug carts in IV form.*

Dexamethasone sodium phosphate (AK-Dex, Decadron Phosphate): intra-articular, topical, inhalant, ophthalmic preparations; used for many inflammatory and allergic disorders, dermatologic diseases, and cerebral edema

Methylprednisolone (Medrol): PO

Methylprednisolone (SoluMedrol): IM, IV; anti-inflammatory; used in radiography as premedication for high-risk patients who have had previous allergic reactions or a history of allergies

Hydrocortisone (Hydrocortone, Cortef): PO, topical, parenteral (route depends on purpose and type of preparation)

ADVERSE REACTIONS: Metabolic toxicity, infections, ocular toxicity, hyperglycemia, osteoporosis, euphoria, depression, psychotic behavior, GI symptoms (mild to severe), hypokalemia. Sudden withdrawal may be fatal!

Insulin: SC, a pancreatic hormone used to lower blood sugar levels, aids in conversion of fat to glycogen and promotes protein synthesis. Used to control diabetes mellitus when diet and oral hypoglycemic agents do not control the disease. There are many types prescribed according to onset of action, duration, and patient tolerance. Is derived from bovine (cow), porcine (pig), or human sources.

ADVERSE REACTIONS: Range from mild to severe and include fatigue, headache, nausea, sweating, tremor, hypothermia, palpitations, visual disturbances, clonic reaction, coma, death.

Glucagon: used to treat hypoglycemia by elevating blood glucose level; also used in radiographic imaging to induce intestinal relaxation before GI examinations. *Found on emergency drug carts.*

ADVERSE REACTIONS: Hyperglycemia, hypokalemia, nausea, vomiting, hypotension, possible hypersensivity.

Oral Hypoglycemic Drugs

All are used to treat mild, stable non–insulin-dependent diabetes mellitus. The older agents require larger doses and have more drug interactions. The newer drugs are more potent and have fewer side effects.

Tolbutamide (Orinase): PO

Glipizide (Glucotrol): PO

Glyburide (Micronase): PO

Metformin (Glucophage): PO

ADVERSE REACTIONS: Older drugs (Orinase, Micronase): must be administered with care to the elderly as they are at risk for renal and hepatic impairment. Newer drugs (Biguanide, Metformin): weight loss, diarrhea, abdominal discomfort. Hypoglycemia and GI upset can occur in patients of any age.

Warning: Oral hypoglycemic drugs must not be administered to insulin-dependent diabetics, persons in severe stress, or those with fevers or infections.

Fluids, Electrolytes, and Nutrients

Intravenous replacement of fluid, electrolytes, and nutrients is part of the medical care of most patients treated in acute care hospitals. It is also part of many home care medical treatments. Intravenous fluids are frequently used in radiographic imaging departments as part of the diagnostic plan of care. Often, the hospitalized patient comes to the radiographic imaging department with intravenous fluids being administered. It is not within the radiographer's scope of practice to select the intravenous solution to be used; however, he must recognize the reasons for their use and the potential hazards of these preparations.

Intravenous fluids are administered to patients to replace fluids, reestablish electrolyte balance, or provide vitamins or calories. They are also used as diluents for medication administration. Fluid must be replaced when a person becomes dehydrated. Dehydration occurs when more fluid is lost from the body than is taken in, usually because of a pathological disturbance of body function. Some electrolytes are lost with the fluid, and some become more concentrated within the body, thus creating an electrolyte imbalance. Electrolytes are elements or compounds that, when dissolved in a solvent (water in the human body), separate into ions able to conduct electrical activity. Electrolytes in the body vary in concentration depending upon whether they are in blood plasma, interstitial fluid, or cellular fluid. This variability affects movement of substances between compartments within the body depending upon concentration gradients. Depletion of or an excess of one electrolyte affects the concentration of all others. In order for the body to function in a state of good health, the correct balance of fluids, electrolytes, and nutrients must be maintained. When an individual is acutely ill, this balance is maintained by IV therapy.

There are many prepared combinations of fluid and electrolyte solutions for IV use. Vitamins, minerals, and medications may be added to these solutions or given separately as prescribed. Parenteral solutions for IV nutrition are also available.

There are hydrating solutions composed of water, carbohydrate, and varying amounts of sodium chloride. These solutions do not usually contain potassium, which is essential to body function but may be harmful if present in excess amounts.

There are solutions designed to help the body meet its energy requirements. The fluid in these solutions may be either normal saline or water. The dextrose content may be either 5% of 10%. Intravenous replacement solutions usually are packaged in containers of 250 mL, 500 mL, and 1000 mL. Some of the widely used IV replacement solutions are:

Lactated Ringer's (Hartman's) Solution: contains sodium, potassium, calcium, chloride, and lactate

Plasma-Lyte 148 5% Dextrose: contains sodium, potassium, magnesium, chlorides, acetate, and gluconate

Plasma-Lyte R +5% Dextrose: contains sodium, potassium, calcium, magnesium, chloride, lactate, acetate

10% Travert's (invert sugar with electrolyte No. 2): contains sodium, potassium, magnesium, lactate, and phosphate

More simple solutions are also available that contain dextrose in various concentrations and normal saline solutions. The radiographer will work with this type of solution when the patient needs an IV line available but does not require electrolytes or nutrients.

Electrolyte replacement therapy is not necessarily prescribed by IV route. Oral and intramuscular preparations are also available. Some of those widely used are:

Potassium chloride (*e.g.*, K-Lor, Slow-K, K-Lyte): PO and in parenteral solutions; potassium is necessary to maintain cellular osmolarity, to transmit nerve impulses, and for muscle contraction

ADVERSE REACTIONS: Bradycardia, nausea, vomiting, diarrhea, cardiac arrest, dysphagic, respiratory distress, weakness, muscle paralysis leading to death. By injection: tissue sloughing, necrosis, phlebitis, venospasm.

Sodium chloride: IV, may take PO; needed to maintain osmotic pressure and serum osmolarity; sodium regulates fluid volume and controls muscle contraction

ADVERSE REACTIONS: With deficit, anorexia, nausea, mental confusion, giddiness, apprehension, convulsions, pallor, clammy skin, low blood pressure. With excess, symptoms of fluid volume excess (edema, disorientation, twitching, hyperirritability, coma).

Magnesium: IV; used to treat convulsive states and cerebral edema, correction of nutritional deficiency and uterine tetany

ADVERSE REACTIONS: Absence of knee-jerk reflex, hypotension, respiratory depression, profuse perspiration, circulatory collapse, cardiac arrest.

Sodium bicarbonate: IV; used in emergencies to treat metabolic acidosis, ketoacidosis, and hyperkalemia. *Found on the emergency drug cart.*

VITAMINS AND MINERALS

The maintenance of good health requires an adequate daily intake of vitamins and minerals. These are usually acquired by eating animal and vegetable products that contain them. If vitamins or minerals are lacking in the diet for a period of time, diseases may result. Many people feel that a daily supplement of vitamins and minerals is needed to assure that these nutritional needs are met.

Vitamins are either fat- or water-soluble. The fat-soluble vitamins are vitamins A, D, E, and K. The water-soluble vitamins are vitamins B_1, B_2, B_6, B_{12}, C, folic acid, pantothenic acid, niacin, and biotin.

The minerals necessary to maintain health are iron, calcium, magnesium, sodium, potassium, phosphorus, copper, zinc, iodine, cobalt, chromium, manganese, and selenium. Most of these are necessary in only trace amounts.

It is not within the scope of this text to discuss each vitamin and mineral individually. Those that the radiographer may see in practice have been discussed in previous sections of this chapter.

Intravascular and Iodinated Contrast Media

Intravascular contrast media are the drugs that the radiographer will work with most frequently in professional practice. These agents are categorized as drugs because they can be absorbed into the systemic circulation and may effect a physiologic response. When an anatomic area is filled or outlined by these agents, the radiograph of the organ will appear to be white or light (positive contrast), whereas use of negative agents would make the organs appear dark. (Negative contrast agents are discussed in Chapter 9.)

Intravascular contrast agents are used in examinations of the GI tract, kidneys, gallbladder, pancreas, heart, brain, adrenal glands, arteries, veins, and joints. They are used to increase the visibility of body cavities, organs, and the vascular system in radiographic imaging, fluoroscopy, and other imaging modalities. Special imaging procedures are discussed in Chapter 13.

The most frequently used intravascular contrast agents in radiographic imaging procedures contain iodine. Iodine is of high atomic density and can provide the contrast needed for visualization in areas of the body where there is no natural contrast, such as there is in the bones (Fig. 11–5).

Z=53
Bone=11-12



Figure 11–5
Intravenous pyelogram using an iodinated contrast agent.

The important variables that a physician considers when selecting a contrast agent for use are the ability of the agent to mix with body fluids, the viscosity of the agent, its ionic strength, and the potential for toxicity. Most contrast agents in use are water based; however, there are a few radiographic imaging procedures that require use of an oil-based contrast agent.

Iodinated contrast agents are administered by oral, vaginal, intravenous, and intra-arterial routes. They may also be directly instilled into joints (percutaneous route) or into body cavities. They can be distributed easily to areas where visualization is needed for diagnosis and then excreted from the body in a relatively dependable manner.

Drugs used to treat most illnesses are administered in small dosages at selected intervals, whereas contrast agents are administered in a large dose at one time (by bolus). Another variation from other drugs used for treatment is that most other drugs administered intravascularly are isotonic. This means that they have the same concentration of solute as another solution; therefore, they exert the same amount of osmotic pressure as that solution (in this case, the fluids of the body). Contrast agents have osmolalities much higher than those of body fluids. They are also very viscous (thick and sticky). When they are administered intravascularly, the high osmolality and the viscosity of iodinated contrast agents prompt a sudden shift in body fluid from the interstitial spaces and cells into the systemic circulation. This abrupt physiological change is thought to cause the adverse effects that occur in some instances with administration of intravascular contrast agents.

There is a group of newer contrast agents that are nonionic and of lower osmolarity (determined by the number of particles in solution). Use of these agents decreases the potential for adverse reactions. Whenever it is possible, these agents are chosen by the physician for use, as they have a wider margin of safety and comfort for the patient.

There are a number of reactions that may occur when an iodinated contrast agent is administered. These reactions are most apt to occur when the agent is administered intravenously or intra-arterially. Expected side effects include a feeling of flushing and a metallic taste in the mouth. These are not considered to be adverse reactions.

The ionic, high-osmolality iodinated contrast agents are most frequently associated with adverse reactions. These reactions range from mild to severe and life threatening. It has been noted that the rapidity and skill with which these reactions are observed and treated makes a significant difference in the patient outcome. The radiographer will most often be the health care worker who is present to observe symptoms of a potential adverse reaction; therefore, it is his obligation to be skilled in assessment so that he may recognize problems quickly and initiate the emergency action necessary to resolve them.

Reactions to iodinated contrast media are as follows:

Side Effects

A feeling of flushing or warmth

Nausea

Headache

Pain at injection site

Altered taste, may be metallic

Radiographer Action

Notify the radiologist or the radiology RN.

Apply a warm compress to the site.

Observe the patient closely.

Minor Reactions

Complaints of itching of nose, eyes

Anxiety

Cough

Hives or rash

Radiographer's Response

Stop the infusion and notify the radiologist and the radiology RN.

Do not leave the patient unattended.

Secondary Reactions

Vomiting

Coughing

Dyspnea and wheezing

Initial symptoms of shock: anxiety, rapid pulse, rapid respirations, hypotension

Chest pain

Radiographer's Response

Stop the infusion.

Notify the radiologist and the radiology RN.

Call for emergency team.

Stay with the patient and offer reassurance.

Prepare for administration of oxygen and intravenous medications.

If patient is in respiratory distress, place in semi-Fowler's position.

Position patient who is vomiting so that he does not aspirate.

Warning: Patients who are receiving iodinated contrast media must not be left unattended. An anaphylactic reaction can occur quickly and without warning.

If symptoms present and are allowed to progress, the patient may develop pulmonary edema, bronchospasm, cardiac arrhythmia, and cardiac arrest. For most radiographic imaging procedures that require use of a contrast agent, an intravenous infusion is started to maintain hydration and to permit emergency administration of medications if the situation requires this. This ensures that there will be an intravenous access line established and saves valuable time in an emergency. Most reactions to contrast agents occur relatively soon after administration is started; therefore, the patient must be carefully observed initially. The radiographer must know where the emergency cart is at all times and how to call a CODE. He must also be certain that the oxygen-delivery equipment is on hand and in working order.

PRECAUTIONS FOR ELDERLY AND PEDIATRIC PATIENTS

Although the contrast agents used for the elderly patient and the pediatric patient are generally the same as those used for the average adult patient, the amount administered will vary. The potential for fluid and electrolyte imbalance is far greater in this population; therefore, the dosage must be individualized with great care to prevent renal failure and other adverse reactions. Low osmolar contrast media are often chosen for infants and children. If the child is to be sedated for a procedure, a person who is educated in pediatric care must be present to administer the drug.

Elderly patients have a greater potential for impaired renal or hepatic function, which makes them more prone to life-threatening fluid and electrolyte imbalance. They may also present for care in a dehydrated state. Careful consideration must be given to the care of persons in this age group.

PATIENT ASSESSMENT AND CARE

Prior to administration of a contrast agent, an assessment must be performed by the radiographer. This is often preceded by requesting that the patient respond in writing to a printed assessment questionnaire that each department has formulated for an overview of the patient's health problems. The radiographer must read the patient's responses and make certain that the patient fully understands the questionnaire and that his responses are accurate. If there are positive responses indicating a problem that may affect the procedure, the radiographer must notify the physician before beginning the procedure. For most invasive procedures, an informed consent must also be signed and in place. It is the radiographer's obligation to confirm that consents are correctly signed and that the health assessment is complete and accurate. The assessment information that must be obtained is as follows:

1. Age of patient
2. History of impaired hepatic function (liver disease)
3. History of impaired renal function (kidney disease)

4. History of hypersensitivity reactions (allergic or anaphylactic reactions) (described in Chapter 7)
5. History of thyroid disease: hyperthyroidism or hypothyroidism
6. Possibility of pregnancy
7. Lactation (nursing mother)
8. Sensitivity to aspirin
9. Sensitivity to tartrazine (a coloring agent used in foods and beverages)
10. History of diabetes mellitus
11. History of multiple myeloma (a malignant tumor of the bone marrow)
12. History of sickle cell disease (a chronic, incurable anemic condition affecting red blood cells)
13. History of hypertension
14. History of heart disease including congestive heart failure
15. History of pheochromocytoma (a tumor of the adrenal gland resulting in excess secretion of epinephrine and norepinephrine)
16. History of homocystinuria (an inherited disease caused by enzyme deficiencies that may result in mental retardation and skeletal abnormalities)
17. Medication history (list all medications taken, include over-the-counter drugs taken occasionally)
18. History of previous reactions to medications or contrast agents

Warning: Patients who are highly anxious, have heart disease or renal insufficiency, or are generally debilitated or dehydrated are at risk for adverse reactions.

Invasive radiographic procedures are frequently stressful. The patient's mental state prior to and during a procedure that requires iodinated contrast media is of great importance. To calm an anxious patient requires critical thinking and skillful use of therapeutic communication by the radiographer. He should assess the patient's understanding of the procedure and inform him in detail about how the examination will proceed. Education about some expected side effects of iodinated contrast media that are not symptoms of an adverse reaction should also be explained to prevent feelings of anxiety should they occur. When the patient understands what to expect and what is occurring, his anxiety will be greatly reduced. He must also be allowed to express his feelings of anxiety, as this also reduces those feelings. Thoughtful care by the radiographer will establish a feeling of trust in the patient and adverse reactions may be avoided.

Other considerations when iodinated contrast agents are used are as follows:

1. Infants, children, and elderly patients are rapidly dehydrated by the osmotic diuretic action of iodinated contrast agents. Restriction of fluids in preparation for diagnostic examinations using these agents is not advised as it may produce life-threatening dehydration and renal failure.
2. Highly viscous contrast agents should not be directly injected into the carotid or vertebral arteries.
3. Extravasation (infiltration) of iodinated contrast agents may cause extensive tissue damage and must be prevented.
4. Overdosage of iodine may occur. Eighty to 90 g of iodine rapidly administered may produce symptoms of overdosage, which are tremors, irritability, and tachycardia (early symptoms). If such symptoms occur, stop administration of the contrast agent immediately and initiate emergency action.
5. All solutions of contrast agents should be administered at body temperature.
6. All solutions administered must be clear. If there are particles in the solution, it must be discarded.
7. Protect iodinated contrast media from exposure to light.
8. Discard all unused agents that have been opened.
9. Do not mix contrast agents with other drugs.
10. Do not mix contrast agents with other contrast agents.

Nonionic, low osmolar (determined by number of particles in the solution), iodinated contrast agents decrease the potential for adverse reactions. Use of such a contrast agent decreases the incidence of cardiovascular symptoms, nausea and

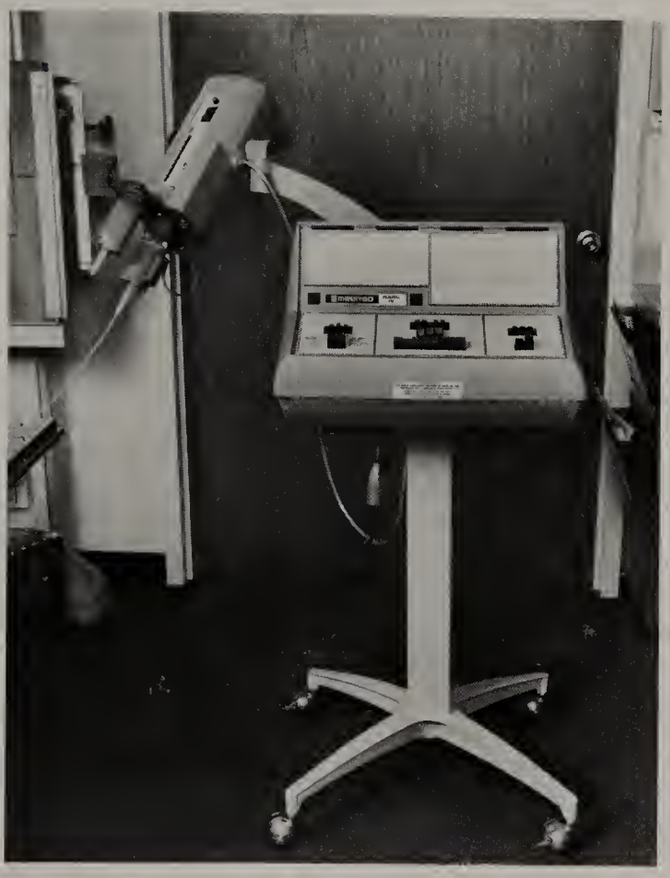


Figure 11–6
An injector pump or power injector.

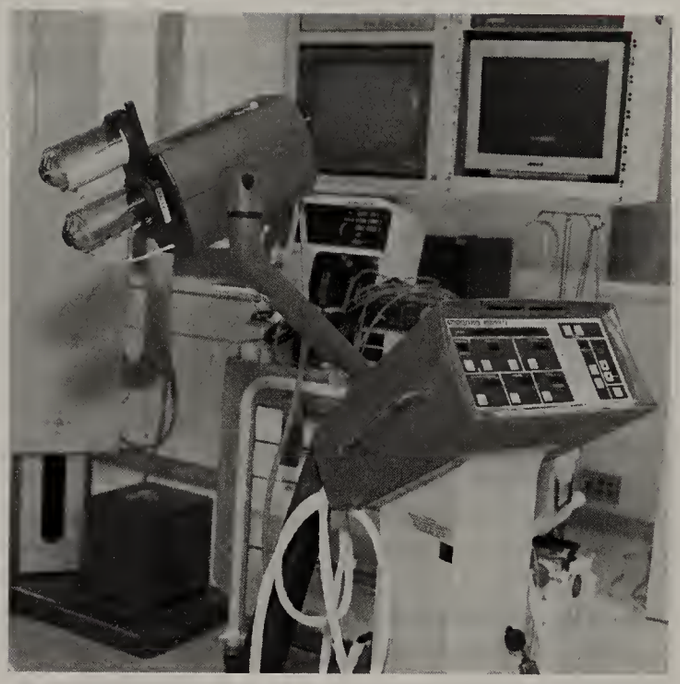


Figure 11–7
Newer injector pump.

vomiting, pain during injection, and adverse effects on the circulating blood volume. Whenever possible, low osmolar, nonionic agents are chosen for use for the safety and comfort of the patient.

Many iodinated contrast agents are quite viscid. This property contributes to discomfort during injection. Some agents are so viscid that they must be administered by power injector (Figs. 11–6 and 11–7). The radiographer must remember that all iodinated contrast agents are most comfortable for the patient when administered at body temperature. This is particularly true of the viscid agents. Power injectors have heating mechanisms. In the absence of a power injector, raise the temperature of the contrast agents to body temperature by placing the solution to be injected into a basin of tepid water for 10 to 15 minutes prior to administration. This reduces the viscosity of the agent and thereby decreases the amount of physiological basal constriction and pain produced by administration at room temperature. The radiographer must ensure that the temperature of contrast agent is not higher than body temperature when administered to prevent unnecessary pain and discomfort.

Although most reactions to contrast media present within the first several minutes following administration, delayed reactions may occur. These are infrequent and the radiographer is usually not aware of them because the patient has left the department by the time they occur. The radiographer must instruct the patient to obtain medical care if they have symptoms such as fever, joint pain, malaise, skin rash, and swollen lymph nodes.

The patient must also be instructed to increase fluid intake following a procedure that involves use of a contrast agent, and to seek medical care immediately if he is unable to urinate or has difficulty doing so.

A list of contrast agents that are used for special procedures appears in Chapter 13.

Summary

Any health care worker who administers drugs must have both theoretical and clinical education in pharmacology. He must also understand the pharmacokinetics and pharmacodynamics of drugs, their intended physiological actions, and the potential adverse reactions that each can cause.

Each drug that is marketed for medical use has several names. It has a chemical name derived from its chemical formula, a generic name given prior to official approval, and a trade name given and governed by a particular manufacturer. The chemical name and the generic name do not change, but the same drug may have more than one trade name. The radiographer must acquaint

himself with the generic name and the various trade names of the drugs used frequently in his department.

The federal government has established standards for control of drug safety. Drugs that create dependency are restricted and are categorized according to their margin of safety. These established categories are called drug schedules.

A drug is taken into the body and then must be made bioavailable for use at a particular receptor site. The route of administration determines the amount of time it takes for a drug to become bioavailable. The amount of blood flow; the size of the surface area available for absorption; and the patient's emotional state, age, and other factors determine how a drug is absorbed and utilized in the body. The routes of drug administration are enteral (oral or rectal), parenteral, and topical. The method of administration is determined by the chemical nature of the drug and the limitations of the particular individual.

Drugs are most commonly administered by the oral route. This is considered to be the most efficient and economical route and is used for drugs that will not be destroyed by gastric secretions or when the patient is not suffering from nausea and vomiting. This route is also used when a prolonged period of effectiveness is necessary.

The most common parenteral routes of drug administration are subcutaneous, intramuscular, intradermal, and intravenous. These routes of drug administration are used when rapid action and shorter duration of action is desired.

After a drug is administered, it is absorbed. The manner in which a drug enters the body determines the rate at which it is absorbed and the length if time it takes to achieve its desired effect. Once a drug has been absorbed, it is distributed to its intended site of action through the circulatory system. The rate and extent of distribution depends upon adequacy of circulating blood, protein binding, and the drug's affinity for lipoid or aqueous tissues.

The ability of a drug to be distributed throughout the body is largely dependent upon the health status of the patient. The blood–brain barrier is a deterrent to the distribution of many drugs to the brain and central nervous system. Drugs are more easily distributed through the placental barrier. For this reason, all female patients of childbearing age must be screened to be certain that they are not pregnant before any drug is prescribed or administered.

Following absorption and distribution, drugs are metabolized and excreted from the body. The liver is the center for drug metabolism, and most drugs are excreted through the kidneys following biotransformation. Age, overall health, time of day, emotional status, and the presence of other drugs in the body may alter the rate of drug metabolism. The radiographer must proceed with caution when administering a drug to the very young and the very old patient, for they have special problems with drug metabolism. A health care worker educated in administration of drugs to children should be called to give these drugs.

The potential for an adverse reaction to a drug must always be considered, as all drugs are potentially harmful and may be life threatening. The radiographer administering any drug must be acquainted with its potential adverse reactions as well as its intended action. He must observe his patient for these and educate the patient to the effects of drugs that he administers. The right patient must receive the right drug in the right dose at the right time by the right route. A drug history must be taken for every patient prior to administering any drug.

Drugs may be categorized in various ways. In this chapter, they are categorized according to their intended purpose or the manner in which they affect a body system. The radiographer must become familiar with the drugs that will be found on the emergency drug cart and those frequently administered in his department. Contrast media are the drugs that the radiographer will see used most frequently. He must be knowledgeable concerning their indications, contraindications, and adverse reactions.

The radiographer must also compile a patient history prior to administering a contrast agent. Any negative data gathered from that history must be reported to the physician caring for the patient. This must be done before the agent is administered. If the patient has an adverse reaction to a contrast agent, the radiographer must stop the administration of the agent and call for assistance. He must never leave a patient who is receiving a contrast agent unattended.

The patient's age, weight, sex, medication history, history of allergies, emotional status, occupation, and overall physical condition, as well as the reason for the drug administration and the route and time, are factors that must be taken into account in determining the strength and quantity of drug to be prescribed. The radiographer must be aware of these factors and be alert to any deviation from normal reactions to drugs by patients when in radiographic imaging.

Chapter 11, Pre–Post Test

b 1. All drugs, if misused, are poisons.
   a. True
   b. False

2. Explain the legal accountability of any health care worker who administers drugs.

d 3. The purpose of drug metabolism is to
   a. Initiate a physiological response
   b. Break down the drug for absorption throughout the body
   c. Transform the drug for distribution throughout the body
   d. Break down the drug for distribution throughout the body

a 4. Which of the following best describes drug efficacy?
   a. The maximal response produced by the drug
   b. The amount of drug required for an adverse reaction to occur
   c. The amount of drug needed to produce the desired response
   d. The amount of drug needed to reach the plateau response

d 5. What change in an elderly person alters the absorption of an oral medication?
   a. Decreased gastric secretion
   b. Decreased total body mass
   c. Increased total body fat
   d. Decreased cardiac output

6. List factors that will alter drug absorption in the body.

____ 7. Drugs given by mouth are generally given in larger doses. This is because
   a. They absorb more slowly
   b. They absorb more rapidly
   c. They are unreliable
   d. Larger doses ensure that some of the drug will remain to perform the intended effect

a 8. In order for a drug to reach its therapeutic effect more quickly, a physician might order
   a. A larger initial dose and, later, smaller doses
   b. A smaller initial dose and then a larger dose
   c. A bolus
   d. A maximizing dose

9. Differentiate between an adverse reaction and a side effect of a drug.

c 10. Marjorie Belweather takes oral morphine for chronic pain. After taking the prescribed dose for 2 weeks, she notices that it no longer seems to be controlling the pain. This reaction is called
   a. Addiction
   b. Dependency
   c. Tolerance
   d. An adverse reaction

c 11. Two drugs must never be mixed in the same syringe for administration before checking their
   a. Effectiveness
   b. Correct dosage
   c. Compatibility
   d. Expiration dates

12. List the problems with antimicrobial drugs other than adverse reactions.

13. List the composition of neurotransmitters.

14. Identify the following symptoms as either:
    A. Sympathetic response
    B. Parasympathetic response
    _____ **1.** Heart rate increases
    _____ **2.** Epinephrine is secreted
    _____ **3.** Gastric motility and secretion increase
    _____ **4.** Salivation increases
    _____ **5.** Gastric motility decreases

15. Differentiate between administration of an iodinated contrast agent and most other drugs administered.

16. List the side effects and the adverse reactions to iodinated contrast agents, and describe the radiographer's response to each.

17. Explain the problems with administration of iodinated contrast agents to the elderly patient and the pediatric patient.

_____ **18.** The drug name given it by a particular manufacturer is the
    a. Trade name
    b. Generic name
    c. Chemical name
    d. Proper name

_____ **19.** An analgesic is a drug used for
    a. Vasodilation
    b. Decongestion
    c. Relief of pain
    d. Enuresis

e **20.** Factors that may influence the effect of a drug are
    a. Age and weight
    b. Sex and time of day
    c. Medication history and the patient's temperament
    d. a and b
    e. a, b, and c

_____ **21.** The channel of drug administration does not influence the amount of drug administered.
    a. True
    b. False

_____ **22.** Parenteral drug routes may include
    a. Intramuscular
    b. Intravenous
    c. Oral
    d. a and c
    e. a and b

_____ **23.** An abnormally rapid heart beat is called
    a. Tachypnea
    b. Tachycardia
    c. Tetany
    d. Teratogenic

_____ **24.** A drug that increases the flow of urine is called a
    a. Derivative
    b. Diuretic

c. Digestant
d. Demulcent

25. Define *cumulative effect* of drugs, *drug tolerance*, and *drug resistance*.

26. List the assessment questions the radiographer must ask prior to his patient's receiving an iodinated contrast agent.

27. List precautions to be taken if iodinated contrast agents are to be administered.

28. Match the words with the most appropriate word or medical abbreviation below.
    1. The study of drug actions and interactions with living organisms
    2. Drugs with potential for abuse
    3. Interaction of drugs with body tissues
    4. Drugs metabolized and changed into water-soluble substances
    5. A change in normal physiological function due to a drug

    a. Controlled substances 2
    b. Pharmacology ____
    c. Pharmacokinetics ____
    d. Pharmacodynamics ____
    e. Biotransformation ____



Critical Thinking Problems

1. Janie Packjet is about to receive an iodinated contrast agent in preparation for a computed tomography scan of her kidney. You have been asked to prepare her for the procedure and administer the contrast media. Valium 5 mg IV and Vistaril 20 mg IV are ordered to be administered prior to the procedure. You are uncertain how to manage this. How will you proceed?

2. You are ordered to administer a contrast agent. When you gather the equipment and solution that you need for this task, you note that the contrast medium is cloudy and has an oil base. You reread the doctor's order and note that this is the solution ordered and it is to be administered by IV route. How will you proceed?

3. Mr. Andrew Ailing is in the radiologic imaging department where you are assisting the special procedures technologist. He tells you that he is having chest pain and needs his "pills" from his pocket. You go to his pocket and find a small bottle of nitroglycerin tablets. You offer Mr. Ailing the bottle, and he asks you how he should take the medicine. The directions say, "Take one tablet SL for chest pain. If pain is not relieved, take another." Explain how you will manage this situation.

12

Drug Administration

Systems of Drug Management
The Medication Order and Documentation
Medication Errors
Equipment for Drug Administration
Packaging of Parenteral Medications
Vials
Ampules
Packaging of Fluids and Medications for Intravenous Use
Methods of Drug Administration
Oral Route
Parenteral Drug Administration
Intradermal Administration
Subcutaneous Administration
Intramuscular Administration
Identifying Correct Sites for Intramuscular Injection
Administering an Intramuscular Injection
Intravenous Drug Administration
Site Selection and Preparation for Venipuncture
Venipuncture
Care of Patients With Intravenous Infusions
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. List the precautions to be taken during drug administration.
2. Differentiate between the apothecary and metric systems of measurement and be able to quickly convert from one measure to the other.
3. List the components of a medication order and the method of documenting drug administration.
4. Describe the radiographer's accountability in drug administration and his responsibilities should an adverse reaction occur.
5. State the components of a patient's drug history.
6. Explain the procedure to be followed if a medication error is made.
7. Identify accurately the sites for administering by oral, buccal, and sublingual routes, and for intradermal, subcutaneous, intramuscular, and intravenous injections.
8. Accurately demonstrate in the school laboratory the administration of drugs by oral, buccal, sublingual, subcutaneous, intramuscular, intravenous, and intradermal routes.
9. List the symptoms that indicate infiltration into the surrounding tissues by an intravenous infusion.
10. Identify the common medical abbreviations used in medication administration.

Glossary

Antipyretic: an agent that reduces fever
Arrhythmia: an irregularity in or loss of rhythm of the heart beat
Enteric coated: a covering added to oral medications that is designed to be absorbed in the intestinal tract
Intra-articular: within the joint
Intrathecal: an injection into the spinal cord
Percutaneous: performed through the skin
Periostitis: inflammation of the periosteum of the bone
Sclerosed: to become hardened
Viscosity: thickness; resists flow
Wheal: a localized area of edema of the body surface

All drugs (medications) are potentially harmful. The radiographer must never become casual or careless when administering drugs or assisting with drug administration. He must never give a drug that has not been specifically ordered by a physician and must understand the intended action, contraindications, side effects, and potential adverse reactions of any drug that he administers.

If the radiographer is not familiar with a drug that he is to administer, he must consult the pharmacist or an available literary source prior to administering the drug. All radiologic imaging departments should have a current *Physician's Desk Reference* available for this purpose. There are addenda to this reference that include contrast agents. There is detailed information packaged with drugs used commonly in radiographic imaging. If the radiographer does not know and cannot find information about a drug, he must not administer it. *The radiographer must remember that contrast agents are drugs and the precautions listed in this chapter pertain to these agents.*

The radiographer must identify the *five rights of drug administration* at all times as follows:

1. The right patient
2. The right drug
3. The right amount or dose
4. The right route
5. The right time

Other precautions that must be taken are as follows:

1. Read the label carefully before pouring or drawing up a medication for administration. Check the strength, dosage, and name of the drug.
2. If a drug contains a sediment or appears to be cloudy, it must not be used until the pharmacist has approved it. If in doubt, discard the drug.
3. The expiration date of each drug is written on its label. If that date has already passed, that medication must be discarded.
4. Never use drugs from unmarked or poorly marked containers. Destroy these drugs.
5. Measure exact amounts of every drug used.
6. Drugs must be stored in accordance with the manufacturer's specifications. No drug should be stored in an area where temperature and humidity vary greatly or are extreme. Low room temperature is advised.
7. If the medication is a liquid to be poured, it must always be poured away from the label of the bottle.
8. Two medications must not be combined without verifying their compatibility with the pharmacist or a drug compatibility chart. If there is doubt, do not combine.
9. Before selecting a medication, check the label of the container three times: before it is taken from the storage area, before pouring or drawing it up for administration, and after it has been poured.
10. Take only one drug to one patient at one time.
11. When approaching a patient who is to receive a drug, ask him to state his name. Do not accept the fact that a patient answers to what is thought to be the correct name. When a patient is anxious, he may not hear clearly or respond correctly.
12. A drug history of adverse reactions or allergic reactions to drugs must be taken for each patient before drugs are administered (as described in Chapter 11). Drug reactions occur frequently and quickly.
13. Report complaints of itching, shortness of breath, dizziness, or extreme drowsiness to the physician immediately and prepare for

emergency action. Stop intravenous infusions or bolus if these symptoms occur.

14. Do not leave unattended a patient who may be having a drug reaction.
15. The patient must not be allowed to drive himself home following a drug reaction or after receiving a sedative, hypnotic, antianxiety, or narcotic analgesic medication.
16. A child who has received a medication and is sleeping may not leave the department until he is fully awake.
17. Patients must be observed for at least 1 hour before leaving the department alone after receiving any drug.

Warning: Patients who receive narcotic analgesics or hypnotics may suffer respiratory depression and shock. They must not be left alone.

Systems of Drug Measurement

The metric system of measurement has been adopted in most countries of the world as the official standard; however, its use is recommended but not required in the United States.

It is used in most medical settings in this country, but the apothecary system of measurement is also used. This means that anyone who administers drugs must understand and be able to use the two systems interchangeably. Household measurements are not commonly used in medical facilities and only those most commonly used will be mentioned. The radiographer who plans to administer drugs must learn to convert quickly from metric to apothecary measurement depending upon how the physician's order is written.

The basic unit of weight in the apothecary system is the grain. The fluid equivalent of one grain is the minim. Units derived from the grain are the dram, the ounce, and the pound. Units derived from the minim are the fluidram, the fluid ounce, the pint, the quart, and the gallon.

The metric unit of measure is the liter (L), which contains 1000 milliliters (mL) or the approximate cubic metric equivalent of 1000 cubic centimeters (cc). The unit of weight is the gram (g). Kilograms (kg), milligrams (mg), and micrograms (mcg) are used in health care. The kilogram is 1000 g or, in nonmetric terms, 2.2 pounds.

The radiographer must have a conversion table at hand or memorize conversions so that he is able to use these measures interchangeably. He must also be able to compute dosages if this is required.

Medical symbols and abbreviations are used in health care on a daily basis and any person who works in this arena is expected to understand them. A list of the most common abbreviations and equivalencies appears in Table 12–1. The radiographer must not make up his own abbreviations, nor must he administer a drug unless he is certain that his understanding of the dosage is correct.

The Medication Order and Documentation

Licensed physicians, dentists, podiatrists, and, in some states, optometrists can prescribe, dispense, and administer drugs. Under select circumstances that vary from state to state, registered nurses with specialized education, physician assistants, and pharmacists may legally order and dispense drugs.

No health care worker may take it upon himself to prescribe or administer drugs that are not ordered by a person licensed to do so. In health care settings, an order must be dated, written, and signed by the physician. If the patient is to be cared for in a hospital setting, such as a radiologic imaging department, the order will be written on an order sheet.

If a patient is to be discharged with a prescription, it will be written on the physician's personalized order form. The following information is required on a legal physician's order.

The patient's full name, the date, and the time the order is written

The date and time or times that the drug is to be administered

The generic or trade name of the drug

The dosage form and the route of administration

The physician's signature

An example of a physician's order for a hospitalized patient might be as follows:

June 3, 1996, 7 AM
Give Valium, 5 mg PO at 8 AM
J. Glucose, M.D.

An order may be given verbally to a person authorized to receive physician's orders. If an order is

TABLE 12–1
Measurements

Household	Apothecary	Metric
1 teaspoonful (tsp)	1 fluidram (f3)	4 or 5 mL
1 tablespoonful (tbs)	½ fluidounce (f3)	15 mL
2 tablespoonfuls	1 fluidounce	30 mL
1 cup (c)	8 fluidounces	240 or 250 mL
1 pint (pt)	16 fluidounces	473 or 500 mL
1 quart (qt)	32 fluidounces or 30 fluidounces	1000 mL (1 L)
Apothecary	**Metric**	
15 grains (gr)	1 gram (g) (1000 mg)	
10 gr	0.6 g, 600 mg	
7½ gr	0.5 g, 300 mg	
1½ gr	0.1 g, 100 mg	
¾ gr	0.05 g, 50 mg	
½ gr	0.03 g, 30 mg	
¼ gr	0.015 g, 15 mg	
$\frac{1}{60}$ gr	0.001 g, 1 mg	
$\frac{1}{100}$ gr	0.6 mg	
$\frac{1}{120}$ gr	0.5 mg	
$\frac{1}{150}$ gr	0.4 mg	
Other frequently used equivalents:		
1 cubic centimeter (cc) = 1 mL		
30 grams = 1 ounce (oz)		
1 inch = 2.54 centimeters (cm)		
2.2 pounds = 1 kilogram (kg)		

given in that manner, it must be written on the prescriber's order sheet and signed by the person receiving the order followed by V.O. (verbal order).

John Glucose M.D. by Jane Terminal R.N. (V.O.)

The physician giving the order must sign the order in a designated period of time, usually within 24 hours.

There are also *stat* orders. This means that a physician gives an order for a medication to be administered immediately. This order must also be written on the order sheet and signed by the physician.

Another type of order is the *prn* (*pro re nata*) order. This order is written for a drug to be taken or administered to the patient as necessary. Medications for relief of pain are frequently prn orders.

A *single order* is an order written for a medication to be given only once at a designated time. The order used as an example above is a single order. The medication ordered would be given once. It would not be given again without a new physician's order.

In radiographic imaging, the radiographer frequently assists with medication administration rather than actually giving the drug. If this is the case, after receiving a verbal order from a physician to procure a drug for him to administer, the radiographer will proceed as follows:

1. Obtain the drug from the storage area.
2. Verify that it is the correct drug by checking the label before taking the drug from storage.
3. Obtain the correct supplies for the particular route of administration and prepare the drug; *i.e.*, draw it into a syringe or pour it into a medicine glass for oral administration as appropriate (this is discussed in later sections of this chapter) and read the label a second time.

4. Put the medication, the package from which it was taken, and other items that will be needed for administration on a tray and take them to the physician.
5. Hold the package (bottle, vial) at the physician's eye level and state the name and dosage of the drug that you have prepared. Be certain that the physician reads and acknowledges that he has approved the drug.
6. Assist the physician to administer the drug to the patient.
7. Document the drug in the correct area of the patient's chart and present it to the physician to sign.

Every institution will have a slightly different manner of documentation. It is the radiographer's responsibility to learn the correct method in the facility in which he is employed. Whatever the situation, the radiographer is obligated to document on the patient's chart the name of the drug, the dosage, the route, the time, and the patient's reaction to any drug that he administers. It may also be his obligation to record the drugs administered by the physician and then have the physician sign the entry.

Medication Errors

As a professional health care worker, the radiographer is responsible for his own actions. It is his legal and ethical obligation to be knowledgeable about any drug he feels competent to administer. If he administers a drug incorrectly or misinterprets an order from a physician, he is legally liable and he may also have violated his code of professional ethics, since administering a medication without sufficient knowledge of its potential is not acting in the best interest of the patient.

The radiographer must be aware of the federal regulations pertaining to controlled substances. The Controlled Substances Act of the federal government restricts personnel who are legally permitted to administer narcotic and hypnotic substances and drugs that may produce dependency (as described in Chapter 11). It also restricts access to these drugs, which are always kept in a locked area. Documentation of use of these drugs is also carefully controlled. The radiographer must learn the methods of adhering to these regulations in the department in which he is employed and abide by them at all times.

Medication errors are an area of frequent litigation in radiographic imaging. The radiographer who is administering or assisting with administration of drugs is frequently implicated in this type of litigation. If an error in medication administration is made (this includes contrast agents) or if the patient has an adverse reaction to a drug he receives, the radiographer involved must assess the patient's condition and then notify the prescribing physician immediately. The error or adverse reaction must be included in the patient's chart. The radiographer must also write an incident report (sometimes called an *unusual occurrence report*).

Every detail of the incident must be included on the incident report, which becomes the property of the department and is not a part of the chart. Items to include in this report are the incorrect dosage of the drug, why it was given, the patient's reaction, and how the error was remedied.
For instance:

> 3/3/96; 8 AM Iopamidol 30 mL administered IV. Administered in error to this patient.
>
> 8:10 AM BP 110/60, AP 70, R 16. Patient is alert and oriented to person, place, and time.
>
> 8:15 AM Dr. J. Glucose notified of the error. (radiographer's signature)
>
> 8:20 AM Dr. J. Glucose examined pt. Assessment of pt. performed.
>
> BP 120/80, AP 72, R 16. Pt. reports that he has no complaints.

The patient must be observed for an appropriate time interval and periodic reports on his condition would be added to his chart until he was discharged from the department. Accurate documentation is the best defense the persons involved can have if there is litigation.

Equipment for Drug Administration

Needles used for parenteral drug administration range in length from approximately ⅓ to 6 inches in length. The size of the lumen of the needle can vary from very large to very small. The smaller the lumen, the larger the gauge of the needle (*e.g.*, a 30-gauge needle is much smaller than a 13-gauge needle). The viscosity of the fluid and patient need dictate the size and gauge chosen.

Many health care facilities use syringes with needles attached in a manner that protects the health care worker from needle-stick injuries. This is accomplished in a variety of ways depending

upon the manufacturer. Some syringes come encased in an extra plastic barrel, which is outfitted with a safety lock (Fig. 12–1). The outer plastic barrel is held against the skin before the plunger is pushed down on the syringe and held there until the plunger is retracted. The safety lock prevents the needle from puncturing the outer barrel, thus protecting the health care worker from needlestick injury.

Syringes and needles are disposable and must not be reused. The parts of the syringe are shown in Figure 12–2. They are available in sizes from 1 mL to 50 mL. Syringes are calibrated in milliliters and in minims (minim, singular); 1 mL is equal to 15 or 16 minims. They are packaged in treated paper wrappers to maintain sterility and needles are often attached. The size of the syringe and the size of the needle are printed on the package (Fig. 12–3).

After a syringe and needle are used, they should be disposed of in a container prepared for this purpose. These containers are labeled "contaminated sharps" and are made of a hard plastic material. The radiographer must consider all used needles potentially lethal. A needle that has been injected into a person must not be recapped and, if it has a protective mechanism, it should be engaged following the injection. The used syringe should be held by the barrel and carried immediately to the receptacle for disposal where it is deposited needle first. A used syringe and needle must never be placed back onto a tray to be disposed of at a later time. The radiographer must use great care to prevent needle sticks. This is considered a hazardous medical incident and must be reported as a "critical incident" and attended to immediately. Human immunodeficiency virus (HIV), hepatitis B, non-A non-B, and C and be contracted in this manner.

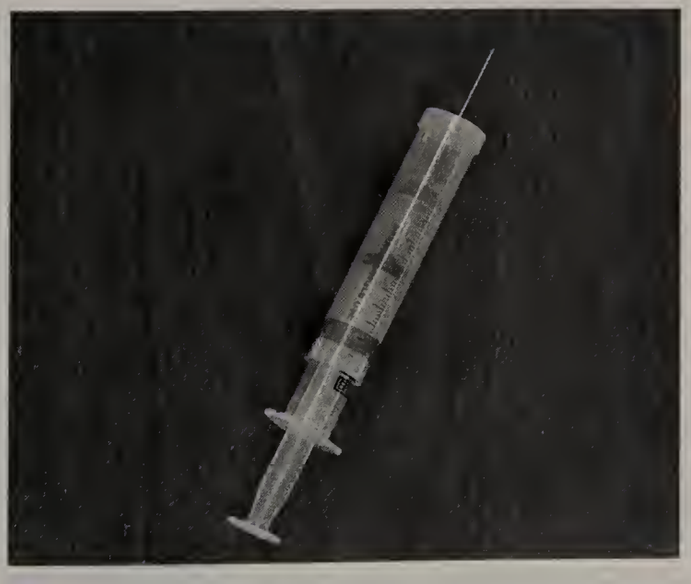


Figure 12–1
Syringe with safety lock.

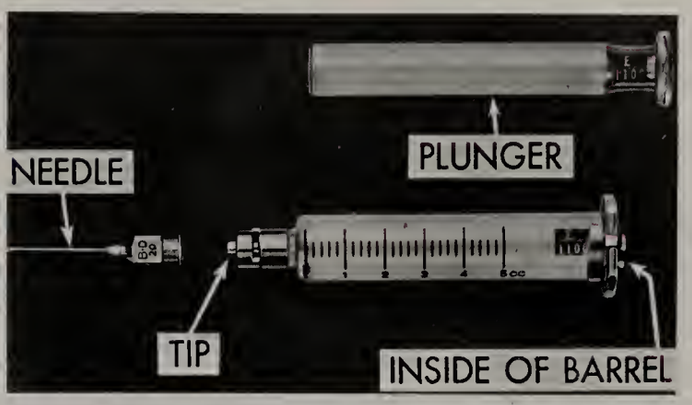


Figure 12–2
The parts of a syringe.

Medicine glasses are used for oral drug administration. Most medicine glasses are made of disposable plastic. All are of 1-ounce (30 mL) size and are calibrated for household, apothecary, and metric measures (Fig. 12–4).

PACKAGING OF PARENTERAL MEDICATIONS

Drugs intended for parenteral administration are packaged to maintain sterility. If they are intended for intramuscular, subcutaneous, or intradermal injection, they are either in an ampule or a vial. If they are to be administered intravenously, they may be contained in an ampule or a vial if the amount of drug to be administered is small. If there is to be a large amount of fluid or drug administered, it will be contained in a calibrated glass or plastic container.

Vials

A vial is a glass container with a rubber stopper circled by a metal band; the band holds the rubber stopper in place. Vials are generally available in 5-, 10-, 20-, 30-, and 50-mL sizes. On the label are the name of the medication, the dosage per milliliter,

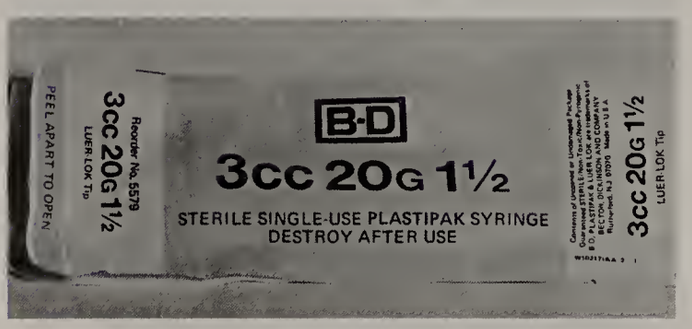


Figure 12–3
The size of the syringe and the size of the needle are printed on its outer package.

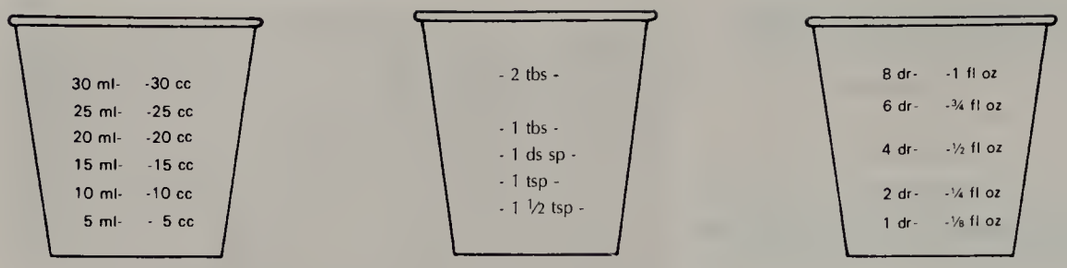


Figure 12–4
Calibrations on a medicine glass: metric and apothecary.

and the route by which it may be administered (*e.g.*, morphine sulfate—1 mL = 15 mg). Multidose vials are not frequently used because of the hazards of contamination.

If a multidose vial is used, a sterile needle must be inserted into the vial for each dose.

The top of the rubber stopper is cleansed thoroughly with an alcohol wipe. Air equivalent to the amount of fluid to be withdrawn from the vial is then drawn into the syringe. Then insert the needle into the vial and inject the air in the syringe. The fluid in the vial will replace the air in the syringe rather quickly. The plunger of the syringe can be drawn back until the exact amount of drug needed is obtained (Fig. 12–5).

Ampules

An ampule is made of glass and contains a single dose of a drug. The indented area at the neck is opened by filing the neck with a small metal file (Fig. 12–6*A*). The top then easily snaps off the container. The radiographer must never attempt to snap the top off an ampule without protecting his hands with a sterile gauze pad, because the glass may break unevenly and cut the hand (see Fig. 12–6*B*). The ampule is labeled, like the vial, with the name of the medication, the dosage per milliliter, and the route of administration. If all of the medication is not used, the remainder must be discarded, because it does not remain sterile once the ampule has been opened.



Figure 12–5
Insert a sterile needle through the rubber stopper in the vial.

PACKAGING OF FLUIDS AND MEDICATIONS FOR INTRAVENOUS USE

Fluids, contrast agents, and medications that are of a large volume (50 to 1000 mL) are packaged in either heavy plastic or glass containers. Plastic bags containing fluid for intravenous infusion collapse under atmospheric pressure as the fluid leaves it. Glass bottles do not collapse; therefore, they are constructed with an air vent so that air can replace the fluid as it infuses into the vein.

Like the vial, the glass intravenous fluid container has a rubber stopper that is protected by a metal cap and a rubber diaphragm. There are two ports in the stopper, one for air and one for insertion of the intravenous tubing. The plastic bag has two ports, one for the intravenous tubing and one to use if other drugs are to be added to the infusion. The methods of proceeding with intravenous drug administration are discussed in a later section.

Methods of Drug Administration

ORAL ROUTE

Oral medications are available in liquid, tablet, or capsule form. Liquid drugs are most quickly absorbed into the systemic circulation. A solid form of a drug will be absorbed more quickly if it is given with an adequate amount of fluid, usually water. If a tablet has an enteric coating, the patient must be instructed not to chew it, as its effect may be destroyed by gastric secretions. It must also not

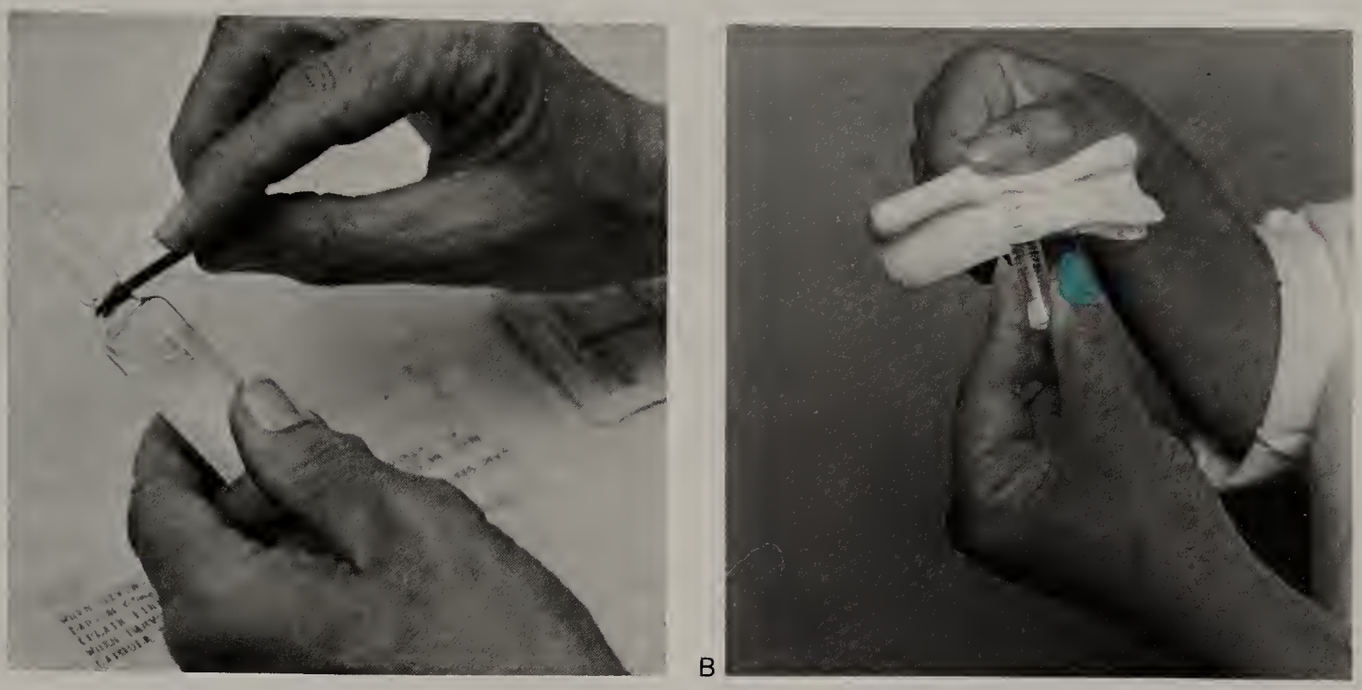


Figure 12–6
(**A**) Before attempting to snap off the neck of the ampule, file the indentation so it will break evenly. (**B**) Protect your hand with a sterile gauze pad.

be crushed or cut. If a tablet is not scored, it should not be broken. Capsules must not be tampered with as this may result in incorrect dosage.

Drugs given by the sublingual or buccal routes must be small, uncoated tablets. They will disintegrate or dissolve very quickly and bypass the gastric mucosa to go directly into the bloodstream.

When the physician prescribes an oral medication, the radiographer must observe **the five rights of drug administration** and follow the procedure outlined below:

1. Read the order or make certain that the order is correct.
2. Write the name of the patient, the name of the drug, and the dosage on a small identification ticket or paper.
3. Wash your hands.
4. Obtain a tray on which to carry the drug to the patient.
5. Obtain the correct medication, a medicine glass, or pill cup in which to pour the drug.
6. If you are to administer the drug, pour it while reading the label. Make certain the drug is the correct one and the dosage is correct. Pour tablets into the cap of the bottle and then into the cup. Do not touch the tablet (Fig. 12–7).
7. Place the identification ticket on the tray and carry the drug to the patient.
8. Ask the patient to state his name. Then, if he has an identiband, read the band to further check his identity.
9. If the drug is to be swallowed, give the patient the drug and direct him to swallow.

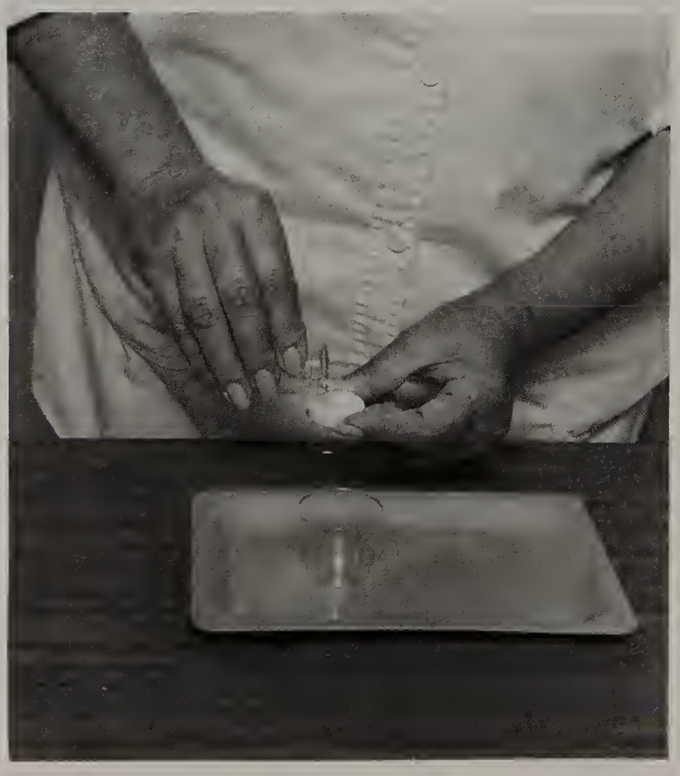


Figure 12–7
Pour the medication into a graduated medicine glass. Have the physician check the name of the drug and the dosage.

Give the patient water to assist in swallowing the drug if it is permitted.

10. If the drug is to be absorbed by buccal route, instruct the patient to hold the tablet inside his lower cheek beside his gum toward the back of his mouth until it is absorbed. Do not give water with tablets administered by this route.
11. If the drug is a sublingual tablet, instruct the patient to hold the tablet under his tongue until it is absorbed. Do not give water with tablets administered by this route.
12. Stay with the patient until the drug has been taken.
13. Return to the area where the equipment is kept; clean and replace or discard the equipment and wash your hands.
14. Document that the drug was given, by what route, and at what time.
15. Observe the patient carefully to be certain he has no adverse reactions to the drug.

PARENTERAL DRUG ADMINISTRATION

The methods of administering drugs by parenteral route will vary depending upon the route ordered by the physician. Percutaneous, intrathecal, and intra-articular drug administration is done by the physician and will not be discussed. Health care workers who plan to administer parenteral medications to children require special education that is beyond the scope of this textbook. The procedures described in the following paragraphs pertain to the average adult patient.

There are some rules that apply to all parenteral drug administration. They are as follows:

1. All equipment, including needles, syringes, and the drug itself, must be sterile.
2. The skin at the injection site must be as free of microorganisms as possible before a medication is injected.
3. The antiseptic chosen for skin preparation will vary from institution to institution, but isopropyl alcohol or a povidone-iodine solution is frequently used.
4. All persons administering parenteral drugs must wear gloves during the procedure as exposure to blood is possible.
5. There must be a physician's order for all drugs to be administered.
6. The **five rights of drug administration** must be followed.
7. The drug administered must be documented on the patient's chart following administration.
8. The patient must be observed closely for 1 hour following drug administration for adverse reaction.
9. No patient who has had a sedative, tranquilizing, or hypnotic drug administered may drive themselves home.

INTRADERMAL ADMINISTRATION

Intradermal injections are also called *intracutaneous injections*. This type of injection is usually used for testing for sensitivity to a drug or antigen. Usually less than 0.5 mL of medication is used. After the test dose has been given, the patient must be observed carefully for an anaphylactic reaction. These injections are usually administered into the dermis on the inner aspect of the forearm. Areas where there is excessive hair or scarring must not be used as results may be difficult to detect.

The equipment required is as follows:

A tuberculin syringe with a 25- to 27-gauge needle ½ inch in length.

An alcohol wipe

A pair of clean gloves

The drug to be injected

The procedure is as follows:

1. Cleanse the site with an alcohol wipe in a firm, circular motion.
2. Don the gloves.
3. Hold the skin at the area to be injected taut with the nondominant hand.
4. Insert the needle, bevel side up at a 5- to 15-degree angle.
5. Inject the drug. A small raised area, or wheal, should be seen at the injection site.
6. Withdraw the needle and do not massage or cleanse the site.
7. Instruct the patient concerning time to read the results of the test. Watch for a reaction.

SUBCUTANEOUS ADMINISTRATION

Medications are injected into the tissues beneath the dermis at a 45-degree angle. The following equipment is required:

A syringe of the correct size. A tuberculin syringe may be used for an amount of less than 1 mL; a 2- or 3-mL syringe may be used for administering 1 mL of a drug. *No more than 1 mL of fluid may be injected subcutaneously.*

A needle of ½ to ⅝ inches in length with a 23 to 25 gauge

2 or 3 alcohol wipes

The correct medication

A pair of clean gloves

Subcutaneous injections are given in the outer aspect of the upper arms, the abdomen, the scapulae, or the anterior thigh (Fig. 12–8). Only small amounts of the drug, 1 mL, should be administered in these areas. Subcutaneous drugs should be highly soluble and nonirritating to the tissues into which they are injected. Since this is an invasive procedure, sterile or surgical aseptic technique is used. Edematous or scarred tissue and the 2-inch diameter of flesh around the umbilicus should not be used for injection. The procedure is as follows:

1. Identify the patient and expose the site for injection.
2. Cleanse the site with an alcohol wipe.
3. Don gloves.
4. If the patient is very thin, grasp the skin in a slight fold or bunch.
5. Inject the medication at a 45-degree angle; do not aspirate.
6. Withdraw the needle. Do not rub the area following injection.
7. Correctly discard the needle and syringe and make the patient comfortable.
8. Follow the procedures listed above for all parenteral injections.

Medications commonly administered by the subcutaneous route are heparin, epinephrine, and insulin.

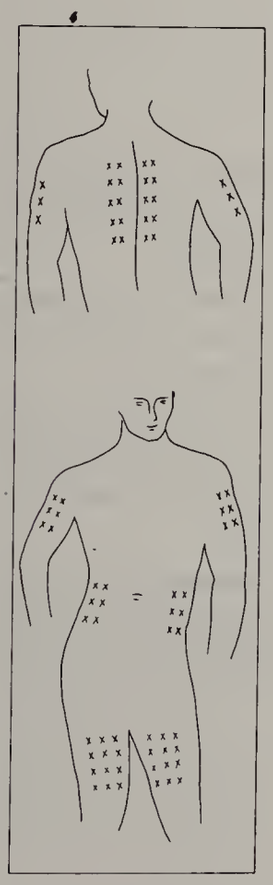


Figure 12–8
Appropriate sites for subcutaneous injection. (Walsh J, Parsons CB, Wieck L: Manual of Home Health Care Nursing. Philadelphia, JB Lippincott, 1987.)

INTRAMUSCULAR ADMINISTRATION

The intramuscular (IM) route for medication administration is chosen when prompt absorption of drugs is desired, because there is a rich blood supply to muscles. It is the site chosen when a medication given subcutaneously would be irritating to the tissues and when a larger amount of a drug is needed. The amount of medication that can be given intramuscularly ranges from 1 to 5 mL; however, the person receiving the injection must be relatively large if more than 3 mL of medication is to be injected into a muscle.

Administering an injection into a muscle must be learned in a laboratory setting before it is actually performed in the clinical setting as incorrect technique can result in harm to the patient. Major blood vessels and nerves traverse muscles used for injection, and permanent damage can be done to a person who receives an injection incorrectly given or in a site that is inappropriate for a given drug. The tissues around an injection site may also be damaged. Complications that may result from incorrect injection into a muscle are abscesses, necrosis, skin slough, nerve damage, prolonged pain, and periostitis.

Identifying Correct Sites for Intramuscular Injection

The radiographer who administers injections into muscles must be able to select a safe site. The sites commonly used to administer IM injections for adult patients are the dorsal gluteal, ventrogluteal, vastus lateralis, rectus femoris, and deltoid muscles. A site that is already sore, hardened from many injections, or extremely tense must be avoided. Sites of IM injections must be rotated if the patient is to receive a series of drugs by that route.

Methods of identifying the correct sites for IM injection follow.

Dorsogluteal

The patient may be placed in a prone position with toes pointed inward or in a Sims' position with the entire gluteal muscle exposed. The posterior superior iliac spine and the greater trochanter are palpated and an imaginary line is drawn between them. The site for injection is lateral and slightly above the midpoint of the imaginary line (Fig. 12–9*A*). Another method of identification of the correct site is to divide the buttock into four quadrants using the iliac crest and the gluteal fold as the superior and inferior boundaries. The injection is given into the upper outer quadrant of the buttock. Incorrect placement of the injection can result in damage to the sciatic nerve, which is located in the lower midline of the muscle.

Ventrogluteal

The patient may be in a supine, Sims', or prone position. If the patient is in a prone position, he should be encouraged to flex his knees if possible as this relaxes the muscle. The health care worker giving the injection should place the palm of his hand on the greater trochanter and his index finger on the anterior superior iliac spine. Then the middle finger is stretched as far as possible along the iliac crest. The injection should be given within the triangle that is formed by the spread fingers (see Fig. 12–9*B*).

Vastus Lateralis

The patient may be placed in a sitting or prone position. The thigh is then visually divided into thirds, both horizontally and vertically. The injection is given into the outer, middle third of the muscle (see Fig. 12–9*C*). This is a relatively safe area for injection because the muscle is thick and there are no large blood vessels or nerves.

Deltoid

The patient may be placed in a sitting or supine position with the arm away from the body. This muscle, which is located in the lateral aspect of the upper arm, is relatively small and not frequently used for IM injections because it is not able to absorb large amounts of medication. It is recommended that no more than 1 mL of solution be injected into this site. Damage to the radial nerve and artery are possible here. The deltoid muscle may be located by identifying the lower aspect of the acromion process and forming an imaginary inverted triangle with the midpoint in line with the axilla on the lateral aspect of the arm (se Fig. 12–9*D*).

Administering an Intramuscular Injection

The equipment needed for an IM injection is as follows:

A 3- to 5-mL syringe

An 18- to 22-gauge needle 1 ½ inches in length. A 1-inch long 22- or 23-gauge needle may be selected for use in the deltoid area or for use on a very thin patient.

Three alcohol wipes

A pair of clean gloves

The procedure is as follows:

1. Assess the patient to determine the length of needle that is appropriate; this depends on the site and the size of the patient.
2. Determine the gauge of needle that is appropriate. Use the smallest gauge possible to accommodate the viscosity of the drug.
3. Draw up the drug into the syringe. If the medication is an irritating substance such as hydroxyzine (Vistaril), change the needle after it is drawn into the syringe.
4. Proceed to the patient, position him, and cleanse the area with an alcohol wipe. Don clean gloves. Open a second alcohol wipe to have it available.
5. Place the nondominant hand on the muscle to be injected to support the patient. Quickly insert the needle into the muscle at a 90-degree angle.
6. When the needle is inserted, you may support the needle with the nondominant thumb and index fingers and draw back (as-

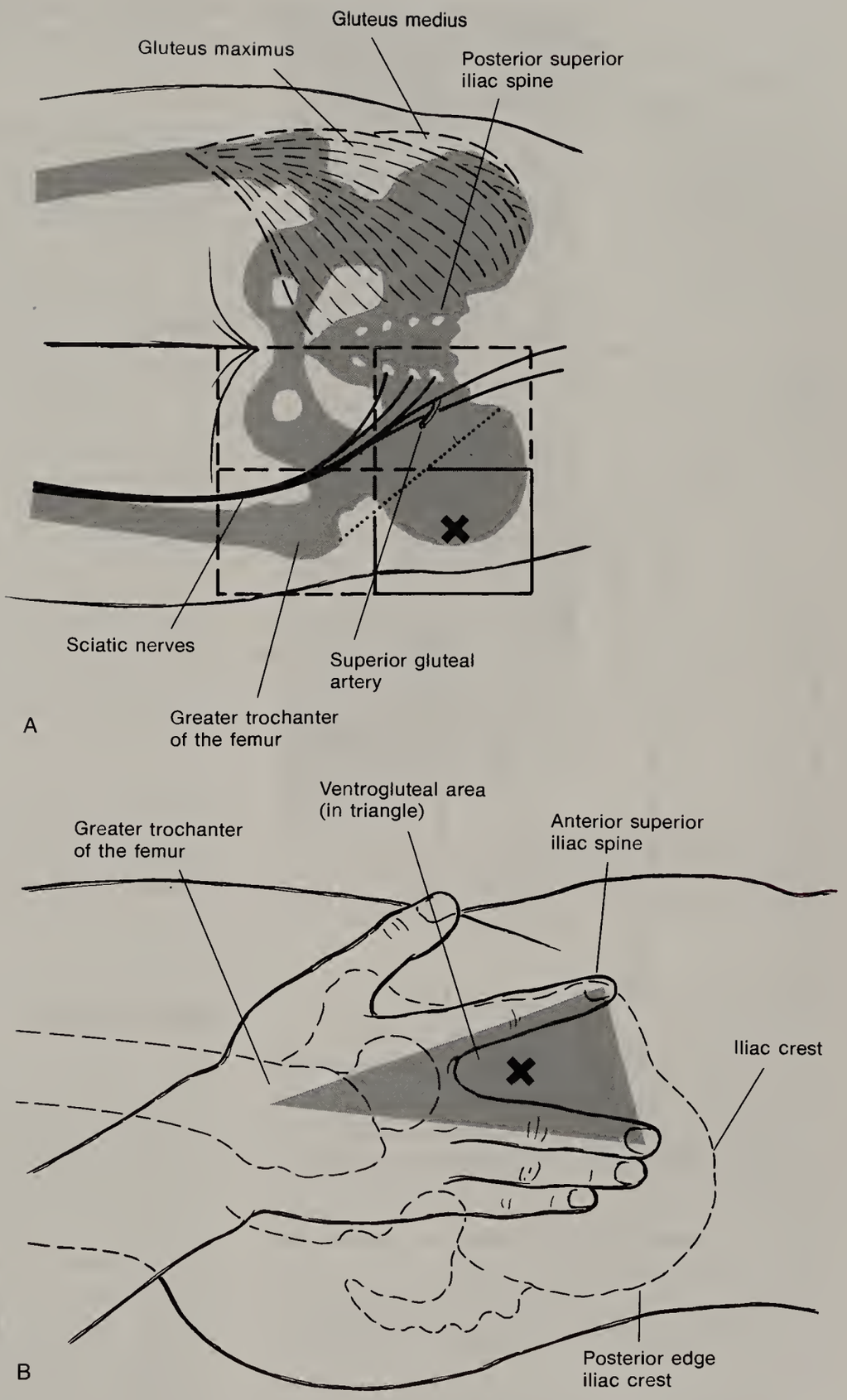


Figure 12–9
Sites for intramuscular injection: (**A**) Dorsal gluteal. (**B**) Ventrogluteal. (**C**) Vastus lateralis. (**D**) Deltoid. (Abrams Clinical Drug Therapy, 4th ed. Philadelphia, JB Lippincott, 1995.)

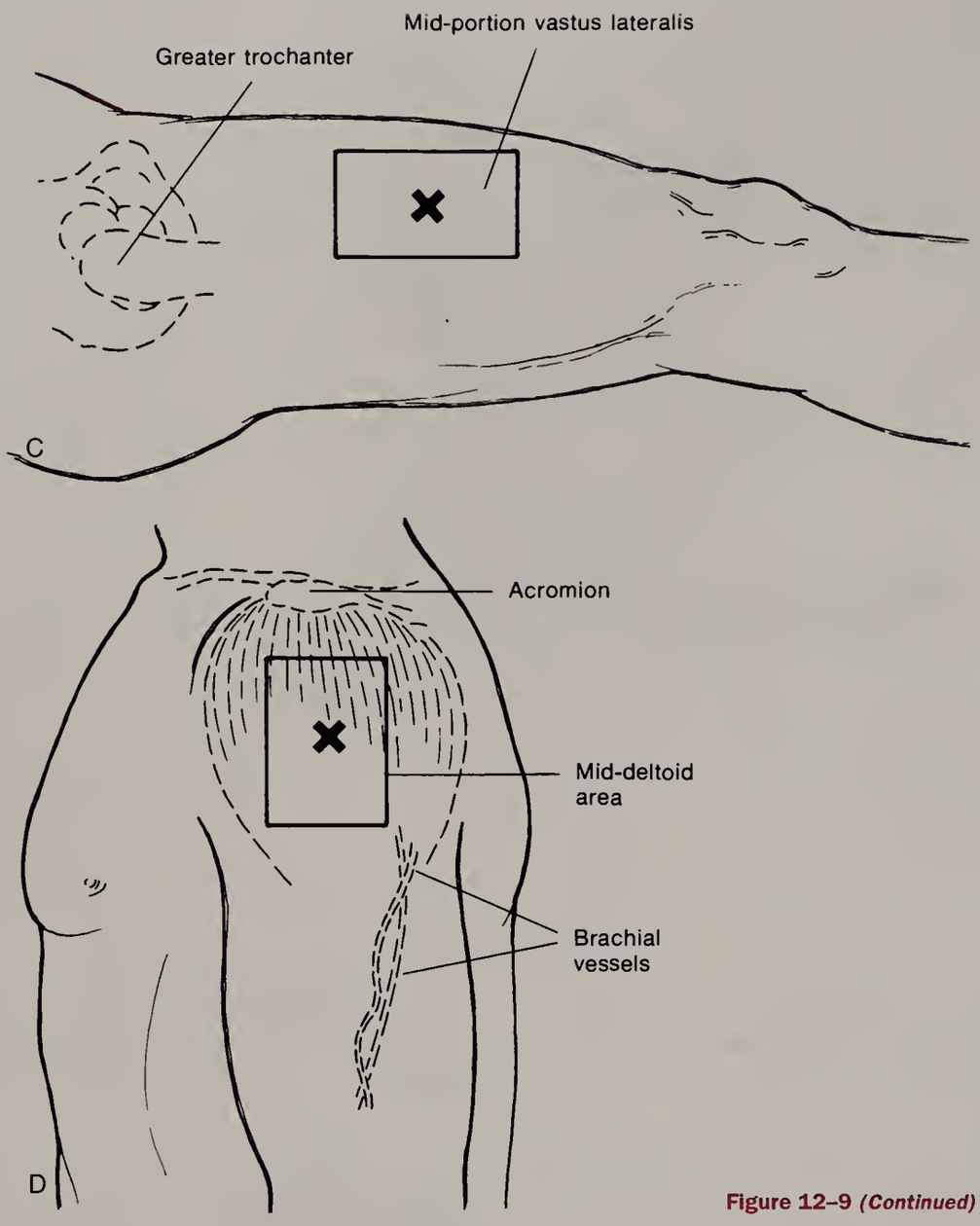


Figure 12–9 ***(Continued)***

pirate) the plunger slightly. If a blood vessel has been entered, blood will return in the syringe and you must withdraw the needle.

7. Assuming that no blood returns in the syringe, inject the fluid into the muscle and quickly withdraw the needle.
8. When the needle is withdrawn, gently wipe the area where the needle was inserted.
9. Make the patient comfortable and follow procedures as described in this chapter.

Under normal circumstances, the radiographer will not inject irritating substances into the muscle with the exception of hydroxyzine (Vistaril). If there is an occasion for this to occur, a Z-track method of IM injection is used. This procedure varies as follows:

1. Draw a small amount of air into the syringe after the medication is drawn up (about 0.2 mL as an air lock). Change the needle to prevent irritating medication from gaining access to subcutaneous tissues.
2. The deltoid muscle is not appropriate for this purpose, nor is the ventral gluteal muscle.
3. The injection procedure is as described above; however, the skin is pulled to one side before the needle is inserted and held in this position with the nondominant hand as the medication is injected. Aspirate for blood. After the medication and the air in the syringe are injected, count to 10 (wait 10 seconds) before withdrawing the needle.
4. Withdraw the needle and release the skin simultaneously.

5. Do not massage the site after the injection. An alcohol wipe may be held in place over the site for a moment.

INTRAVENOUS DRUG ADMINISTRATION

The intravenous (IV) method of drug administration is selected when immediate effect of a drug is desired, or if a drug cannot be injected into body tissues without damaging them. This can be one of the most hazardous routes of drug administration, because once a drug is injected directly into the circulatory system, reaction to it is instantaneous. Any health care worker who administers IV medications must be aware of the hazardous effects of the drug and its life-threatening potential. In many areas of the United States, official authorization is required of all persons administering IV drugs.

Most drugs given in diagnostic imaging are administered intravenously. The radiographer must not leave a patient receiving an IV drug or contrast agent alone; the patient must be observed continuously. Pulse rate and blood pressure should be taken before and at frequent intervals during IV drug administration. Any change in the patient's vital signs or behavior should be reported to his physician immediately.

Because the radiographer's primary experience will be with intravenous administration of contrast agents and drugs given by infusion or as a bolus, these methods will be discussed in some detail. Other intravenous methods will be discussed only briefly.

Some drugs are given in small amounts through pre-existing IV lines. They are of several types and their use is not within the radiographer's scope of practice. The heparin or saline lock and an IV piggyback, both are commonly seen, as well as central venous lines that are discussed in Chapter 10.

A *heparin* or *saline lock* is a venous catheter that is left in place in the vein for a designated period of time but is not attached to IV tubing. It has a protective rubber cap over a reservoir at the top of the venous cannula into which a small amount of heparin is added following each drug administration to prevent blood from clotting in the cannula. If a medication is to be administered through this port, the rubber cap is cleansed with alcohol wipes and it is irrigated first with 1 mL of sterile normal saline to ensure that it is not clogged. If the lock is clogged, it must be changed. Saline should not be forced through a clogged cannula.

An IV *piggyback* is another method of administering drugs through an established line (Fig. 12–10). A piggyback is a small intravenous infusion (usually 100 mL to 250 mL), which is attached to an adjoining or already existing line. This solution is attached to the pre-existing line in such a manner that is flows into the vein at the intended rate; when it has been fully administered, the original IV solution is continued.



Figure 12–10
Giving intravenous medication using the piggyback method. The medication in the small container will enter the venous system before the solution in the larger container. (Walsh J, Parsons CB, Wieck L: Manual of Home Health Care Nursing. Philadelphia, JB Lippincott, 1987.)

Medications (including contrast agents) may be given by bolus or infusion. A *bolus* is a designated amount of a drug that is administered at one time, usually over a period of several minutes. An *infusion* usually refers to a larger amount of a drug, fluid, or fluid containing a drug or electrolytes that is administered over a longer period of time ranging from hours to days. Both of these methods require venipuncture; each require different equipment and preparation.

Site Selection and Preparation for Venipuncture

The area selected for venipuncture will require careful assessment before the procedure is begun. The type of drug, the purpose of its administration,

and the age and condition of the patient are all factors influencing venipuncture site selection. Except in cases of extreme emergency or if no other vein is accessible, veins in the hands and arms should be selected over those in the lower extremities because there is a greater hazard of embolus formation in the lower extremities related to IV infusion. Unless a drug is to be injected by bolus, a vein over a joint should not be selected, as any movement will dislodge the needle or catheter and the arm or hand must be immobilized. The volar (palm) side of the wrist must not be used as the radial nerve is in that area and the patient may feel extreme pain.

For infusions, veins in the lower arm are recommended if they are not sclerosed or bruised. Veins in the hand may seem attractive, but many are small and the walls are thin and easily perforated. The basilic and cephalic veins are often good choices if they are available (Fig. 12–11). Veins must be palpated during the selection process to assess for strength and firmness.

Once the site for venipuncture has been selected, the area must be prepared. Infection, tissue damage, pain, and discomfort are all hazards of IV drug administration. The radiographer participating in this procedure must make every effort to avoid each of these. Any jewelry or restrictive clothing is removed from the area. Hair is not removed as shaving may increase the possibility of infection.

Elderly patients must receive special consideration. Their veins are more fragile and have a greater tendency to "roll" as the needle or catheter is inserted. The tissues of the elderly patient are also more fragile, necessitating use of a smaller needle or catheter. The tourniquet is more apt to damage the skin and must be applied with less tension.

Equipment needed for an IV bolus or infusion is as follows:

A tourniquet

A syringe of the correct size or an infusion set (choice depends on the IV to be administered)

An intravenous cannula of the correct type and size

A butterfly needle (also called a *scalp vein needle*) or a venous catheter are two common types of needles used for IV therapy (Fig. 12–12). The butterfly needle is used for short-term IV therapy but is not recommended if it is to be in place for more

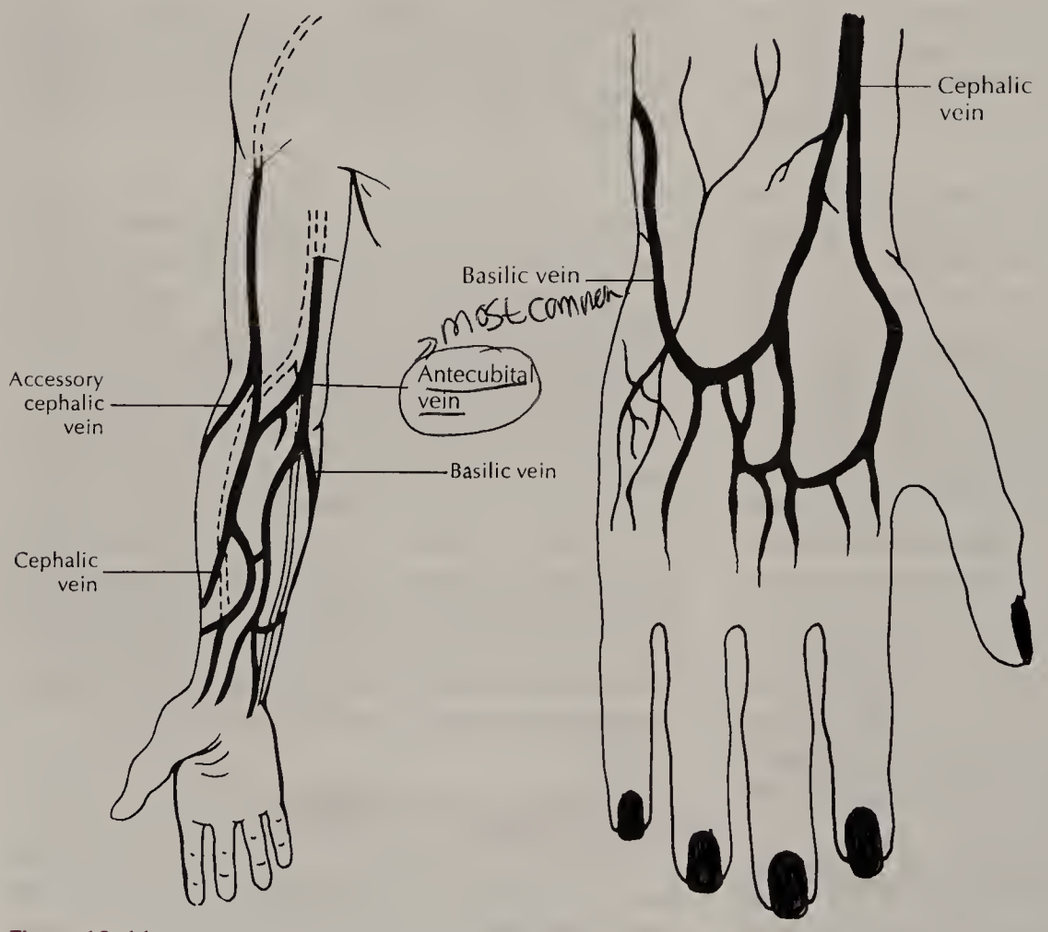


Figure 12–11
Sites recommended for insertion of venous cannulae.

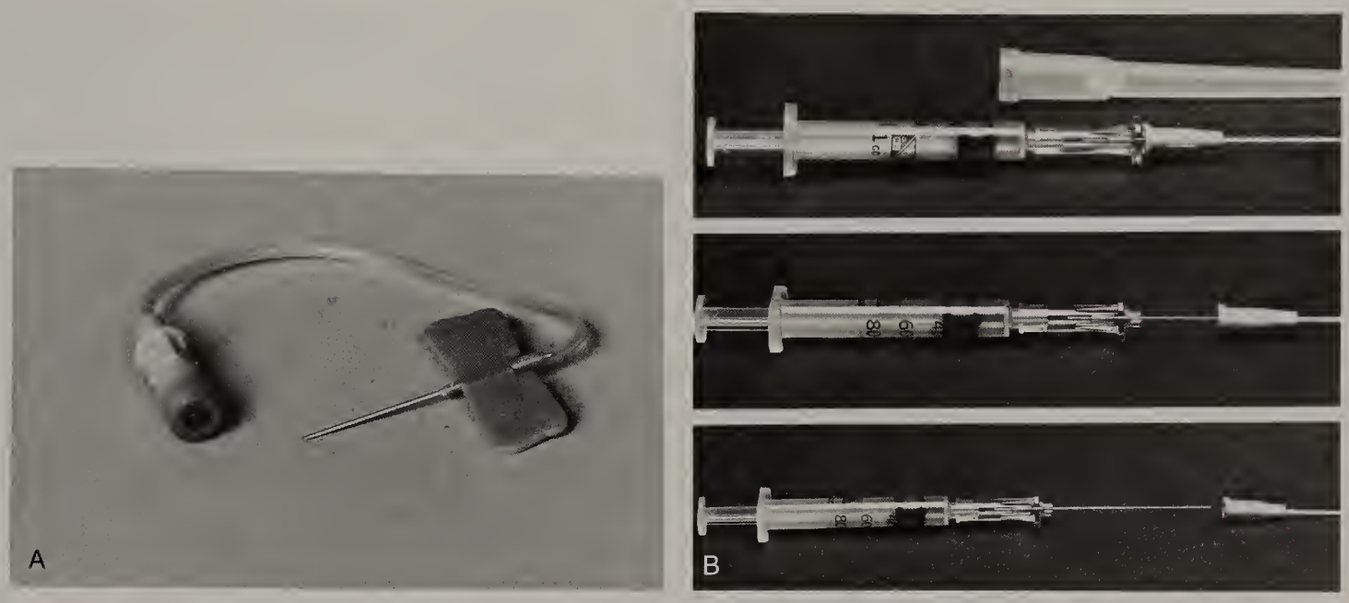


Figure 12–12
(A) A butterfly needle. **(B)** Venous or angiocatheters.

than 2 or 3 hours. The venous catheter, also called an *angiocatheter,* is recommended for longer infusions. It is a plastic tubing with a needle that goes through the tube for insertion into the vein.

Once the catheter is in place, the needle is removed and discarded. The catheter is then threaded into the vein and connected to the IV tubing. This type of catheter is flexible and will tolerate some movement without becoming dislodged. There are several new types of cannulae on the market that prevent needle-stick injuries. If they are available, their use is recommended.

The gauge of the cannula will depend upon the drug to be injected. The smallest possible gauge that can be safely used must be chosen. The gauges vary as they do for subcutaneous, IM, and intradermal drugs. Contrast agents tend to be viscous and will require a larger-gauge cannula than many other drugs.

Alcohol, iodophor, or chlorhexidine sponges for skin preparation

Skin preparation prior to intravenous therapy is dictated by the policy of the institution in compliance with standards of practice and must be followed.

A pair of clean gloves

Tape or a clear adhesive dressing to be placed over the infusion site

The drug or fluid to be administered

If an IV infusion is to be started, an IV standard must be on hand. An infusion pump or controller may be required in some situations.

An IV infusion controller is an electronic system controlled by gravity. The amount of fluid infused is controlled according to the amount desired to be administered in a set time period. An alarm sounds if the desired rate is not met.

An infusion pump allows a more precise monitoring of the amount of fluid to be infused in a set time frame. It may pump more fluid than would be allowed by the gravity drip method (Fig. 12–13).



Figure 12–13
Intravenous pump.

Intravenous infusion requires the following additional preparation:

1. Obtain the solution to be administered. If it is in a glass bottle, remove the metal cap and the rubber diaphragm (Fig. 12–14*A*).
2. Obtain an infusion set that includes IV tubing and a drip chamber.
3. Open the outer packaging from the infusion set and remove the protective cover from the insertion tip of the drip chamber. Do not allow this tip to be touched or contaminated as it will be placed into the IV fluid and must remain sterile.
4. Place the tip into the opening in the rubber stopper that is marked for it until it is completely covered (see Fig. 12–14*B*).
5. There will be a clamp attached to the tubing. Close the tubing with the clamp.
6. Have a receptacle or a sink at hand. Invert the bottle of solution and hang it on the standard. Remove the protective cover from the end of the IV tubing, again being careful not to contaminate it (see Figs. 12–14*C* and *D*).
7. Open the clamp and allow fluid to run through the tubing until all of the air in the tubing is displaced by fluid. Air must not remain as it may cause an air embolus.
8. When all air is removed from the tubing, replace the protective cover on the tip of the tubing using sterile technique and proceed to the patient with the equipment.

If the solution is in a plastic bag, the container must be removed from its protective covering (Fig. 12–15*A*). Once the protective cap is removed from the port of the drip chamber on the intravenous tubing and the port of insertion on the bag, the drip chamber and tubing can be connected to the port (see Fig. 12–15*B*). The radiographer then follows the procedure for identification of the patient and documentation as discussed previously.

Venipuncture

The health care worker who performs venipuncture must be skilled in the technique so the patient is not subjected to the pain and threat of injury or infection. This skill must be learned in a classroom laboratory prior to actual practice.

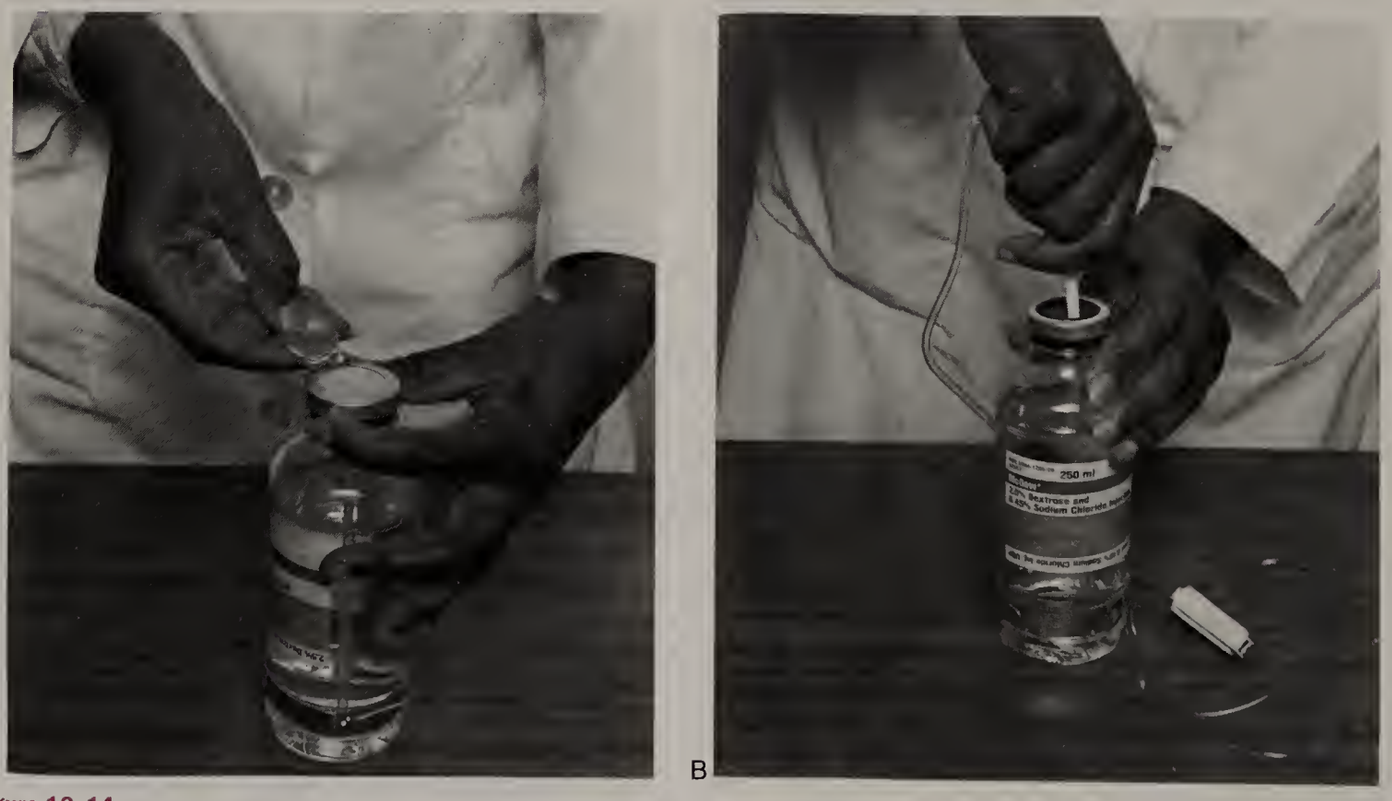
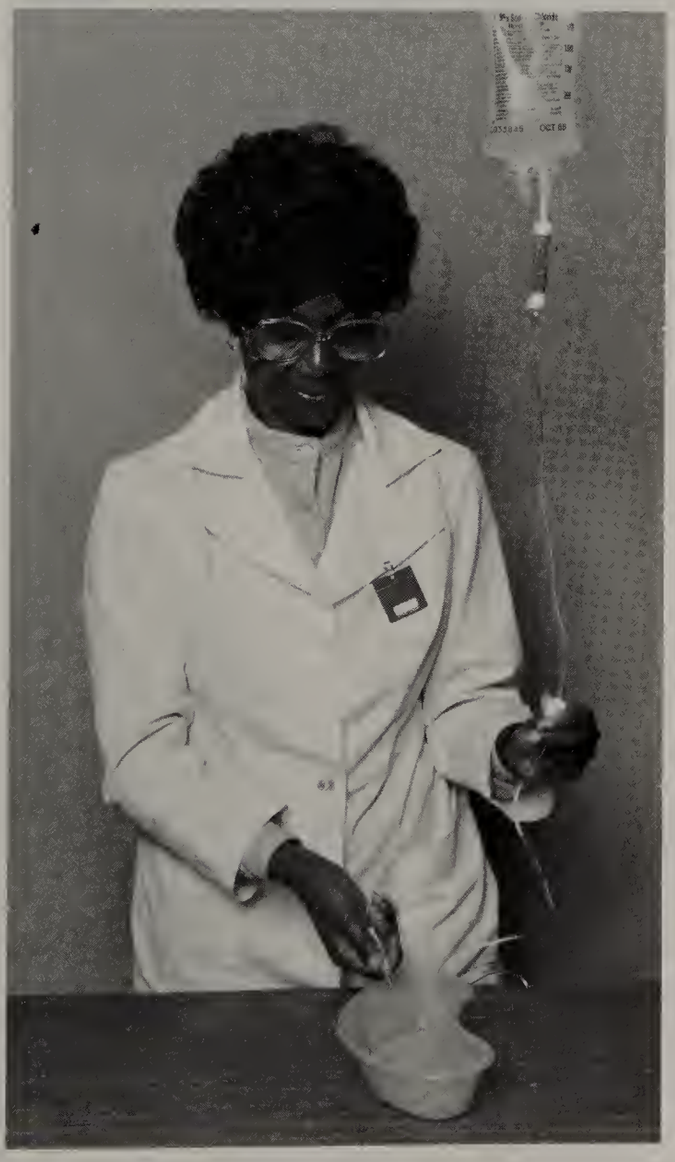


Figure 12–14
(**A**) Remove the metal cap and the rubber diaphragm from the vacoliter. (**B**) Insert the drip chamber into the rubber stopper. (**C**) The tips of the drip chambers that are inserted into the solution containers must be kept sterile. (**D**) Invert the bottle or bag of solution and allow the fluid to run through the tubing.



C



D

Figure 12–14 ***(Continued)***

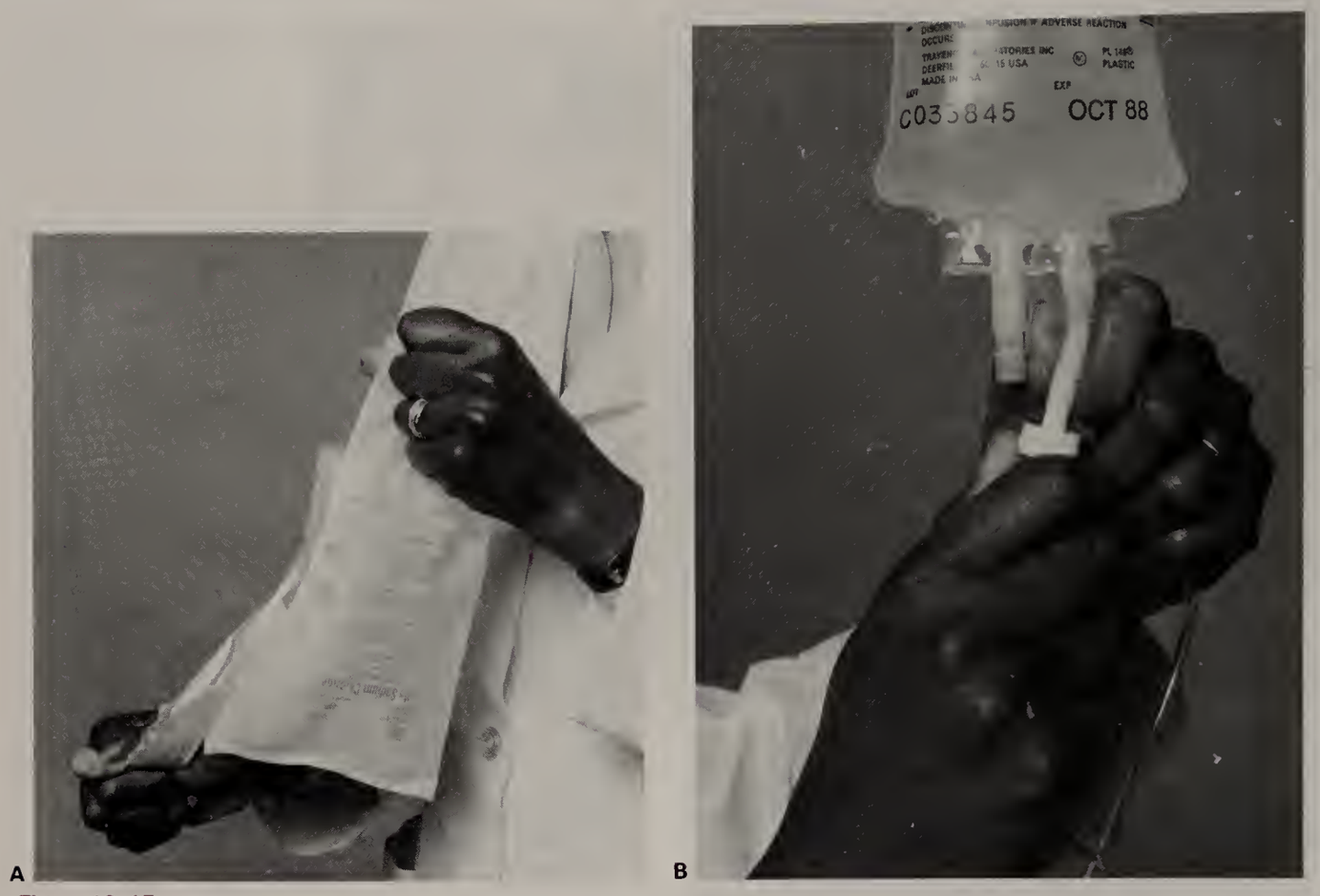


Figure 12–15
(**A**) Intravenous solutions in plastic bags must be removed from their outer covering. (**B**) Place the tip of the infusion tubing into the port.

The radiographer identifies the patient and explains and plans the procedure with the patient. The procedure for venipuncture is as follows:

1. Secure the tourniquet above the selected site. If a vein in the lower arm is selected, the tourniquet is applied below the elbow. Do not pinch the patient's skin as it is applied. The tourniquet should be secured so that it can be released by pulling one end (Fig. 12–16).
2. Have the patient make two or three tight fists as the tourniquet is applied. This forces more blood into the veins so that they are more visible.
3. Don gloves. Gloves do not have to be sterile, but the prep swabs and all items that enter the vein must be sterile. Do not touch the swabs as you cleanse.
4. Cleanse the area using at least three swabs. The site is cleansed from the site outward using firm strokes. Remove as many microbes as possible. Allow the area to dry.



Figure 12–16
A correctly applied tourniquet can be removed rapidly by pulling one end. (Spencer RT, Nichols LW, Lipkin GB et al: Clinical Pharmacology and Nursing Management, 2nd ed. Philadelphia, JB Lippincott, 1986.)



Figure 12–17
Hold skin taut and insert the needle with bevel up.

5. Hold the skin taut above or below the insertion site and insert the needle bevel up into the vein (Fig. 12–17). The needle may be inserted from directly over the vein or from the side or next to the vein. When the needle enters the vein, blood will return into the flashback chamber. If no blood returns, the venipuncture was not successful. A new sterile needle must be used to start the IV. If you are not successful with the second effort, call a member of the IV team or the anesthesia department to start the IV. Do not subject the patient to multiple punctures.
6. Once the needle is in the vein, release the tourniquet and attach the drug or infusion to be administered. A bolus is administered at the speed required depending upon the drug order. An infusion is begun at the rate ordered by the physician.
7. The needle or venous catheter is taped securely into place and the infusion is monitored to be certain that it maintains a safe rate of flow. A control pump may be attached at this time.

Care of Patients With Intravenous Infusions

If the IV infusion site is the antecubital vein, the patient's arm should be placed on an arm board so that the elbow joint is immobilized. The arm may be attached to the arm board with plain or elasticized gauze. The arm must be checked frequently to be certain that the arm board is not applied so tightly that it interferes with circulation. The signs and symptoms of impaired circulation for a patient with a casted extremity listed in Chapter 4 may be used. Also, the infusion site must be checked for any signs of infiltration of the fluid into the surrounding tissues.

The IV standard should be placed 18 to 24 inches above the level of the vein, because the height at which the container of solution is suspended affects the rate of flow. If the bottle of solution is positioned lower than the vein, blood will flow into the tubing. The rate of flow of an IV infusion may also be affected by the position of the catheter or needle in the vein. If the bevel of either is positioned against the wall of the vein, it will slow or stop the infusion. Changing the position of the patient's arm will often correct the problem.

If there is a question about rate of infusion, a safe rule to follow is to allow the solution to infuse at 15 to 20 drips/min. If a large amount of solution infuses too quickly, there is a danger of fluid intoxication or pulmonary edema. Unless the physician has ordered a rapid infusion, the IV solution that is flowing very rapidly should be slowed down. This can be done by simply tightening the control mechanism on the tubing slightly. 60ml/hr

Any complaint of pain or discomfort at the site of insertion of an IV needle should be heeded, and the site should be checked immediately. Swelling around the site or cold, blanched skin is an indication that the needle or catheter has become dislodged from the vein, and the fluid or medication is infiltrating into the surrounding tissues. The radiographer should turn the IV off immediately and notify the physician in charge of the patient. Severe tissue damage may result from infiltration of IV drugs and fluids. Drugs administered intravenously act very rapidly. Any complaint of itching or feeling of congestion or fullness in the chest or throat is cause to discontinue administration of an IV drug. The radiographer should not wait for further evidence of complications. He should stop the infusion immediately, and then notify the patient's physician.

A warm or cold compress may be applied to the site of an infiltration. The temperature of the compress depends upon the medication that has infiltrated. The physician or a pharmacist must be consulted.

Discontinuing IVs

An infusion is not discontinued without a physician's order to do so. The patient who must receive IV drug therapy endures varying amounts of dis-

comfort to begin the procedure, because venipuncture can be painful. The radiographer must be certain that the procedure is to be discontinued so the patient does not have to endure such discomfort a second time as a result of carelessness or misunderstanding.

In order to discontinue an IV, the radiographer will need the following equipment:

A pack of dry, sterile, 2-inch by 2-inch gauze sponges

Clean disposable gloves

Scissors to cut the tape

Tape

A tourniquet

The following procedure should then be observed:

1. Go to the patient and carefully identify him.
2. Clamp off the intravenous solution and prepare two strips of tape; place them where they can be reached easily later.
3. Loosen the tape that holds the venous catheter or needle in place so that the hub is clearly visible and free of tape.
4. Open the sterile gauze sponges, being careful not to contaminate them.
5. Put on the clean gloves.
6. Gently withdraw the needle or catheter from the vein until it is completely removed (Fig. 12–18).
7. Immediately after the catheter is removed, apply pressure to the site of withdrawal with a dry, sterile sponge until the bleeding stops.
8. Inspect the needle or catheter that has been removed from the vein to be certain that it has emerged intact. If there is a possibility that a portion of it has broken off and remains in the vein, immediately apply the tourniquet above the site of needle or catheter insertion and notify the physician; do not leave the patient.
9. When the bleeding stops, use another sterile gauze pad, fold a sterile dry sponge, and tape it in place over the insertion site with some pressure applied. A Band-Aid may be used for this purpose.
10. Explain to the patient that this dressing may be removed in 1 or 2 hours.



Figure 12–18
Gently withdraw the needle or catheter from the vein before applying pressure.

11. Place the used syringe and needle into the "contaminated sharps" disposal container. Do not recap the needle. Remove your gloves.
12. Dispose of the vacoliter and wash your hands.

Summary

All drugs are potentially harmful; therefore, the radiographer must never become casual or careless when administering or assisting with drug administration. Any drug administered to a patient must be ordered by the physician. There are several methods of obtaining an order for a drug to be administered, including written and verbal orders, as well as standing orders and telephone orders. It is the radiographer's responsibility to understand and obtain a legal order prior to preparing or administering any drug. He must also be able to document the medication correctly following its administration.

The radiographer must remember that contrast agents are drugs and that all precautions pertaining to other drugs also pertain to them. He must always abide by the **five rights of drug administration** and follow all precautions pertaining to drug administration.

There are basically three methods of measuring drugs: the household, apothecary, and metric sys-

tems. Although the metric system is followed exclusively in most of the world, apothecary and household measurements are used at times in the United States; therefore, the radiographer is compelled to use each system interchangeably. He must also be able to understand common medical abbreviations.

Only persons licensed to prescribe and dispense drugs may do so. The radiographer must understand the components of a legal prescription and how to correctly document medications given. He must also be able to follow the correct procedure if a medication error is made. There are federal regulations pertaining to controlled substances that he must be aware of and follow.

Each route of drug administration requires its own particular equipment and procedure. The radiographer must learn the lengths and gauges of needles and cannulae necessary for each route of drug administration. He must also learn the correct sites for all routes of drug administration. As with all invasive procedures, the rules of surgical asepsis apply to all drugs administered by parenteral routes.

There are a number of precautions to be taken when drugs are administered. This is particularly true for intravenous drug administration because these drugs travel immediately into the systemic circulation. The radiographer must learn how to prepare the equipment and the site for IV drug administration. He must learn the precautions to be taken when intravenous drugs are administered to the elderly patient.

If a drug administered intravenously infiltrates into the surrounding tissue, it must be discontinued immediately. The radiographer must be able to recognize when this is occurring and take the necessary precautions to prevent tissue damage.

If an IV infusion is to be discontinued, the radiographer must receive an order to do so. He must then disconnect the IV using the correct procedure. Waste must be disposed of correctly during drug administration and universal blood and body fluid precautions must be adhered to at all times.

Chapter 12, Pre–Post Test

1. Match the following:
   1. 0.4 mg
   2. gr $\frac{1}{120}$
   3. 1 g
   4. 1 kg
   5. gr $\frac{1}{2}$

   a. 2.2 lbs ___4___
   b. 0.5 mg ____
   c. gr $\frac{1}{150}$ ____
   d. 60 mg ____
   e. gr 15 ____

2. Match the following:
   1. Give immediately
   2. Give one time only
   3. Give as necessary
   4. Written and signed by the physician
   5. To be signed within 24 hours

   a. prn order ___3___
   b. Verbal order ___2___
   c. Stat order ____
   d. Single order ____
   e. Written order ____

3. Match the following:
   1. IM
   2. SC

3. IV
4. ID
5. PO

a. Buccal ____
b. Scapulae ____
c. Abdomen ____
d. Vastus lateralis ____
e. Ventrogluteal ____

4. List the equipment necessary to administer an IV infusion.

5. List the potential adverse effects of an IM injection.

6. List the patient care precautions to which the radiographer must adhere when a patient is receiving an IV contrast agent.

7. List the factors to consider when assessing a patient for a site for an IV infusion.

____ 8. You are requested to administer Vistaril, 50 mg IM prior to a special radiographic procedure. You plan to administer this drug by
a. Oral route
b. IM
c. Z track
d. SC
e. ID

Match the word, phrase, or symbol with the most appropriate word or medical abbreviation below.

9.

1. Short needle, ⅝ inches long with 23 to 25 gauge
2. Needle, 1 ½ inches long with 18 to 22 gauge
3. Needle, 1 inch long with 18 to 20 gauge
4. Needle, 3 ½ inches long with 20 to 22 gauge
5. Needle, ½ inch long with 26 gauge

a. IM ____
b. IV ____
c. Subcutaneous ____
d. Intrathecal ____
e. Intradermal ____

10.

1. prn
2. gtt
3. stat
4. bid
5. ac

a. immediately ____
b. before meals ____
c. twice a day ____
d. whenever necessary ____
e. drop ____

____ 11. All drugs given by parenteral routes are given by
a. Medical aseptic technique
b. Surgical aseptic technique

12. List the five rights of drug administration.

Laboratory Reinforcement

1. In the school laboratory, draw up 4 mL of sterile normal saline for IM injection. You have several sizes of needles and syringes from which to choose. Choose the correct needle and syringe size.
2. In the school laboratory, prepare to assist the radiologist with administration of 250 mL of a contrast medium for IV instillation.
3. In the school laboratory, prepare to assist the radiologist with administration of ½ mL of sterile water for subcutaneous injection. You have a series of needles and syringes from which to choose. Choose the correct needle size and syringe size.
4. In the school laboratory, position a patient for administration of an IM injection.
5. In the school laboratory, practice assessment questions the radiographer would ask a patient about to receive iodinated contrast agent.

Critical Thinking Problems

1. James Jeaster is a 76-year-old patient who has come to the radiographic imaging department in which you are employed for an intravenous pyelogram. You have been selected to prepare him for the procedure and to administer the IV contrast agent. How will you proceed? What precautions will you take?
2. You have just completed starting Mr. Jeaster's IV. When you return to the preparation area, you notice that you have given him the wrong contrast agent. How will you proceed?

13

Care of Patients During Special Procedures

Cardiac Monitoring
Preparation for Cardiac Monitoring
ECG Rhythms
Angiography, Cardiac Catheterization, and Nonsurgical Interventions
Patient Care Prior to Cardiac Catheterization or Angiography
Patient Care and Education After Cardiac Catheterization or Angiography
Myelography
Patient Care and Education Prior to Myelography
Intrathecal Drug Administration
Patient Care and Education Following Myelography
Computed Tomography
Patient Care and Instruction Before Computed Tomography
Computed Tomography of the Body
Patient Care After Computed Tomography
Lymphangiography
Patient Care During Lymphangiography
Patient Care After Lymphangiography
Mammography
Galactography
Ultrasound
Patient Care
Lithotripsy
Magnetic Resonance Imaging
Patient Care and Education for MRI
Positron Emission Tomography
Patient Care
Radionuclide Imaging
External Radiation Therapy
Patient Care
Proton Therapy
Patient Preparation
Contrast Agents
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Recognize a normal electrocardiograph pattern and the potential implications of one that is not normal.
2. Describe the medical complications, emotional implications, and patient teaching needs for the patient undergoing angiography, cardiac catheterization, or percutaneous transluminal angioplasty.
3. Identify the potential complications, patient care considerations, and teaching responsibilities during myelography.
4. Explain the potential complications, patient care considerations, and teaching responsibilities during computed tomography, lymphangiography, and mammography.
5. Describe the patient care considerations and teaching responsibilities during ultrasonography.
6. Explain the radiographer's patient care responsibilities during lithotripsy.
7. Describe the patient care considerations, teaching responsibilities, and emotional implications for the patient receiving magnetic resonance imaging or positron emission tomography.

8. List the patient care considerations and teaching responsibilities for the patient receiving radionuclide imaging.
9. List the side effects, emotional implications, patient care considerations, and teaching needs of the patient receiving external radiation therapy or proton radiation therapy.

Glossary

Cancerous: type of tissue that has the ability to grow and invade other body organs (a tumor); if not halted, is often fatal
Cathode: negative electrode, from which electrons are emitted and to which positive ions are attracted
Cineangiographic: the photographic recording of fluoroscopic images of the blood vessels by motion-picture techniques
Claustrophobic: a morbid fear of enclosed spaces
Cyclotron: an apparatus for accelerating protons to high energies by means of a constant magnet and oscillating electric field
Dementia: organic mental syndrome characterized by general loss of intellectual abilities including impairment of memory, judgment, and abstract thinking
Doppler effect: the change in pitch of sound measurable by ultrasound
Gadolinium: a chemical element
Galactogram: radiography of the mammary ducts after injection of a radiopaque substance
Hyperinsulinism: an overabundance of insulin in the body causing harmful effects
Lymphoma: a tumor originating in the lymph nodes
Metastatic: spread from one organ to another
Monoamine oxidase inhibitor: a substance that deters the activity of monoamine oxidase, an enzyme used in many antidepressant drugs; if used in combination with a number of other substances, produces severe hypertension, headache, and cerebrovascular disease
Multiple sclerosis: a disorder of the nervous system characterized by hardened patches scattered throughout the white matter of the brain and spinal cord; a chronic disease with symptoms varying depending on the area of the nervous system affected
Neoplastic: pertaining to any new, abnormal growth of cells
Occlusion: an obstruction or a closing off
Orthostatic hypotension: a dramatic drop in blood pressure with position change which results in dizziness and unsteadiness
Oscilloscope: an instrument that displays a visual representation of electrical variations on a fluorescent screen
Palliative: decreases pain, makes condition better but does not cure
Percutaneous: performed through the skin
Pott's disease: tuberculosis of the spine
Proton: a component of every nucleus
Radionuclide: a radioactive nuclide; one that disintegrates with the emission of corpuscular and electromagnetic radiation
Serial: consisting of or relating to a series
Transducer: a device that translates one physical quantity to another, *e.g.*, pressure or temperature to an electrical signal.

Patients undergoing special radiographic imaging procedures require special consideration. Many of them have been informed that they may have life-threatening illnesses and that the procedure that they are about to undergo will either confirm or rule out this threat. Special imaging procedures are not without pain and risk, and most patients find them anxiety provoking. Even something as innocuous as the diagnostic setting can cause the patient distress.

The atmosphere into which the patient is received is often forbidding. The chamber resembles an operating room, and the health care team is either masked and gowned or is hidden behind protective screens, which requires that they address the patient by microphone. This, combined with the prospect of a shortened life span, often elicits from the patient feelings of helplessness, vulnerability, and fear.

Patients receiving radiation or proton therapy may be in various stages of the grieving process. They know that they have a potentially terminal illness and that the prescribed treatment is being administered in an attempt to prolong their lives or provide them some relief from pain during their final days. The radiographer working in these diagnostic and treatment areas must have exceptional technical skills and superior communication and patient-teaching skills. In these areas of patient care, the physician, the registered nurse (RN), the radiographer, and other health care specialists work together as an interdependent team. Each depends on the other for safe and successful diagnostic and treatment outcomes. All patient-care skills presented in the previous chapters of this text need to be applied in these areas.

The radiographer who assists with special procedures must understand the properties of the contrast agents used and be acquainted with basic cardiac monitoring, because many patients receiving these procedures will be monitored continuously.

Most will also receive contrast agents to aid in visualization of organs and tissues.

Expertise in advanced radiologic and special imaging techniques is required to work in most departments that are discussed in this chapter. The intent of this text is to give the radiologic technology student an overview of patient care in these areas so that he may benefit from observational experiences and preview potential areas of specialization. Detailed technical discussion of these procedures is beyond the scope of this text and is only mentioned when relevant to patient-care instruction.

Cardiac Monitoring

Many diagnostic imaging procedures require continuous cardiac monitoring. The RN on the special procedures team will initiate this procedure and, in most instances, monitor this aspect of the patient's condition during the procedure; however, the radiographer should be able to recognize aberrant readings and notify the physician or RN if he recognizes a problem. The discussion of cardiac monitoring presented here is not extensive. Interpretation of an electrocardiogram (ECG) is a specialty area and requires a separate course of study. The ECG patterns presented in this chapter are some of the most ominous. It is important that the radiographer be able to recognize these patterns, as each must be noted and reported to the physician or RN immediately if encountered in a clinical situation.

An ECG is the most frequently used test for evaluation of the functional status of the heart. An ECG tracing assists with identification of disturbances in the rhythm, conduction, and electrical activity of the myocardium (the heart muscle). As the heart is monitored, a tracing of its electrical activity is made on electrically sensitive paper or on the screen of an oscilloscope. This tracing is used to detect abnormal transmission of cardiac impulses from the heart through the surrounding tissues to the skin surface. When the impulses reach the skin, electrodes that have been placed in standardized anatomic positions transmit them to the ECG machine or to the oscilloscope. The impulses are then recorded in graphic form.

The radiographer must understand that ECG readings simply measure the electrical activity of the heart; therefore, not all ECG readings that seem abnormal are necessarily indicative of heart disease. Conversely, a normal ECG pattern is not always an indication that the heart is healthy,

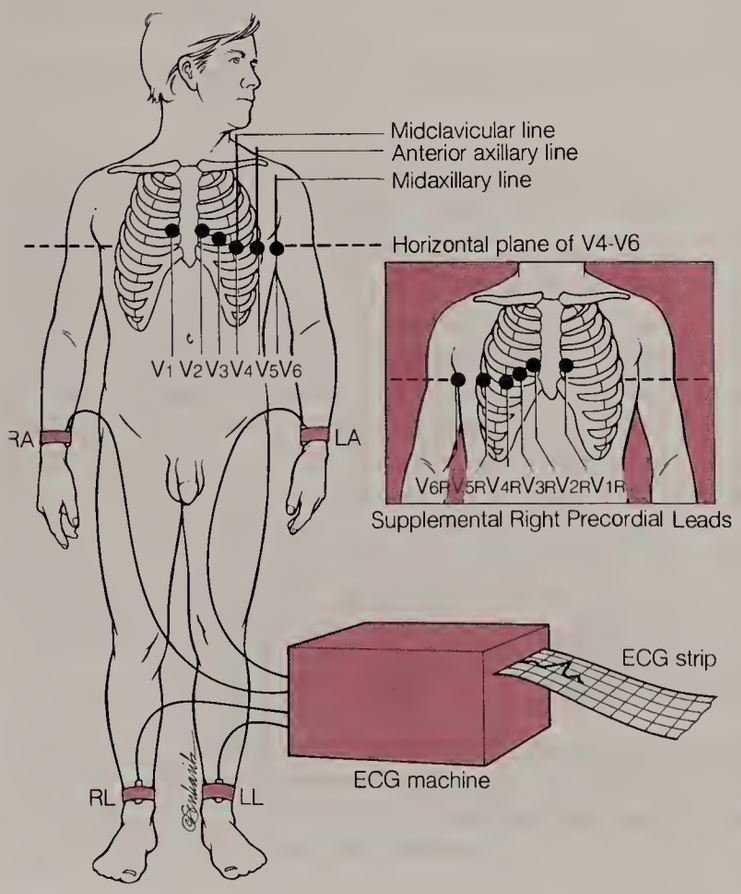


Figure 13–1
ECG electrode placement. (Smeltzer SC, Bare BG: Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996.)

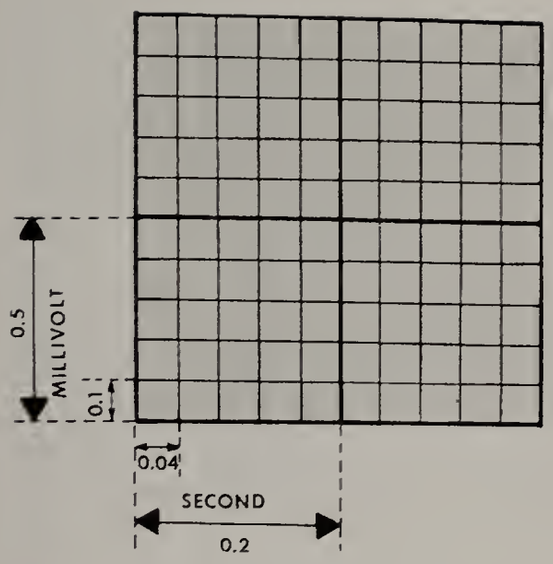


Figure 13–2
Time and voltage lines on ECG paper. *Vertically:* 1 mm = 0.1 mV; 5 mm = 0.5 mV; 10 mm = 1.0 mV. *Horizontally:* 25 small boxes = 1 second; 1500 small boxes = 60 seconds. (Patrick ML, Woods SL, Craven RF et al: Medical-Surgical Nursing. Philadelphia, JB Lippincott, 1986.)

since some disease states of the heart cannot be detected by this method of monitoring.

There are several types of ECG testing. All require that electrodes be placed in various positions and in varying numbers. The only type discussed here is that used for continuous monitoring, the type to which the radiographer will generally be exposed in his work.

Continuous monitoring detects patterns of cardiac impulses and displays them on a monitor so that the patient's status is readily observable. Blood pressure, respiratory rate, and oxygen saturation are also continuously monitored and displayed. If the patient's heart rate, rhythm, or other vital signs deviate from their usual rate or rhythm, an alarm sounds to alert the team caring for the patient. In this manner, life-threatening problems are detected instantly. A printout of the ECG pattern is made at specified times to retain for the patient's record.

PREPARATION FOR CARDIAC MONITORING

When the patient is to have continuous cardiac monitoring during a special diagnostic procedure or treatment, he is informed of what is to take place. If the radiographer assists with the placement of electrodes, he must be directed by a person who has been trained to do this.

Wherever the electrodes are to be positioned, the patient's skin must be prepared by removing the dirt and oils present with alcohol. Hair in those areas is sometimes removed by physician's order to reduce skin resistance. Electrodes used for continuous monitoring usually come prelubricated in a prepared package. If the electrodes are not prelubricated, an electroconductive paste must be applied to each electrode before placement. Patterns

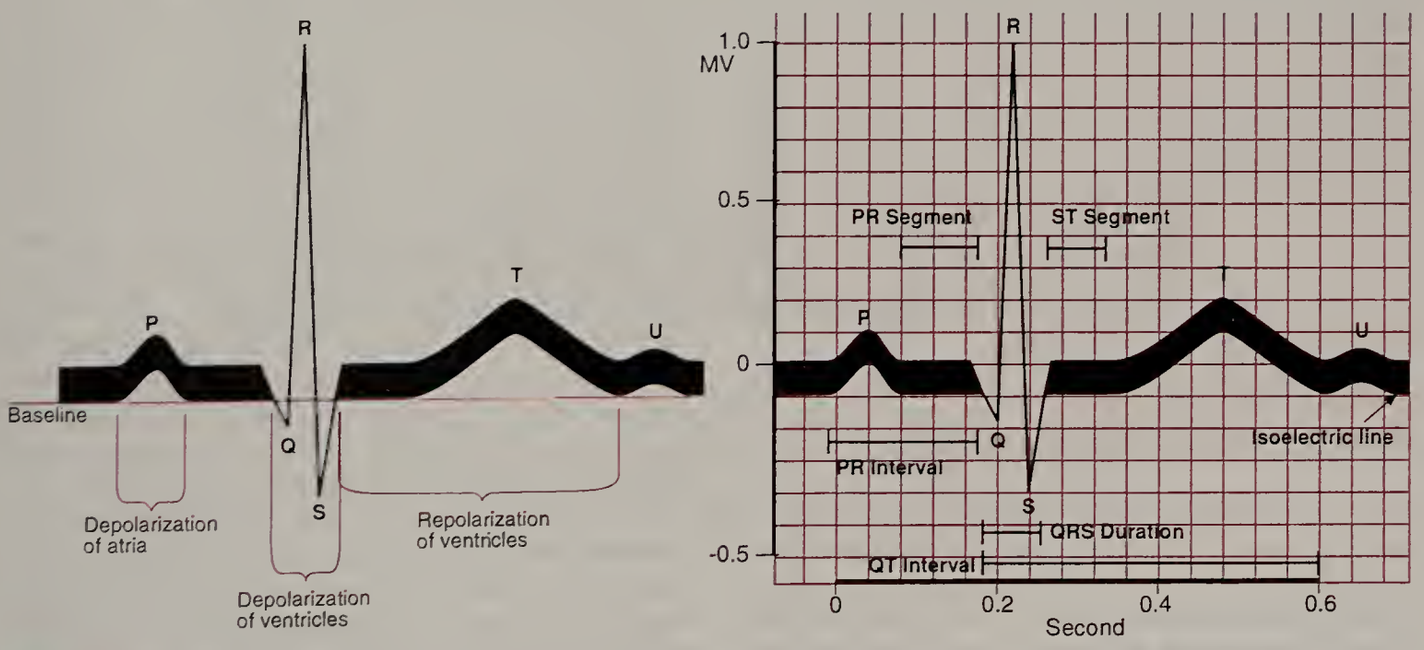


Figure 13–3
Diagram of the electrocardiogram (lead II) and representative depolarization and repolarization of the atria and ventricle. The P wave represents atrial depolarization; the QRS complex, ventricular depolarization; and the T wave, ventricular repolarization. Atrial repolarization occurs during ventricular depolarization and is hidden under the QRS complex. (Patrick ML, Woods SL, Craven RF et al: Medical-Surgical Nursing. Philadelphia, JB Lippincott, 1986.)

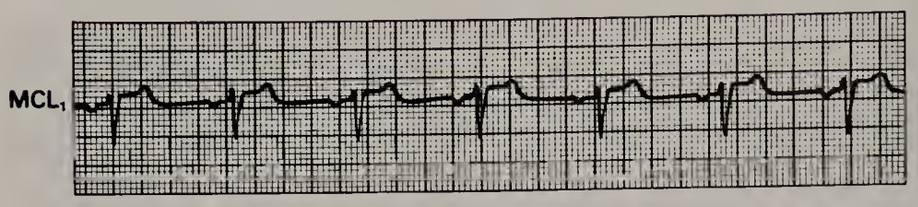


Figure 13–4
Normal sinus rhythm. (Patrick ML, Woods SL, Craven RT et al: Medical-Surgical Nursing. Philadelphia, JB Lippincott, 1986.)

of placement of electrodes vary, but three electrodes are placed on the anterior chest wall (Fig. 13–1). Once the electrodes are applied, an alarm is set on the ECG machine for 30% above and 30% below the patient's baseline heart rate, and then the monitor and machine are activated. Any deviation from the setting will activate the alarm.

ECG RHYTHMS

The cardiac monitor screen or ECG paper will display the heart rate, rhythm, and patterns of impulses on a grid (Fig. 13–2). The components of cardiac rhythm are expressed in waves called *P waves*, the *QRS complex*, *T waves*, the *ST segment*, and the *PR* and *QT intervals*. A *U wave* is sometimes present following the T wave. When a U wave is present, it is usually indicative of an abnormality (Fig. 13–3).

When the cardiac monitor displays a pattern in which the P, QRS, and T waves are present in a normal rate and rhythm sequence, it is referred to as *normal sinus rhythm*. All P waves should be upright, rounded, and similar in size and shape. A P wave should exist for, and be equidistant from, every QRS complex. All QRS complexes in a normal sinus rhythm are of equal size and shape, point in the same direction, and are equidistant from the P wave (Fig. 13–4). Some rhythms that the radiographer may see and should recognize as ominous are shown in Figure 13–5.

Angiography, Cardiac Catheterization, and Nonsurgical Interventions

The radiographer will be a part of the health care team assigned to care for patients undergoing invasive diagnostic and treatment procedures of the arteries and veins throughout the body. An RN, who is also part of the team for these special procedures, will administer medications and monitor the patient's condition as the physician conducts the procedure. If the procedure is a cardiac catheterization, a cardiologist will be a part of the team. The radiographer's role as a member of this highly technical team is to participate in the patient's education, assessment, and general care. He must be alert to any symptoms of respiratory or cardiac distress; be able to monitor vital signs accurately; assist with drug and contrast agent administration; apply the principles of surgical aseptic technique; and communicate with the patient in a therapeutic manner. Each member of the team must have special education in the problems and potential complications that may result from these procedures. The patient and the medical team must wear protective shielding to protect themselves from unnecessary exposure to radiation during these lengthy procedures, which involve use of fluoroscopy and cineangiography (a movie camera used to record fluoroscopic images of the cardiovascular system).

The most frequent medical indication for angiography is the presence of symptoms of vessel occlusion. It is possible to examine one or more arteries or veins in all areas of the body in order to diagnose and treat vessel pathology such as aneurysms and occlusions caused by atherosclerosis, tumors, hemorrhage, or other abnormalities. The area above the catheter insertion site is anesthetized with a local anesthetic, and the artery or vein is accessed with a needle. A guide wire is inserted through the needle. A catheter is then passed over the wire into the artery with fluoroscopic guidance. When the desired artery or vein is accessed, the contrast medium is injected and serial radiographs are taken as the agent infiltrates the vessel or vessels being studied. The site of catheter insertion is most frequently the femoral artery. In cerebral angiography, the carotid, vertebral, or brachial artery may be used. Peripheral vessels may be injected directly. The vasculatures most often visualized during angiography are the renal system, the carotid and cerebral vessels, and the peripheral vascular system of the legs. In recent years, renal dialysis has become a standard medical treatment that requires a shunt to redirect blood. Assessment of the patency of these shunts has become a frequent indication for angiography.

Treatment of diseased arteries may be performed at the time of the angiogram or cardiac catheterization. If the coronary arteries are oc-

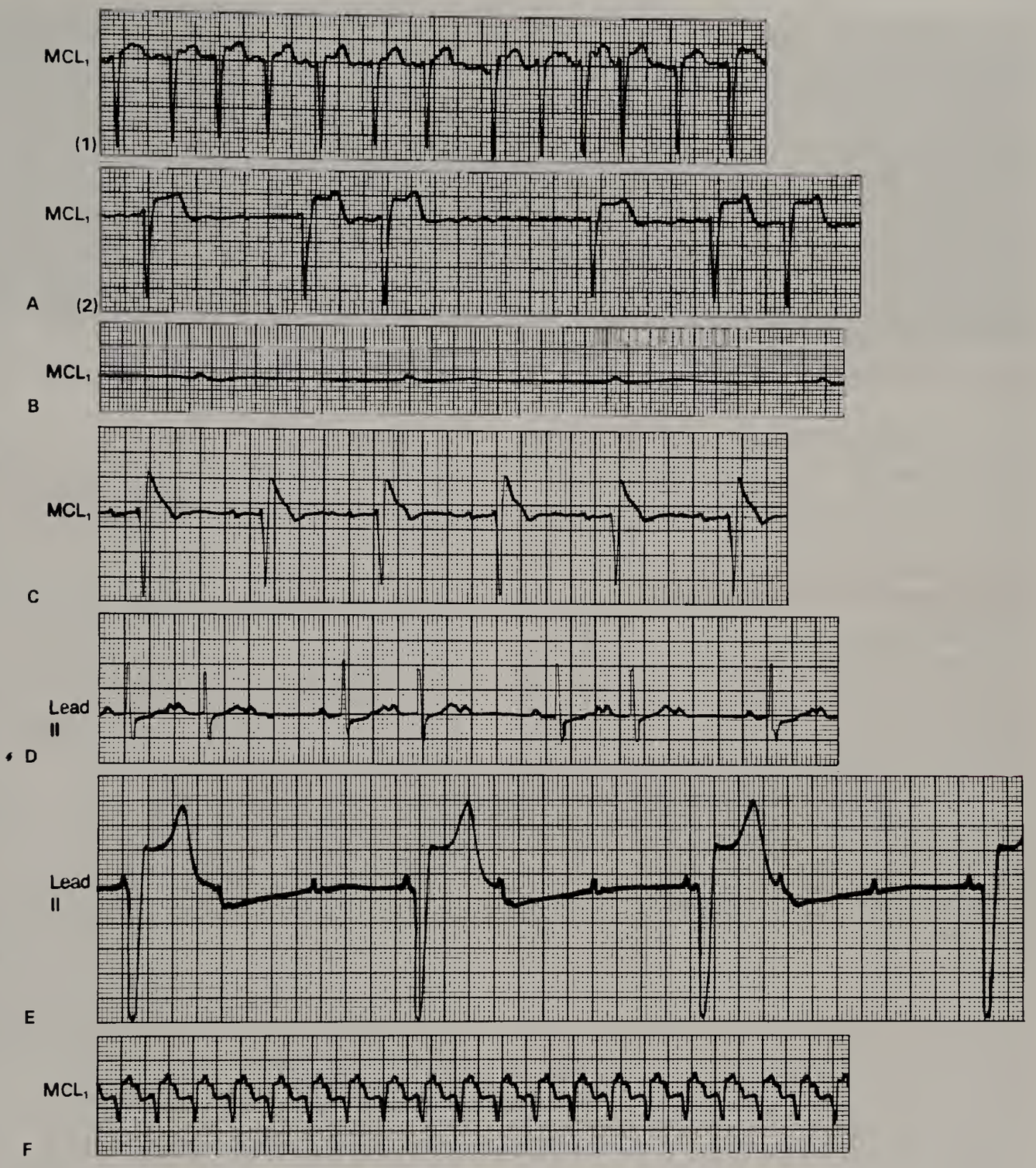


Figure 13–5
Abnormal sinus rhythms. (**A**) (*1*) Atrial fibrillation with uncontrolled ventricular response (more than 100 beats/min). (*2*) Atrial fibrillation with controlled ventricular response (fewer than 100 beats/min). (**B**) Ventricular asystole. (**C**) First-degree heart block. (**D**) Second-degree heart block, Mobitz type I. (**E**) Complete heart block, third degree. (**F**) Paroxysmal atrial tachycardia. (Patrick ML, Woods SL, Craven RF et al: Medical-Surgical Nursing. Philadelphia, JB Lippincott, 1986.) (**G**) Ventricular tachycardia. (Smeltzer SC, Bare BG: Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996, p. 624.)

cluded and would benefit from percutaneous transluminal coronary angioplasty, or if a patient has an evolving myocardial infarct, a balloon-tipped catheter is introduced through the guide wire. Once the site of occlusion is reached, the balloon is inflated to compress the plaque that is causing the occlusion. If there is reason to believe that vessel restenosis will occur, a stent may be used to maintain patency of the vessel. A stent is an object that provides support and structure to a

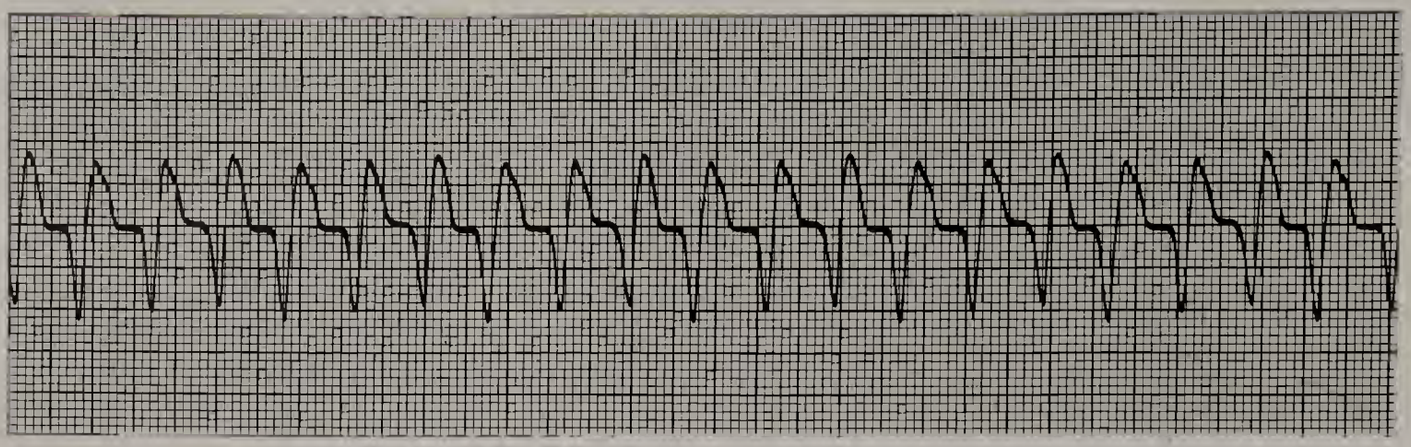


Figure 13–5 ***(Continued)***

vessel. It is introduced in the same way that the balloon is introduced and is left in place when the catheter is removed (Fig. 13–6).

PATIENT CARE PRIOR TO CARDIAC CATHETERIZATION OR ANGIOGRAPHY

Before scheduling a patient for an angiogram or cardiac catheterization, the physician must instruct him in the potential adverse effects of the procedures and an informed consent must be signed. Patients who are unable or unwilling to cooperate during the procedure must be treated with other modalities. Prior to cardiac catheterization, the patient must be instructed in the potential for immediate cardiac surgery if complications or outcomes indicate that it is necessary.

For most angiography, the patient must abstain from oral intake of food and fluids for 4 to 8 hours prior to the procedure. The procedure must be explained and time taken for the patient to express his feelings of anxiety. Use of therapeutic communication techniques is required to allay the fears of the patient. The insertion site for the catheter must be prepared as for a surgical procedure: it must be shaved and scrubbed with an antiseptic solution. The peripheral pulses are identified and marked with a pen so they may be quickly assessed during the examination. The patient must be instructed to empty his bladder and remove prostheses, dentures, and jewelry and don a patient gown. He is informed that the procedure will take from 2 to 3 hours and during this time he will be lying on a hard table. He must be assessed for allergies to medications including iodinated contrast media. If a pre-procedure medication is ordered, it is administered and an IV is started for access and to facilitate the administration of drugs as needed. Drugs that the radiographer must recognize that are frequently administered during angiography may include the following:

Heparin: administered IV to prevent thrombus formation

Nitroglycerin: administered IV or via intracoronary route to prevent coronary spasm

Nifedipine: administered sublingually to prevent coronary spasm

Urokinase: IV, used for lysis of coronary and pulmonary emboli and to clear shunts

Demerol: IV for analgesia

Morphine: IV for analgesia

Valium: IV for anxiety and sedation

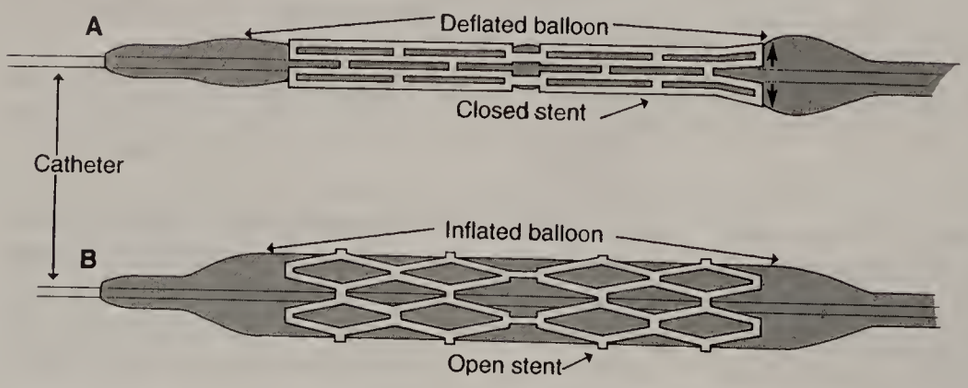


Figure 13–6
Schematic drawing of an intracoronary artery stent. (**A**) Stent closed, before balloon inflation. (**B**) Stent open, balloon inflated; stent will remain expanded after balloon is deflated and removed. (Smeltzer SC, Bare BG: Brunner and Suddarth's Textbook of Medical-Surgical Nursing, 8th ed. Philadelphia, Lippincott-Raven, 1996, p. 646.)

When the patient arrives in the cardiac catheterization laboratory or special procedures room, the radiographer should spend a few minutes acquainting him with the machinery, explaining the procedure, and allowing him to ask questions. The patient's anxiety may be relieved by allowing him to bring a favorite musical tape to play while being cared for. If the patient is a child, he should be allowed to bring a favorite toy or story tape. He should be encouraged to play the tape, especially if the procedure extends beyond 1 hour.

For angiograms in areas other than the heart, the patient is required to be well hydrated prior to examination. This is the case with cerebral angiography.

PATIENT CARE AND EDUCATION AFTER CARDIAC CATHETERIZATION OR ANGIOGRAPHY

Patient care following angiography and cardiac catheterization is relatively uniform and must be followed meticulously in order to prevent circulatory deficit, thrombus formation, or hemorrhage. In most instances, the patient is transported to the hospital postanesthesia recovery area or to an intensive coronary care area to be monitored following cardiac catheterization or angiography. The radiographer must understand the monitoring and care required following these examinations so that he can instruct the patient and so that he can begin to monitor the patient before leaving the diagnostic imaging area.

The patient may be extremely fatigued, and any movement required of him following the procedure must be done with adequate assistance so there is little demand on the patient. The patient's pulse rate must be monitored on the side of the invasive procedure every 15 minutes for 1 hour and then every hour until a 12-hour period is complete and no complication has been detected. The blood pressure is monitored on the side opposite the invasive procedure at the same time intervals. The pulses distal to the site of catheter insertion must also be monitored at frequent, regular intervals for 24 hours following the procedure. Following femoral catheterization, the patient should be instructed to move his toes and dorsiflex his feet frequently. He also must be instructed to keep his legs straight and still. The extremities must be assessed for coldness, cyanosis, pallor, numbness, size as compared to the other extremity, and tingling. The patient should be instructed to inform the nurse if he has any of the symptoms listed. If there should be a circulatory deficit, surgical intervention may be necessary to correct the problem. The patient should also inform the nurse of any feeling of wetness at the site of the catheter insertion; he may be hemorrhaging.

If a femoral artery was used for the catheter insertion, the patient is informed that he must remain at bedrest for 10 to 12 hours following the procedure to prevent hemorrhage. A weight or a sandbag is often placed over the site of catheter insertion to apply pressure to the area. The patient should also be told to apply pressure at the insertion site if he coughs or sneezes. The patient's head should not be raised more than 20 degrees during the immediate postcatheterization period.

If the brachial site was used for catheter insertion, the arm on the side of insertion is kept straight with an armboard for several hours but the patient may be up as soon as his vital signs are stable. Regardless of the site of insertion, the patient must be monitored for 24 hours for external bleeding or for bleeding into the tissues surrounding the catheter insertion site.

The patient who has received iodinated contrast media must be instructed to increase his fluid intake to prevent dehydration and hypotension. This may be contraindicated in some patients with congestive heart failure. Patients are often given intravenous fluid replacement therapy during these procedures, but the patient should be made aware of his need for increased fluid intake.

The time that the procedure began and ended, any drugs or contrast agents administered, and the patient's tolerance of the procedure are recorded on the patient's chart. Also recorded are the instructions given to the patient following the procedure.

Myelography

Myelography (myelogram) is a radiographic examination of the spinal cord in which an iodinated contrast agent, and on some occasions, air, is injected into the subarachnoid or epidural spaces of the spinal cord. This examination is done to detect pathological conditions of the spinal cord such as a herniated intravertebral disc, tumors, malformations, and arthritic bone spurs.

PATIENT CARE AND EDUCATION PRIOR TO MYELOGRAPHY

A consent form must be signed by the patient or an appointed person before this procedure is begun. The patient is assessed for potential allergic reaction to iodinated contrast media. He must be

instructed to increase clear fluid intake and omit solid food for 4 hours before the examination so that he is well hydrated but will not become nauseated because of food in his stomach. Food and fluid restrictions may vary depending upon the contrast agent used. The patient should empty his bladder and bowels prior to this examination.

The patient must also be instructed to stop taking all drugs 24 hours prior to the examination. Drugs that may enhance the possibility of seizure activity are particularly important to omit. This includes phenothiazines, tricyclic antidepressants, central nervous system stimulants, and amphetamines. Monoamine oxidase inhibitors must be discontinued 2 weeks before a myelogram. Patients with a diagnosis of diabetes mellitus must be instructed by their physician on how to prevent a hypoglycemic or hyperglycemic reaction during preparation for myelography.

Myelography should not be performed on patients with multiple sclerosis, inflammation of the meninges, Pott's disease, infections or bloody subarachnoid fluid, increased intracranial pressure, or a recent myelogram. Iodinated contrast agents are used for this procedure, so all precautions taken when these drugs are administered apply. Myelograms may also be contraindicated in patients who are prone to seizures. Seizure-prone patients may receive medication to reduce the possibility of seizures prior to the examination. Physicians may order medication to reduce the patient's anxiety in preparation for this procedure.

The area into which the iodinated contrast agent is to be injected intrathecally is shaved, if necessary, and prepped as for other sterile invasive procedures. The radiographer should inform the patient that the table will be tilted during the examination but that a foot rest and shoulder harness will prevent him from falling. The patient's privacy must be protected by having him wear pajamas or by taping a draw sheet in place to prevent it from sliding off during the table movement.

Baseline vital signs should be taken before the myelogram begins and then monitored during the examination. The patient should be informed that the examination will take from 1 to 2 hours to complete.

INTRATHECAL DRUG ADMINISTRATION

Intrathecal (intraspinal) injections are given with a needle that is 3½ inches long with a 16- to 25-gauge lumen. A stylet within the needle remains in place until the physician has completed the spinal puncture. When the needle is in the desired position in the spinal column, the stylet is removed, and the syringe containing the medication or contrast agent is attached to the needle.

Intrathecal drugs are administered by the physician who is performing the special procedure or by an anesthesiologist. An open sterile tray containing the necessary equipment and drugs will be available. The radiographer assists by obtaining any extra articles needed by the physician and placing them on the sterile field and by positioning the patient.

For lumbar myelography, the patient is usually placed in a prone position with a pillow under the abdomen to raise the lumbar area slightly (Fig. 13–7). Other positions that may occasionally be used for administration of intrathecal drugs are the bent sitting position (Fig. 13–8*A*) and the side-lying position with knees pulled up and spine curved forward as much as possible (see Fig. 13–8*B*). All these positions make the spinal column more accessible.

Many patients receiving myelograms are in severe pain as a result of injury or disease. Pain medication may be ordered to be administered 15 to 30 minutes prior to beginning the procedure so that the patient is more comfortable. The radiographer must assist the patient with any movement he must make during the procedure and return him to a normal physiological position as quickly as possible. The patient must also be kept warm. A flannel sheet over the patient and booties on his feet often make him more comfortable.

Any unusual symptoms or complaints that the patient has while the myelogram is in progress should be reported to the physician performing the procedure. Specimens of spinal fluid are often collected during this procedure and should be correctly labeled, bagged, and taken or sent to the laboratory immediately.

PATIENT CARE AND EDUCATION FOLLOWING MYELOGRAPHY

Following a myelogram, the patient who received a water-soluble contrast agent should be instructed to remain at bedrest for 8 to 10 hours with the head of the bed slightly elevated at a 35- to 45-degree angle. This will prevent the contrast agent from being dispersed upward and possibly prevent headache following the examination. If an oil contrast agent is used, the patient should remain at bedrest for 8 to 24 hours with the head elevated to prevent upward flow of the oily agent. If air was injected into the subarachnoid space, the patient is positioned with the head lower than the

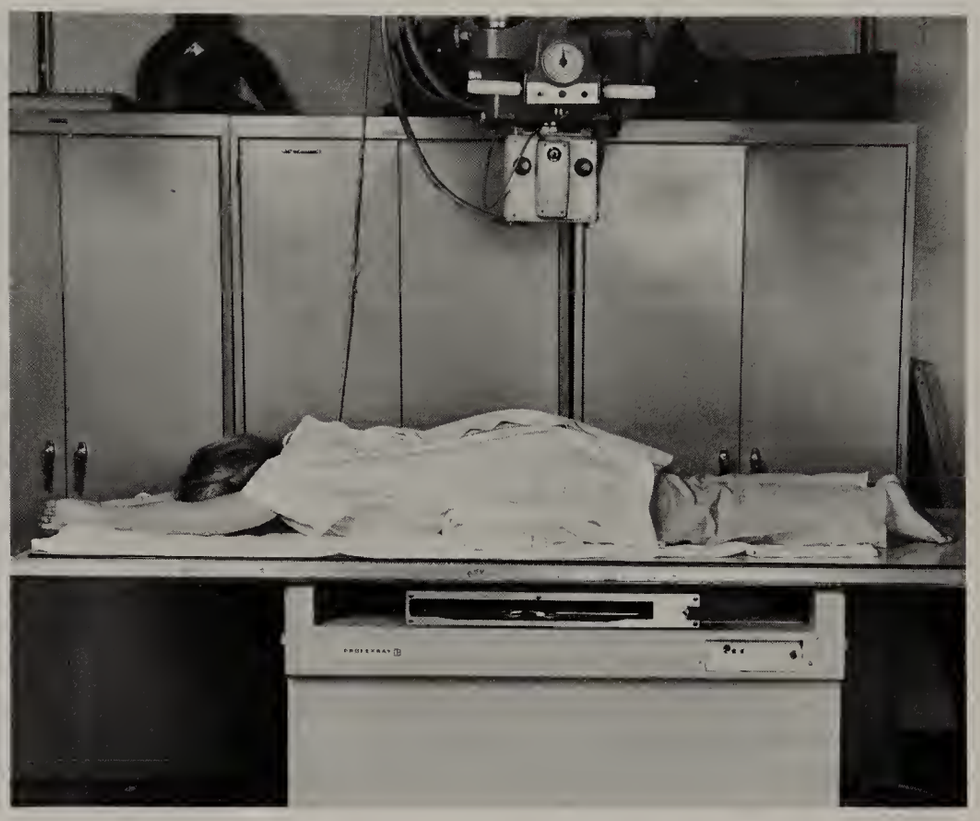


Figure 13–7
Patient positioned for myelography.



A



B

Figure 13–8
(**A**) Intrathecal administration with the patient in a bent sitting position. (**B**) Intrathecal administration of drug with the patient lying on his side. The radiographer helps the patient to maintain this position. The patient's knees are flexed, and his head is brought down close to his knees so that his back arches.

trunk of his body for 48 hours to prevent headache. The air is usually absorbed within this time frame and the patient can then resume a normal position.

The patient should be informed that he may have increased lumbar pain following a lumbar myelogram. He should also be encouraged to increase his fluid intake. The radiographer should inform the patient to notify his physician immediately if he is unable to urinate or if he develops a fever, drowsiness, stiff neck, seizures, or paralysis. Other complications of myelography are arachnoiditis (inflammation of the delicate spinal cord covering) and meningitis. Any unusual reactions that the patient had to the contrast agent or in general are recorded on the patient's chart. The time the procedure began and ended, specimens sent to the laboratory, and the patient's tolerance of the procedure are also recorded. Instructions given to the patient for postmyelogram care are to be included on the chart.

Computed tomography scans are frequently used in combination with myelograms to improve visualization. They are described in the following section.

Computed Tomography

Computed tomography (CT) may be called computerized axial transverse tomography (CATT) when the brain is being examined. In this section it is referred to as CT. This is a diagnostic imaging procedure that can be used to scan the brain and head or the entire body. CT scans produce multiple cross-sectional pictures of body organs that, when displayed on radiographic film, are three dimensional in appearance. This is a highly effective method of diagnosing intracranial and organic pathology.

Iodinated contrast agents are used to increase tissue density for body and brain scans. Barium solutions may be used to increase organ density of the gastrointestinal tract.

PATIENT CARE AND INSTRUCTION BEFORE COMPUTED TOMOGRAPHY

In preparation for CT of the brain, the patient should be instructed not to eat or drink for 2 to 3 hours prior to the examination. Any medications that the patient is taking routinely may be taken. If the patient has diabetes mellitus, his CT should be arranged so that his regular meal pattern and insulin administration are maintained. The patient will be receiving an iodinated contrast agent, so all precautions and questioning that precede administration of that drug are included in pre-CT patient care.

The radiographer must spend a few moments explaining the procedure to the patient in order to alleviate anxiety. The patient should be told that the will be expected to lie very quietly to ensure clear images. He should be allowed to inspect the equipment and to express any feelings of claustrophobia or fear of the procedure. The radiographer must inform the patient that he may communicate with him through a microphone placed above the machine portal. The patient should be shown where the radiographer will be sitting behind the glass window and be told that the radiographer can observe, hear, and communicate with the patient at all times (Fig 13–9).

The radiographer must establish a feeling of trust in the patient. It is very frightening for patients to feel that they are in a room alone, receiving an intravenous drug to which they may have a reaction, with nobody in close proximity on whom they can rely for help. The extremely anxious patient, or those patients who are in pain and are unable to lie quietly, may need an analgesic or sedative medication if this can be prescribed.

The patient should be informed of the feelings of nausea, warmth, and flushing, and the metallic taste he may have following administration of the



Figure 13–9
Computed tomography (CT) scanner.

iodinated contrast agent. An emesis basin should be placed near the patient where he can pick it up easily if need be. The patient should know that this examination usually takes about 1 hour. A special legal consent form is signed by the patient receiving these studies.

COMPUTED TOMOGRAPHY OF THE BODY

Patients who are to have CT of the bowel and abdominal organs are to have nothing to eat or drink after midnight the night before the examination. They may receive a barium contrast agent mixed in orange juice to drink the night before the examination and more (1000 mL) immediately prior to the scan. An iodinated contrast agent is also injected intravenously immediately before the CT scan begins.

The radiographer must spend the same amount of time explaining the procedure to the patient before beginning this examination as for the head CT scan. For the bowel and abdominal CT scan, the patient must also be instructed to listen carefully for instructions to breathe, hold his breath, and release his breath. He must be told that these instructions will be numerous.

Whichever area of the body is being scanned, the radiographer should pause from time to time and ask the patient how he is feeling and inform him of the time remaining for examination. If the patient is made to feel that he is the major focus of the procedure and is kept informed, he will be more cooperative and relaxed while the examination is in progress.

PATIENT CARE AFTER COMPUTED TOMOGRAPHY

Patients who have come from their homes and plan to return home should be accompanied by a person who can drive them or assist them to get there safely. Patients who have received sedative or antianxiety medication may not drive themselves.

When the procedure is complete, the intravenous contrast agent is discontinued by order of the physician as described in Chapter 12. The patient is then allowed to sit up with assistance. He should sit quietly on the table for several minutes before he is assisted back to the dressing room, wheelchair, or gurney. If the patient is hospitalized, he may be returned to his room with assistance. If he is going home, assist him to the dressing room and give him the help he needs to get dressed. Observe the patient for at least 1 hour for adverse reaction to drugs received and for general instability before discharging him from the department.

If the patient has received an iodinated contrast agent, he must be instructed to increase his fluid intake to at least 3000 mL for the next 24 hours to aid in its excretion from the body and to prevent dehydration. If barium has been administered, the instructions in Chapter 9 concerning post-barium administration should be followed.

Any adverse reactions that occurred during CT and any medications that the patient received must be recorded on the patient's chart. The time that the procedure began and ended, the patient's tolerance of the procedure, and the instructions that the patient received for post-procedure care must also be recorded.

Lymphangiography

Lymphangiography is a special type of angiography used to examine the lymphatic blood vessels and the lymph nodes. This procedure is performed to diagnose Hodgkin's disease (a malignant disease of the lymphatic system). Lymphangiography is also used to diagnose edema of extremities, lymphomas of unknown origin, or carcinoma of the prostate. These examinations can last from 1 to 3 hours and can cause the patient extreme discomfort.

After the patient has been positioned on the examining table, isosulfan blue dye is injected intradermally between the first three toes of each foot. This agent stains the lymphatic vessels and improves visualization. A cannula is then inserted into the lymphatic vessels through small incisions in the dorsal portion of the feet. The radiographer assisting with this procedure must follow the rules of surgical asepsis. An iodinated contrast agent is then injected at a very low pressure through the cannula in order to prevent extravasation. The contrast agent is allowed to infuse until it reaches the lumbar vertebrae and is then discontinued. Fluoroscopy and multiple radiographic films are used to image the lymph nodes in the upper and lower portions of the body. The patient is returned to diagnostic imaging after 12 or 24 hours to have another set of films taken and to assess the filling of the lymph nodes.

The same procedures may be performed using the lymphatic vessels of the hands. This is the site of insertion of the cannula if the axillary and supraclavicular nodes are to be identified and examined.

There is no food or fluid restriction with this examination. Patient history and post-examination

care are the same as for all examinations that require use of contrast media.

PATIENT CARE DURING LYMPHANGIOGRAPHY

The radiographer assisting with lymphangiography must take special care to make the patient as comfortable as possible during this lengthy and somewhat painful examination. These patients are often very ill or are very concerned about the results of their examination. Help the patient to relax and to be as comfortable as possible because the examination is very fatiguing. It will be important to explain the procedure to the patient to reduce anxiety. Continue to communicate in a therapeutic manner during the procedure; offer fluids from time to time—food and drink are usually allowed during the examination; allow the patient time to void; and offer him a bedpan or urinal if he cannot go to the lavatory. Consent forms must be signed prior to this examination. The patient will receive an iodinated contrast agent, so he must be assessed for potential problems (as described in Chapter 11) prior to this examination. The radiographer must be observant for signs and symptoms of untoward reactions to the iodinated contrast agent as the procedure progresses.

PATIENT CARE AFTER LYMPHANGIOGRAPHY

Following lymphangiography in which the insertion site is in the lower extremities, the patient may be instructed to keep his legs elevated to prevent swelling. His body temperature should be measured every 4 hours for 48 hours to assess for infection or for an inflammatory reaction. Other potential complications from this procedure that the radiographer should be aware of are headache, fever, sore throat or sore mouth, inflammation of the lymph nodes, infection at the incision sites, or oil embolism.

Mammography

Mammography is an imaging modality that is performed on a routine basis for prevention or early diagnosis of breast cancer and on an acute-care basis if a lesion, lump, or nodule found in the breast is suspected of being cancerous. A baseline first mammogram is recommended for any woman aged from 35 to 40 years. This routine examination can be repeated every 1 to 2 years or at any time that it is indicated because of detection of an abnormality of the breast tissue. The American Cancer Society recommends yearly examinations for women aged 50 and over. Men do not usually receive routine mammograms for prevention of disease; however, if there is a family history of cancer of the breast or if any abnormality of the male breast is discovered, a mammogram is ordered.

There is no iodinated contrast agent used for routine mammography. The radiographer should instruct the patient to wear an item of clothing that can be easily removed to the waist. Deodorant or powders in the axillary region should not be used prior to the examination because they may prevent adequate visualization. The patient's breasts are exposed and positioned between two film holders. Radiographic films are taken from 2 views. During the procedure, the breasts are compressed tightly between the two film holders to remove skin folds and air pockets. It is usually known by women presenting for mammogram that the procedure is most uncomfortable. They are, therefore, in a state of anxiety when they arrive for examination. If the patient is having the mammogram because of suspected pathology, the radiographer must ask the patient to identify the area that is suspect so that additional care is taken to obtain optimum exposures of that area. The radiographer performing a mammogram must make every effort to preserve patient privacy and minimize anxiety.

Galactography

If the patient has bleeding from the nipple or when a single mammary duct is dilated as noted on routine mammography, a galactogram may be ordered. This test is accomplished by administration of a minute amount of iodinated contrast agent into the duct opening on the areola of the nipple involved, followed by a mammogram. There is usually no more pain and discomfort with this type of an examination than from the routine mammogram; however, the patient's anxiety will be higher, and the radiographer's care of this patient must be particularly sensitive.

Ultrasound

Ultrasound is a method of visualizing the soft tissue structures of the body for diagnosis of disease or malfunction without the use of radiation or contrast media. It is a noninvasive, painless proce-

dure that requires the skill of a specially trained technologist, usually a radiographer with additional education. Ultrasound employs high-frequency sound waves to search for pathological changes in body organs and is used frequently to monitor fetal growth in pregnancy.

The use of the Doppler effect has increased the imaging potential of ultrasound. Doppler examinations make it possible to study the behavior of moving body structures such as blood flow or a beating heart and to identify areas of occlusion and malformation in a noninvasive manner.

While the ultrasound examination is in progress, the images are displayed on a cathode ray tube. Permanent copies of the examination results are produced either as Polaroid pictures or on sensitized paper with recordings somewhat like those from an ECG reading (Fig. 13–10).

This form of imaging is useful in obstetrics for fetal monitoring; in neurology to diagnose brain disorders; and in urology for diagnosis of urinary bladder, scrotal, prostatic, and renal pathology. It is also used to diagnose vascular aneurysms, as well as pancreatic, gallbladder, thyroid, venous, parathyroid, lymph node, eye, and breast pathology. This is not an all-inclusive list and new uses for ultrasonography continue to be found. The radiographer who is not trained as an ultrasonographer must have an awareness of the process of ultrasound in order to correctly schedule imaging procedures to the patient's best advantage.

PATIENT CARE

Patient care considerations for ultrasound include instruction in preparation for the procedure, an explanation of the procedure itself, and correct scheduling to prevent unsatisfactory examinations. There is little post-examination instruction needed.

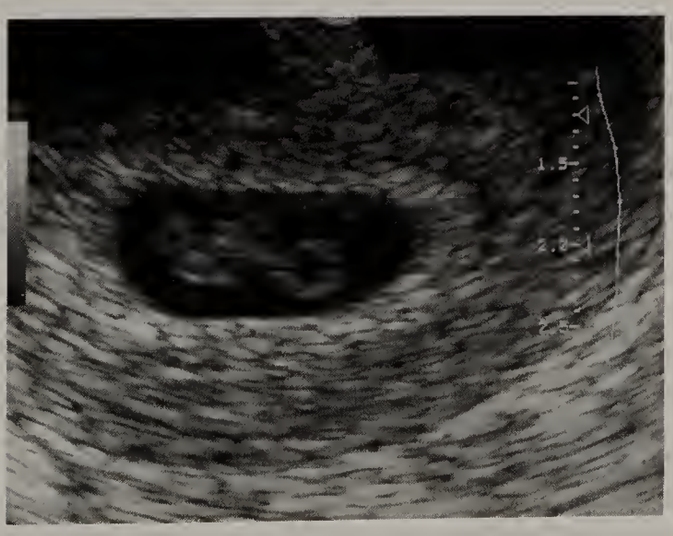


Figure 13–10
Ultrasound picture of fetus in utero.

If a patient is to have barium studies as well as an ultrasound examination, the ultrasound examination should be scheduled to precede the barium studies because residual barium in the gastrointestinal tract will interfere with effective ultrasound examinations. If a patient has a tendency to have large amounts of gas in his bowel, the gas will interfere with visualization. A patient with this problem should be instructed to eat low-residue foods for 24 to 36 hours prior to the examination and be scheduled at a time when the bowel will be relatively gas-free, as is the case in the early morning before breakfast.

Active children or patients who are unable to remain quiet because of pain, emotional illness, or anxiety must be scheduled at a time when they can be accompanied by a person who can keep them calm and relaxed. Use of sedative drugs may also be recommended by the physician.

Patients should be informed that this is a painless, noninvasive procedure that takes from 15 minutes to 1 hour to complete. A lubricating gel or water is used as the conductive agent. The gel will be applied by the ultrasonographer if it is used. If water is used, the patient will be immersed in water, or a water bath is hung over the area to be scanned.

A transducer is held by the sonographer and is moved over the surface to be examined as the screen is watched and images are produced. The patient must be shown the transducer and reassured that it will cause no pain.

Some examinations require a preparatory cleansing enema and fasting for several hours prior to the scheduled time. Others require a full urinary bladder. If either of these is required, the radiographer or sonographer must explain the preparation to the patient.

Wound dressings, scars, and obesity are all factors to be considered when ultrasound is the imaging technique prescribed. Dressings must be removed, and lubricating gel cannot be applied over an open wound. Scars and obesity prevent good visualization. A clear sterile patch may be worn over wounds if ordered by the physician.

Patient care following ultrasonography is the same as thoughtful patient care following any diagnostic imaging procedure. The lubricating gel must be carefully removed so that the patient's clothing is not soiled by it. If the patient was immersed in water, he must be provided with towels and a private area in which to dry and dress. Patients who are in a weakened condition must not

be left alone, and any assistance the patient needs must be provided. Patients who have had sedative medication must not be allowed to drive home or return to their hospital room unattended.

Lithotripsy

Extracorporeal lithotripsy is a relatively new method of removing gallstones (biliary calculi, cholelithiasis), renal calculi (kidney stones, urolithiasis), and salivary stones (sialolithiasis). This is a noninvasive procedure that uses shock waves directed at calculi in the gallbladder, the common bile duct, the renal calyx, and the submandibular gland. The radiographer is a part of the team that conducts these procedures because radiographic films and fluoroscopy are a part of the procedure.

For lithotripsy procedures performed for removal of biliary or renal calculi, the patient is immersed in a water bath or positioned on a fluid-filled cushion, and shock waves generated by electric, piezoelectric, or electromagnetic discharge are directed at the stones that are meant to be fragmented. The waves are transmitted through the water without being absorbed as long as solid body tissues such as the lungs, bones, or gastrointestinal tract are avoided. The calculi are broken into fragments and are then passed in the urine or dissolved in bile acid or saliva. Ultrasound may be used to visualize the calculi.

The patient who receives extracorporeal shock-wave lithotripsy is usually treated on an outpatient basis as there is no surgical incision or pretreatment care. If high total shock wave energy is used during the procedure to disintegrate the stones, the patient may receive a light anesthesia with a medication such as fentanyl or midazolam (Versed). The patient is usually discharged following the procedure, but he should be instructed to plan to be transported to his home by another person as he will be unable to drive himself.

A second type of lithotripsy procedure, called *intracorporeal lithotripsy,* is used to remove stones from the gallbladder or kidney after percutaneous insertion of an endoscope or nephroscope with visualization provided by use of a contrast agent and fluoroscopy. The stones are then fragmented with ultrasonic waves transmitted by an ultrasound probe placed near the stone. Another method of removing the pulverized stones is with a forceps or stone basket.

Many of the patients who receive this treatment are in a weakened state, as they have undergone severe pain from the symptoms of their illness. They will also be anxious because of the unusual aspects of this treatment and will require additional time for reassurance and instruction. The treatment must be explained to them in some detail. If there will be a contrast agent or other drugs administered, the usual drug history is required. Informed consent forms must also be signed. Pregnancy and the presence of a cardiac pacemaker are contraindications for lithotripsy of any kind.

Following the procedure, patients should be instructed to inform their physician if there is excessive blood in their urine, decreasing urine output, fever, or increasing pain. They may eat and drink according to physician's orders. If the procedure was for renal calculi or if the patient received a contrast agent, fluid intake must be increased.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is usually a noninvasive procedure used for diagnosing neoplasms as well as vascular, soft tissue, bone and joint, and central nervous system pathology. Gadolinium-based contrast agents may be injected intravenously for some MRI diagnostic procedures.

MRI is performed by placing the entire body of the patient (or an extremity, if the problem is limited to that extremity only) in a magnetic field that puts out measurable radio signals, which are then displayed on a computer monitor or magnetic tape to be replayed on a video screen.

If a limb or limbs are being diagnosed for measure of blood flow to extremities, the patient sits or lies quietly while the limb being examined is placed in a flow cylinder. The limb or limbs are moved in and out of the cylinder as the extremity studies are completed. If both legs and arms are to be examined, the legs are usually examined first. MRI arthroscopic examinations of knees are now being done with some success.

If entire body imaging is to be done, the patient is placed on a pallet that moves slowly through a large magnetic cylinder (Fig. 13–11). If the head is to be scanned, a clear plastic cylinder with antennae is placed around the head.

PATIENT CARE AND EDUCATION FOR MRI

Patient education is the key to successful imaging when MRi is the diagnostic procedure selected. The patient should be informed that the procedure

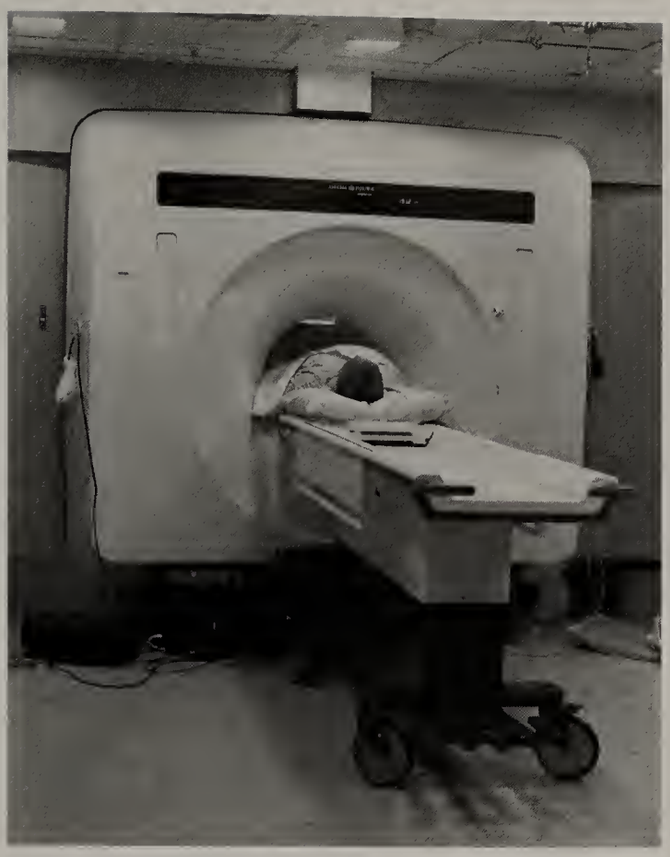


Figure 13–11
Patient on MRI pallet.

may take from 1 to 2 hours. Claustrophobic fears are common and emerge when the patient is faced with spending 1 hour or more in a rather close cylinder, in a large room, alone. Accurate information and instruction help to alleviate these fears. Antianxiety medication such as Valium is often prescribed to assist in relieving the anxiety of the adult patient. These medications may not be given if blood flow is to be assessed because they interfere with normal blood flow. The adult patient is to be informed during the examination he will lie in a supine position. Ear plugs may be worn to quiet the sound. The patient should be informed that, although he may feel that he is completely alone, there will be at least two persons just on the other side of a glass window who are constantly observing him, and that they can and will be communicating with him frequently during the examination. The patient should also be shown that there is a microphone through which he can communicate to the staff. The patient should be allowed to examine the machine and ask any questions he may have before beginning the examination. This is especially necessary for children. The patient should also be informed that he will hear a pounding noise during the entire examination.

If the patient is a child, a parent may be allowed to sit beside the cylinder and talk to the child during the examination. Infants may be fed shortly before the examination and may then sleep during the entire time. Some adults benefit by keeping their eyes closed during the time in the cylinder. The radiographer can assist patients during the examination by speaking to them frequently and letting them know how much time is left for the examination to be completed.

The radiographer must remember that many patients who are having MRI are anxious and fearful because of possible ominous diagnostic outcomes, as are the parents of children who are having this examination. Patients may focus on their claustrophobic feelings in an attempt to deny the possibility of a threatening diagnosis. The radiographer must be patient, sensitive, and nonjudgmental when communicating with these patients and their family members. Making the patient's feelings seem foolish or offering reassuring cliché responses will only increase the patient's anxiety. Time must be spent discussing the process and the patient's or the parents' feelings and concerns before beginning the examination. If this is not done, the patient may be unable to remain as quiet as is necessary for a successful examination.

Patients must be instructed to remove all metal jewelry, dental bridges, clothing with metal closures, belts, metal-containing prostheses, hair clips, and shoes before entering the MRi room. Purses and wallets containing credit cards must be left outside in a secure place. The radiographer will be responsible for placing these items safely away for patients and for informing them of where their belongings are being kept.

If the patient is to receive a contrast agent, the institution may require that an informed consent be signed. A medical history, as previously described, must be taken prior to MRI. Patients must also be assessed for a history of allergic reactions to all drugs including previous reactions to iodinated contrast agents. Although the gadolinium-based contrast agents used for MRI do not contain iodine, there have been some reports of allergic reactions to them. If the patient has a history of allergies, this must be a consideration.

Patients who receive sedative drugs prior to MRI and patients who have a history of asthma and receive a contrast agent should be monitored during MRI. There are pulse oximeters made specifically for use in the MRI chamber.

The patient should be informed that this procedure does not expose him to radiation and is relatively painless. There may be some tingling sensations felt if the patient has metal dental work.

MRI is contraindicated for patients who have internal pacemakers, implanted heart valves, metal

orthopedic implants, or surgical clips. It may be contraindicated for pregnant women because the effects of MRI on pregnancy are unknown at present. Patients on life-support pumps or who are critically ill usually do not have this examination because of the difficulty of monitoring them while in the magnetic scanner.

There are no special patient instructions or teaching responsibilities following MRI unless the patient has received medication or a contrast agent. If the patient has received drugs or a contrast agent, the instructions are the same as for other invasive imaging procedures.

Children are sometimes sedated for this examination. If this is the case, the patient is monitored throughout the examination and until fully recovered from the sedative by an RN proficient in this field. Sedating children requires special evaluation that will not be discussed in this text.

Before MRI may begin, the patient must be questioned or given a written screening data form to complete that asks him whether he has the following:

1. A cardiac pacemaker
2. Aneurysm clips
3. An implanted insulin pump
4. A bone-growth stimulator
5. An internal hearing aid
6. A cochlear (middle-ear) implant
7. Any vascular or surgical clips
8. A neurostimulator
9. A heart valve
10. Any metal in the eye or eye prosthesis
11. A vena cava clot filter
12. Any metal in the body (if so, where it is located)
13. A pregnancy
14. An intrauterine device or diaphragm in place
15. Dentures or braces of any type in the mouth
16. Any type of orthopedic prostheses, rods, or pins in the bones.
17. Any other type of implants
18. Any surgeries (if so, what type of surgeries)
19. Claustrophobia
20. Regular need for oxygen administration
21. Any abnormal condition that is visible, or can be palpated (if so, explain)
22. Any allergies (if so, explain)

Positron Emission Tomography

Positron emission tomography (PET) combines the qualities of radionuclide imaging with CT to study blood flow and volume and protein metabolism. The body organs studied by this technique with great success to date are the brain, the heart, and the lungs. PET is able to assist in diagnosis of Alzheimer's disease, brain tumors, cardiac disease, and, most recently, the physiological changes in psychiatric diseases. It is one of the most innovative techniques currently used. Unfortunately, it is a very expensive procedure that requires sophisticated technology such as a cyclotron, a specialized chemical laboratory, computerized equipment, and a team of scientists and health care specialists to carry out the diagnostic procedures. PET is currently available only at university medical centers, but it is expected to become a widely used diagnostic imaging technique in the future.

The patient inhales or is injected with a radioisotope of an element that occurs naturally in the body such as oxygen, nitrogen, carbon, and fluorine. These isotopes emit subatomic particles called *positrons* (positively charged electrons). When a positron encounters an electron, which it does just after emission, both are destroyed and two gamma rays are released (Smeltzer and Bare, 1996). These rays are recorded on a computer to be reconstructed as an image on a cathode ray screen.

PATIENT CARE

The patient or his caregiver must have a clear explanation of the procedure. They must understand that there will be radiation exposure that is minimal and that the patient will receive the radioactive material either by injection or inhalation depending on the organ to be studied. The examination will take from 60 to 90 minutes to complete. An informed consent form is required by most institutions.

There is usually no food or fluid restriction prior to the examination; however, there should be no caffeine, nicotine, or alcohol used for 24 hours. The patient should also receive no sedative or tranquilizing drugs. All of these interfere with the examination. Diabetic patients may receive insulin

3 to 4 hours before the procedure. Patients who are pregnant or breast feeding may be restricted from this examination. Immediately before the examination, the patient must be instructed to empty his bladder.

The patient receiving a brain scan must understand that he may be asked to perform an activity such as a recitation of a simple proverb or the pledge to the flag. This is so that brain activity during recall or cognitive processes can be assessed. He may also be blindfolded and wear earplugs to screen out external stimuli.

Following the examination, the patient must be instructed to change positions slowly and assisted to rise or leave the examining table, because he may experience some dizziness due to orthostatic hypotension. He must be instructed to increase fluid intake for 24 hours and to urinate frequently to eliminate the isotope from his body.

The patient receiving PET is often elderly and may have symptoms of dementia. If this is the case, the radiographer must recognize that the patient is unable to follow directions and may need to be closely guided through every aspect of the procedure. The strangeness of the environment may be frightening to a person with symptoms of dementia. Because excessive anxiety may affect the results of the examination, a family member or a familiar caretaker may need to remain with the patient to decrease his anxiety.

Radionuclide Imaging

Radionuclide imaging is frequently the diagnostic imaging technique of choice to visualize pathological conditions of the kidneys, heart, bones, thyroid, and other body organs. It is relatively noninvasive and is an alternative diagnostic test for persons with hypersensitivity to iodinated contrast agents.

The person who is to receive a radioisotope must sign a special consent form, just as for all special diagnostic procedures. The patient must be informed that he will receive a small amount of radioisotope and that he will be exposed to a minimal amount of radiation. Depending upon the test being done, the patient will receive an intravenous injection of an isotope. The isotope used depends on the organ being examined. Those with a short half-life often are preferred by the physician. The injection of the isotope usually precedes the examination by a period of time that may be from 1 to 3 hours. This allows the contrast agent to migrate to the area that is to be studied.

The patient is then taken to the nuclear medicine department for either dynamic or static scans depending upon his clinical symptoms. The patient is placed on an examining table and expected to lie quietly while the test is in progress. This can be a problem for the elderly patient or for a person who is in pain.

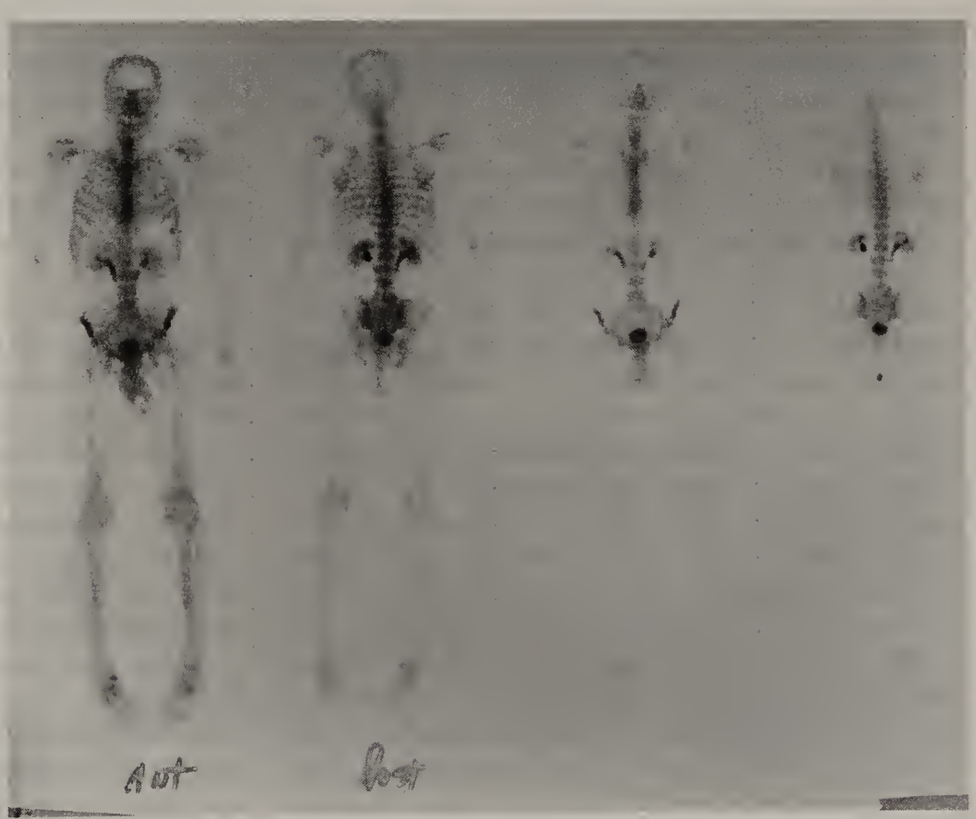


Figure 13–12
Normal bone scan.

The patient should be informed that he will feel flushed for a short time after receiving the isotope. He must also be informed that it will be excreted within 24 hours and there will be no residual radiation effects. The patient may need to abstain from eating or drinking for several hours prior to the examination. There are some dietary restrictions prior to thyroid imaging.

Patients who are pregnant or who are taking antihypertensive medication must be screened and receive special treatment. Only one radionuclide examination should be scheduled on one day as one may interfere with the other.

The isotope accumulates in areas of pathology that are called "hot spots." In bone scans, an area of decreased uptake of the radionuclide may indicate circulatory impairment and is called a "cold spot" (Fig. 13–12). In renal examinations, if the total concentration of the radionuclide is less than normal, a diagnosis of diffuse or generalized renal disorder must be considered.

Following radionuclide imaging, the patient is instructed to resume his usual dietary and medication pattern unless contraindicated by his physician. He should also be informed that the radionuclide will be excreted within 24 hours and that the only precaution to be taken is to flush the commode immediately after use.

External Radiation Therapy

At least one half of the patients with a diagnosis of cancer will receive external radiation therapy during the course of the disease. This form of treatment is used to cure the disease, to control malignant tumors that cannot be removed, to prevent spread of the tumor to the brain and spinal cord, and to decrease pain when the cancer metastasizes to the bones, brain, or soft tissues. Radiographers who work in the area of radiation therapy should receive specialized education; however, the radiography student may rotate to this area in the course of his education and must have some understanding of patient care in radiation therapy.

The intent of therapeutic radiation is not to kill all tumor cells immediately. All cells will react differently, and some may repair the radiation-induced damage and begin to reproduce again. For this reason, radiation for treatment of cancer is administered in a series of divided doses for an established period of time. In this manner, tumor cells that survive initial radiation will eventually be destroyed. The size, location, and degree of sensitivity of the tumor to radiation are the deciding factors when the plan of therapy is devised. The sensitivity of the cells surrounding the tumor is also a factor in the plan.

When external radiation therapy is prescribed by the patient's physician, the patient is sent to the radiation treatment area for preparation known as treatment simulation. During this simulation, the patient is evaluated, and treatment is mimicked with machines that determine the exact treatment field, the volume of tissue to be radiated, and the radiation dosage necessary to accomplish the treatment purpose. When these decisions have been made, the patient's external skin is marked with indelible pen so that the same area of tissue receives the radiation therapy with each treatment. A plan of treatment is outlined for the patient, which usually extends daily for several weeks. The patient is instructed to refrain from removing or altering the markings. If they are accidentally removed, patients are asked not to redraw them, but to notify the radiation team so that they can reconstruct them according to plan.

At the time that the treatment plan is made, the patient should be shown the treatment room and be allowed to ask any questions concerning the treatment. The treatment rooms are large and impersonal, and the patient must remain alone during the radiation treatment. He should be informed that he can communicate by microphone with the radiation team and they with him. He should also be informed that the treatment table is somewhat uncomfortable and hard. If the patient is in pain, it should be suggested that he receive pain medication 30 minutes before each treatment so that he will be more comfortable. The radiographer must also explain to the patient that the radiation treatments themselves are painless and that there is no danger of the patient carrying radiation with him out of the treatment area.

PATIENT CARE

The radiographer caring for patients receiving radiation therapy must be aware that these patients are in various stages of the grieving process. They have received a diagnosis of a disease from which they may or may not recover. Some will have hope of recovery and perhaps be in a phase of denial of the seriousness of their problem. Patients who are in this phase must never be confronted with their denial, since this may be their only means of coping with the problem. Others will be in the later stages of the grieving process. Many have had radical surgical procedures that have altered their body image. This is particularly the case for a man or woman who has had reproductive or-

gans or external genitalia altered by the surgery during the reproductive years.

Some patients receiving external radiation therapy are in the terminal stages of cancer and have metastasis of the disease to their bones. When this occurs, the structure of the bone weakens and becomes very fragile. There is a high incidence of pathological fractures with this condition. The radiographer caring for the person in the terminal stages of cancer must remember this and must allow the patient to move at his own pace with as much assistance as necessary. The radiographer must be extremely cautious when lifting or moving cancer patients. Be certain to have adequate assistance to prevent abrupt, jarring, or pushing movements because this may cause fractures and a great deal of unnecessary pain for the patient. Allow the patient to direct all moves at his own pace.

Patients with cancer often have weakened immune systems. This must be taken into consideration because these patients are highly susceptible to infections. Radiographers must practice judicious medical asepsis and, when the occasion calls for it, meticulous surgical asepsis during patient care.

The radiographer must also remember that the patient undergoing a course of radiation therapy has localized toxic reactions to the treatment. This toxicity usually affects only the tissues surrounding the area being radiated, as the cells in the treatment area are destroyed by radiation. However, generalized systemic reactions may also occur. Some of the local reactions that may occur, depending on the irradiation site, are alopecia (loss of hair); erythema (redness and inflammation of the skin or mucous membranes); loss of appetite; alterations in oral mucous membranes (xerostomia and stomatitis); decreased salivation; difficulty swallowing; chest pain and cough; esophageal irritation; nausea and vomiting; diarrhea; and blood dyscrasias.

Generalized systemic side effects include fatigue, nausea, vomiting, and headache. The patient may be reassured that all these effects will subside when the treatments are completed. Some changes in the area of the radiation treatment are produced, called fibrous tissue formation (scar tissue). This is due to the destruction of the blood supply in the area of radiation, and that tissue will not regenerate.

Use of therapeutic communication techniques by radiographers caring for patients having external radiation therapy is of utmost importance. The radiographer should make himself available to answer questions that he can answer and assist patients to find answers when he does not know. Patients should be allowed to express their concerns and explore their feelings with the use of simple reflective statements.

Proton Therapy

Proton therapy is a recent innovation in the treatment of patients with cancer. Since this procedure requires CT scans and frequent radiographic films, the radiographer is directly involved in this therapy.

The benefit of proton therapy for treatment of malignant tumors is based on the fact that the proton works at the end of its desired pathway with very little effect on tissues that surround the area. In other words, the scatter-effect that is such a problem in external radiation therapy is markedly decreased. This allows the dose to the tumor to be increased with no harmful effect to surrounding tissues. This treatment is currently being used in only a few isolated medical centers, but it is expected to become the treatment of choice for prostate, head and neck, and spinal cord tumors. Protocols for use of proton therapy are being added at this time for use in the treatment of tumors of the cervix, lungs, urinary bladder, and esophagus, and for melanomas. It is also used as a palliative measure in metastatic disease.

PATIENT PREPARATION

The patient preparation for proton therapy is preceded by a diagnostic work-up that includes a CT scan to determine the area of treatment. Following this, a "pod," or shell, is made to fit the contour of the patient's body. The pod is made by placing a patient in a semicircle of warm-malleable foam that quickly solidifies to his body contour. If the head and neck are the areas of treatment, a form-fitted mask of the same material is made to fit the treatment area. A beam-shaping device is created for each patient, dependent upon the treatment area.

Meticulous preparation is made at each treatment time, including redetermining the patient's area of pathology, because the proton beam must be directly aligned with the treatment area. This is done by a radiographic film taken as the patient lies in the pod made for him.

The patient must be instructed to lie perfectly still during treatment because any movements will change the direction of the proton beam. If this occurs, the treatment must be stopped and the alignment process repeated.

No metal can be worn by the patient in the treatment room. The patient must be informed that he will be alone in the room, but that the therapist will be in contact with him by microphone just outside. If claustrophobia or pain is a problem for the patient, a mild antianxiety or analgesic drug may be prescribed 20 to 30 minutes prior to treatment. Each treatment is approximately 15 minutes in length.

The radiographer caring for patients having proton therapy must understand that these patients, like patients receiving external radiation therapy, are in a stage of the grieving process because they have had a diagnosis of life-threatening illness. Their care will require extra sensitivity from the health care team, as described in the previous section.

Contrast Agents

The radiographer who participates in special imaging procedures must learn the protocols for each procedure. He must also be certain that a health history and a drug history are taken for each patient to be examined. If a contrast agent is to be administered, a history of allergic reactions, as described earlier, must be taken. It is the radiographer's responsibility to learn the intended action, the side effects, and potential adverse reactions of any drug that he administers. Table 13–1 lists some of the contrast agents and the radiographic imaging examinations for which they may be used. The agents listed were randomly selected and do not indicate author preference or recommendation.

TABLE 13–1
Contrast Agents

Examination	Agent	Route of Administration
Cholecystography	Iopanic acid Ipodate sodium Ipodate calcium granules	Oral
Cholangiography	Ipodate calcium Ipodate sodium	Oral
Gastrointestinal	Diatrizoate meglumine Barium sulfate	Oral Oral and rectal
Urography	Diatrizoate meglumine (30%, 60%, 76%)	Parenteral or by Urographic infusion
Pyelography	Diatrizoate meglumine (20%)	Instillation
Cystourethography	Iothalamate meglumine (60%) Iothalamate sodium (26%)	Injection
Arthrography	Diatrizoate meglumine (60%)	Injection
Cerebral Angiography	Diatrizoate sodium	Injection
Myelography	Metrizamide Iopamidol	Intrathecal
Angiography	Diatrizoate sodium (60%) Diatrizoate sodium (50%) Iopamidol (61%)	Injection
Angiocardiography	Iothalamate sodium (52%) Diatrizoate meglumine (60%)	Injection
Hysterosalpingography	Diatrizoate meglumine	Local injection: do not inject intravascularly or intrathecally
Lymphangiography	Ethiodized oil	Local injection: do not inject intravascularly or intrathecally
Venography	Metrizamide Ioxaglate meglumine	Injection
Computer tomography	Diatrizoate meglumine (30%) Iothalamate meglumine (60%)	Injection

Summary

A radiographer working in a special procedures area of radiographic imaging is a member of a highly skilled technical team. As a member of this team, he must work with other team members to ensure positive patient outcomes from examinations and treatments. A successful outcome includes adequate patient preparation for the procedure and physical and emotional safety as it evolves.

The radiographer is not responsible for reading ECGs; however, he must be able to recognize a normal ECG pattern and an ominous pattern if he works in an area in which the patient is monitored during the radiographic procedure. An electrocardiograph measures electrical activity of the heart in order to detect patterns of cardiac impulses. These impulses are displayed on an oscilloscope or on a graph for observation and analysis. The components of cardiac rhythm are the P wave, the QRS complex, the T wave, the ST segment, and the PR and QT intervals. When the P, QRS, and T waves are all present in a normal rate and rhythm sequence, it is referred to as *normal sinus rhythm.*

Special procedures and radiographic imaging techniques in which radiographers participate involve specialized education. When working in these areas of patient care, the radiographer must be aware of the increased anxiety experienced by a patient who is about to undergo a complex procedure. The radiographer must not only be a highly skilled technologist but also have excellent therapeutic communication skills so that he is able to alleviate the patient's anxiety and fears.

Patients being examined by angiography, lymphangiography, CT, mammography, lithotripsy, radionuclide imaging, ultrasound, or PET require special preparation and teaching. The radiographer working in these areas of specialization must not neglect these aspects of patient care, as they are an important part of his professional practice.

One half of the patients who are diagnosed as having cancer receive external radiation therapy for treatment or control of symptoms. The radiographer who chooses this area of specialization must understand that patients receiving this treatment are in varying stages of the grieving process and will need extra time for communication. He must also realize that the cancer patient has an increased awareness of his body functions and will focus on physical symptoms that he would ignore at other times. The radiographer should make himself available to discuss these problems with the patient whenever the patient desires. If he omits time for communication when caring for the patient receiving external radiation therapy, he is neglecting a vital professional obligation.

Patients receiving proton therapy have also been informed that they have a life-threatening disease. They will need the same thoughtful care as those receiving external radiation therapy.

The radiographer working in a special procedure area must recognize his responsibility in drug administration. He must learn the protocols for each procedure and understand potential problems so that he is prepared to take the correct action should problems occur.

Chapter 13, Pre–Post Test

1. List the components of a normal ECG pattern.
2. Discuss patient care that the radiographer is responsible for prior to and following cardiac catheterization.
3. List two major subjects the radiographer should cover when instructing the patient after an angiogram.
4. List three patient instructions necessary prior to a myelogram.
5. Describe the positions into which the patient can be placed for intrathecal drug administration.
6. Describe extra patient care for patients having lymphangiography
7. Explain the problems of a person with dementia who is having a PET examination.
8. Patients having mammograms most frequently complain of _____.

9. List aspects of patient care and education that the radiographer must include when a patient is receiving MRI.
10. Explain the generalized systemic reactions that may occur when a patient is receiving external radiation therapy.
11. Describe the special-care considerations of a patient receiving external radiation therapy or proton therapy.
12. Define lithotripsy and explain the medical indications for this treatment.
13. Describe the teaching needs for the patient who has completed a radionuclide examination.
14. Define positron emission tomography and list the patient's educational needs prior to receiving this examination.

○ *Laboratory Reinforcement*

1. In the school laboratory, select a fellow student and role play a patient-teaching situation. Instruct a patient before and after CT that involves a scan of the upper and lower gastrointestinal tract.
2. In the school laboratory, prepare the special procedures room for a myelogram.



Critical Thinking Problem

Mrs. Mary Misfeed is an 80-year-old Caucasian female who has come to the radiographic imaging department for a lumbar myelogram. She has come alone on the bus and plans to return home following the examination. Discuss the problems, potential problems, and teaching needs of this patient.

14

Patient Care During Urologic Procedures

Preparation for Catheterization
Female Catheterization
Male Catheterization
Removing an Indwelling Catheter
Catheter Care in the Radiographic Imaging Department
Cystography
Patient Education Prior to Cystography
Care During Cystography
Patient Care Following Cystography
Retrograde Pyelography
Patient Education and Preparation
The Procedure
Ureteral Stents
Alternative Methods of Urinary Drainage
Summary
Pre–Post Test
Laboratory Reinforcement
Critical Thinking Problems

Expected Outcomes

On completion of this chapter, the student will be able to accomplish the following:

1. Explain the need for infection control when working with patients who have urologic diagnoses.
2. Demonstrate the correct method of inserting a straight and a retention catheter into the urinary bladder.
3. Explain the correct method of transporting a patient who has a retention catheter in place.
4. Demonstrate the correct method of removing a retention catheter from the urinary bladder.
5. Describe the patient care precautions the radiographer must take when a patient is receiving cystography, a retrograde pyelogram, or placement of a ureteral stent.
6. Define the term *autonomic dysreflexia* and explain the actions the radiographer must take if symptoms of this reaction are suspected.
7. Describe alternate methods of catheterization or the urinary bladder and explain the radiographer's patient care responsibilities when these catheters are in place.

Glossary

Cerebral hemorrhage: a profuse amount of blood flowing into the cerebral spaces in the brain from the rupture of a blood vessel, usually an artery

Cystoscope: an instrument used for examining the urinary bladder and the ureters that is equipped with a light, a viewing obturator, and a lumen for passing catheters or other items as needed

Glans: a gland on the head of the penis containing the urethral orifice

Incontinence: the inability to refrain from yielding to the normal impulse to defecate or urinate

Lithotomy position: a posture where knees are flexed and thighs abducted and rotated externally

Penoscrotal junction: the area of the male penis where it meets the scrotum

Perineal: pertaining to the area between the anus and the scrotum in the male and the vulva and the anus in the female

Reflux: backward flow; usually unnatural, as when urine travels back up the ureter
Retrograde: moving in the direction that is opposite of what is normal
Sphincter: a circular band of muscle constricting an orifice that contracts to close the opening
Ureteral catheter: a firm catheter inserted into a ureter attached to a cystoscope
Urologic: pertaining to the study of the urinary tract
Void: to empty urine from the bladder

Infections of the urinary tract are the most common nosocomial infections. A frequent cause for these infections is poor infection-control practices by health care workers during placement of catheters in the urinary bladder or while providing care for patients who have indwelling catheters in place. The radiographer will frequently work with patients who have urinary catheters in place. In some institutions, he will be responsible for insertion of a catheter into the urinary bladder prior to radiographic imaging procedures. He must learn to care for patients with catheters in place and may need to learn the catheterization procedure as it is described in this chapter.

Catheterization of the urinary bladder refers to the insertion of a plastic, silicone, or rubber tube through the urethral meatus into the urinary bladder. Catheters are inserted into the urinary bladder for a number of reasons. They may be meant to keep the bladder empty while the surrounding tissues heal following surgical procedures; to drain, irrigate, or instill medication into the bladder; to assist the incontinent patient to control urinary flow; to begin bladder retraining; or to diagnose disease, malformation, or injury of the bladder.

Cystography, retrograde pyelography, and placement of ureteral stents all involve radiographic imaging. These procedures are performed frequently in the special procedures area of the radiographic imaging department or in the cystoscopy laboratory. As part of the health care team, the radiographer actively participates in these diagnostic examinations and treatments because fluoroscopy and radiographs are required while they are in progress.

Preparation for Catheterization

The urinary bladder is easily infected, so any object or solution that is inserted into it must be sterile. Poor technique when performing catheterization of the urinary bladder or when caring for a patient who has an indwelling catheter in place may result in infection or injury.

Catheterization is not performed without a specific order from the physician in charge of the patient, and the radiographer must not perform the procedure by himself until he has been adequately supervised and is certain that he understands the technique required. It is less stressful for some patients if male nurses or technologists catheterize male patients, and female nurses or technologists catheterize female patients.

When the radiographer has been requested to catheterize a patient by a physician, he must establish whether an indwelling or straight catheter is to be used. An indwelling catheter is inserted and left in place to allow for continuous drainage of urine. A straight catheter is used to empty the bladder and is then removed. Most hospitals provide prepared sterile trays for catheterization with the desired type and size of catheter and the necessary equipment included. A set is chosen depending on the type of catheter to be inserted.

The equipment needed to perform a catheterization is as follows:

A straight or indwelling catheter (#14 or #16 for an adult female; #16 to #20 for an adult male)

Antiseptic solution

Cotton balls for cleansing

Water-soluble lubricant

A specimen bottle

A receptacle for draining urine for a straight catheterization

A closed-system drainage set for an indwelling catheterization

Sterile gloves

Sterile drapes

Sterile forceps

The antiseptic solution most frequently used for cleansing the penis or the female perineum prior to catheterization is a providone-iodine solution. The patient must be assessed for allergic response to iodine before this solution is used for cleansing purposes. A drape sheet and an extra means of

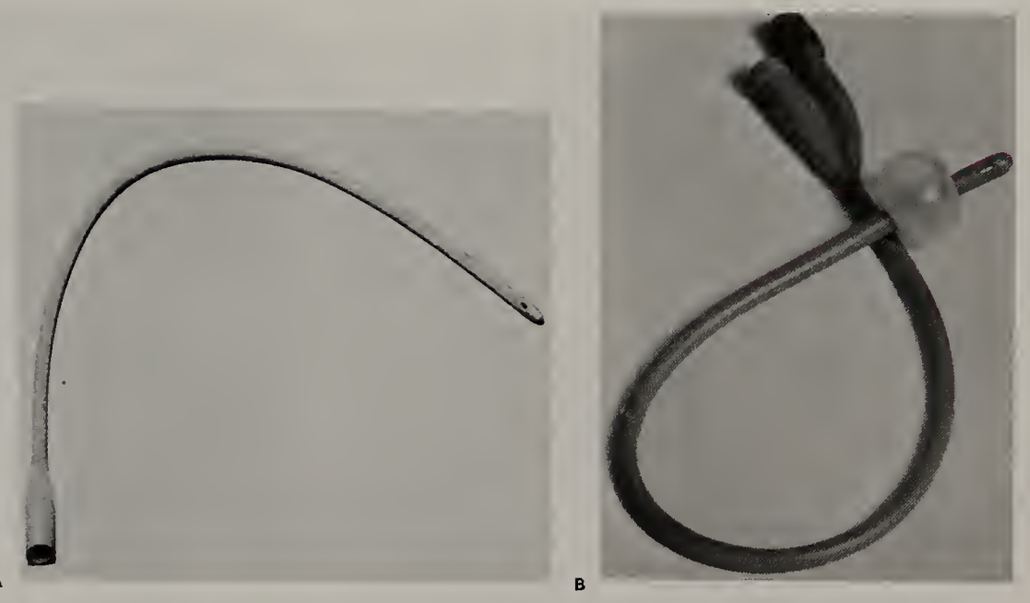


Figure 14–1
(**A**) A plain French-tipped, or straight, catheter. (**B**) A Foley catheter with the balloon inflated.

casting light on the perineal area are also needed. Do not attempt to catheterize a female patient unless adequate lighting is provided. Catheter sizes and tips vary and are graded according to lumen size, usually on the French scale. The size of the catheter is listed on the prepared catheterization set (Fig. 14–1).

A straight catheter is a single-lumen tube. Retention catheters have a double lumen with an inflatable balloon at one end. One lumen allows for continuous urinary drainage, and the other is a passageway for instilling sterile water into the balloon. The balloon holds the catheter in place after it is inserted into the bladder. The indwelling catheter also has a valve at one end that serves as a portal for the instillation of sterile water (see Fig. 14–1*B*). The radiographer may occasionally see a third type of catheter that has three lumens. The third lumen provides a passage for irrigation solution and is used for patients in need of continuous bladder irrigation.

Female Catheterization

When the radiographer receives an order from the patient's physician to perform a catheterization, he must determine the type of catheter to be inserted. He then assembles the equipment necessary, washes his hands as described for 2 minutes, and approaches the patient, identifies her, and explains what is to be done. Patients are often embarrassed and apprehensive about this procedure, so a good explanation and reassurance that there will be little, if any, pain are vital to the success of the procedure. Inform the patient that there will be a slight sensation of pressure when the catheter is inserted. Provide privacy for her by using a screen or by closing the door to the procedure room. Assess the patient's ability to maintain a position that allows for adequate exposure of the perineum. Assess the perineal area for soiling at this time. If the perineum is soiled, obtain wash cloths, soap, warm water, and clean disposable gloves and cleanse the area before beginning the procedure. Then proceed with the steps for catheterization.

1. Position the patient on her back; have her flex her knees and relax her thighs so as to externally rotate them. This is called the *dorsal recumbent* position.
2. Drape the patient with a sheet so that only the perineum is exposed. If she is disabled and cannot maintain this position, be prepared to assist her in order to maintain adequate exposure.
3. Adjust the light so that it shines directly on the perineal area (Fig. 14–2*A*). It is difficult to locate the urinary meatus in many women unless adequate lighting is available.
4. Open the sterile pack, which may be conveniently placed between the patient's legs if she is cooperative and will not contaminate the sterile field. If this is not the case, the tray must be opened on a Mayo stand at the side of the table. You may use the outer plastic covering of the pack as a waste receptacle or provide an impermeable waste bag. Place it in a convenient spot away from

the sterile field and in a place where your hand will not cross the sterile field as you place soiled items into the bag.

5. Put on the sterile gloves. The gloves are usually the uppermost item in the sterile pack and will be cuffed for donning by use of the open-gloving technique for sterile gloving.

6. Pick up the first sterile drape. Cover your hands with the drape to protect your gloves from contamination. Place the drape slightly under the patient's hips extending to the front of the buttocks to cover the table (see Fig. 14–2*B*).

7. Place the second drape, which is a fenestrated drape allowing for only perineal exposure. This drape is frequently omitted.

8. Open the container of sterile, water-soluble lubricant and lubricate the catheter tip (about ½ inch [1.2 cm] for the female patient) (see Fig. 14–2*C*).

9. Open the antiseptic solution and pour it over all except two of the cotton balls. An iodophor solution is usually included in the sterile catheterization sets. Keep one or two cotton balls dry to wipe away the excess antiseptic.

10. If the catheterization being done is an indwelling type, the syringe containing sterile water will be attached to the inflation valve at this time. The balloon may be tested by pushing the plunger down and instilling 2 or 3 mL of solution to be certain that the balloon will not leak. After this has been determined, withdraw the water, and leave the syringe tip connected to the valve to be used later.

11. Inform the patient that you will be cleansing her perineum with a solution that may feel slightly cold.

12. With the nondominant hand, separate the labia minora until the urethral meatus is clearly visible. This glove is now contaminated and will be maintained in this position to maintain exposure until the procedure is complete.

13. Pick up the forceps and then pick up one cotton ball that is saturated with antiseptic solution with the forceps.

14. Cleanse the distal side of the meatus with a single downward stroke and then drop the contaminated cotton ball into the waste receptacle prepared earlier (see Fig. 14–2*D*).

15. Pick up another cotton ball saturated with antiseptic solution and wipe down the proximal side and discard. Then take a third cotton ball and wipe down the center directly over the meatus and discard.

16. Inform the patient that you will be inserting



Figure 14–2
Female catheterization. (**A**) A light must focus on the perineal area. (**B**) A drape is placed under the patient's hips. (**C**) Lubricate the tip of the catheter. (**D**) Cleanse the meatus with single downward strokes. (**E**) Insert the lubricated catheter into the urethral meatus. (**F**) instill the water in the syringe into the balloon if the catheter is to be of the indwelling type.



C



D



E



F

Figure 14–2 ***(Continued)***

the catheter and ask her to take a deep breath as you insert the catheter.

17. Keep the contaminated, nondominant hand in place, and with the dominant hand, which is sterile, pick up the lubricated catheter and insert it into the urethra (see Fig. 14–2*E*). The catheter will usually pass unobstructed into the bladder. If there is any resistance, do not continue the procedure. The female urethra is 1½ to 2 inches (3.7 cm to 5 cm) in length. When urine begins to flow from the catheter, the catheter has passed through the sphincter and into the bladder. When this occurs, insert the catheter about 1 inch more, then remove your hand from the perineum, continuing to hold the catheter in place until the bladder is emptied.

18. If a straight catheter is being used, have the drainage basin in place so that it will catch the urine. Allow it to drain without interference unless a urine specimen is to be obtained. If this is the case, after the initial flow of urine, place the end of the catheter into the opening of the specimen bottle and collect a specimen of about 30 mL of urine. Then close the lid of the container and allow the remaining urine to drain into the collecting basin.

19. If an indwelling catheter is being used, a drainage tube may be attached at the distal end of the catheter, and the urine will flow into the tubing and on into the drainage bag that is attached. Insert the catheter 1 inch more (2.5 cm), and then you may remove your hand from the perineum.

20. If the catheter is to be indwelling, pick up the syringe, which you have already attached to the valve, and push in the plunger until all of the water in the syringe has been injected into the balloon. It is most often filled with 5 mL to 10 mL of sterile water (see Fig. 14–2*F*). Then immediately remove the syringe from the valve. Most indwelling catheter valves are self-sealing, so when the syringe is removed, the procedure is complete.

21. Gently tug on the catheter to be certain that it will be retained. If there is resistance, the balloon is properly inflated.

22. Remove the soiled equipment and make the patient comfortable. Remove your gloves and wash your hands.

23. If the catheter is to remain in place for some time, it should be taped to the inner thigh in order to prevent it from becoming dislodged. Make certain that there is no tension placed on the catheter as it is taped. Arrangements for urinary drainage must be made, depending on the procedure that is to follow.

Male Catheterization

The equipment needed for catheterizing males is the same as for cathetèrizing females, though a slightly larger catheter is usually required (#16 to #20). The patient is placed in a supine position with his legs slightly abducted. His torso is covered to the pubis, and his legs are covered to the pubis so that exposure is minimal. Make certain that the patient's pubic area is clean. If he is not circumcised, withdraw the foreskin of the penis and clean the urethral meatus. Wear clean, disposable gloves to do this, and remove them upon completion. Have good lighting available. Then begin the procedure by washing your hands as for surgical asepsis.

1. Open the sterile pack on a Mayo stand beside the patient or on the patient's thighs if he can be depended upon not to contaminate the sterile field. Pick up the catheter and lubricate it heavily from the tip down about 5 to 7 inches (12.5 cm to 17.5 cm), as more lubricant is required to facilitate passage of the catheter for males than for females.

2. Prepare the pack as in steps 4 through 10 for female catheterization. Place the first sterile drape over the thigh up to the scrotum and the fenestrated drape over the pubic area, leaving the penis exposed.

3. Inform the patient that you will be cleansing him with an antiseptic solution, then grasp the penis firmly at the shaft with the nondominant hand, retract the foreskin, and keep it retracted until the procedure is complete. Slightly spread the urinary meatus between the thumb and forefinger. If the penis is not firmly held, an erection may be stimulated. This hand is now contaminated and continues to hold the penis in position until the procedure is complete.

4. Pick up the forceps, and with it, a cotton ball saturated with antiseptic solution. Cleanse from the urethral meatus to the glans using a circular motion. Then drop the cotton ball into the waste receptacle.

5. Repeat this procedure two more times.
6. Inform the patient that you are going to insert the catheter. Pick up the lubricated catheter with the remaining sterile hand. Ask the patient to bear down as if he were trying to urinate, because this action will relax the sphincter.
7. Using gentle, constant pressure, insert the catheter (Fig. 14–3). Too much force may cause a spasm of the sphincter and delay insertion. Do not try to proceed if there is an obstruction; withdraw the catheter and notify the physician.
8. When the urine begins to flow, you will know that the catheter is in the bladder; insert the catheter slightly further (another ½ inch or 1.2 cm). The adult male urethra is 5½ inches to 7 inches in length (13.75 to 17.5 cm).
9. Depending on the type of catheter used for the procedure, follow steps 16 through 20 for female catheterization listed previously. Replace the foreskin over the glans.
10. If the indwelling catheter is to be in place for some time, it should be taped to the lower abdomen using nonallergenic tape, with the penis directed toward the patient's chest. Allow slack so that there is no tension on the catheter. This position minimizes trauma to the urethra by straightening the angle of the penoscrotal junction.

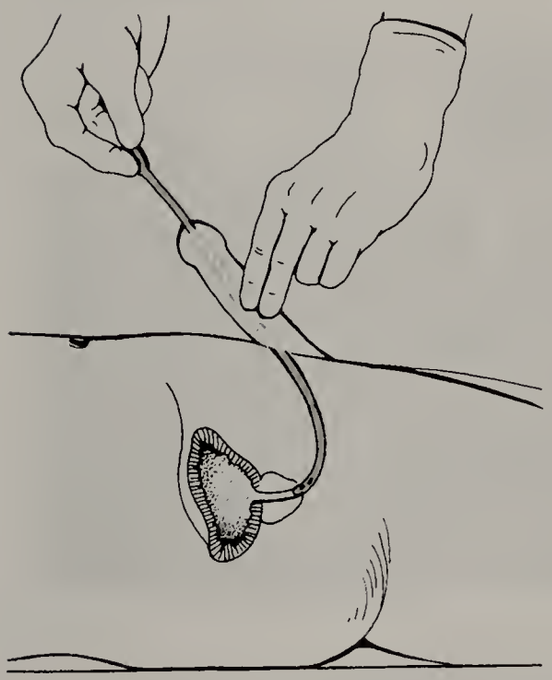


Figure 14–3
Using gentle, constant pressure, insert the catheter into the bladder.

Removing an Indwelling Catheter

A physician's order is needed before an indwelling catheter may be removed. Equipment needed will be a 10-mL syringe or a calibrated medicine glass; several thicknesses of paper toweling, a nonpermeable disposable bag, and clean disposable gloves.

When you receive an order from the physician in charge of the patient to remove an indwelling catheter, collect the equipment necessary and wash your hands. Identify the patient and explain the procedure to him. There is usually little, if any, discomfort with this procedure.

1. Uncover the patient just enough to see the insertion point of the catheter. Ask the female patient to separate her legs slightly. Remove the tape that holds the catheter in place. Put on the clean gloves, and place the paper toweling under the catheter.
2. Insert the tip of the syringe into the valve port and pull back on the plunger until all of the sterile water from the retention balloon is removed; then disconnect the plunger from the valve (Fig. 14–4).
3. When the water is completely removed from the balloon, wrap the paper toweling around the catheter and gently withdraw it from the



Figure 14–4
Remove the water from the balloon with a syringe attached to the valve port.

bladder. If there is any resistance, stop the procedure and notify the physician. The catheter should come out easily.

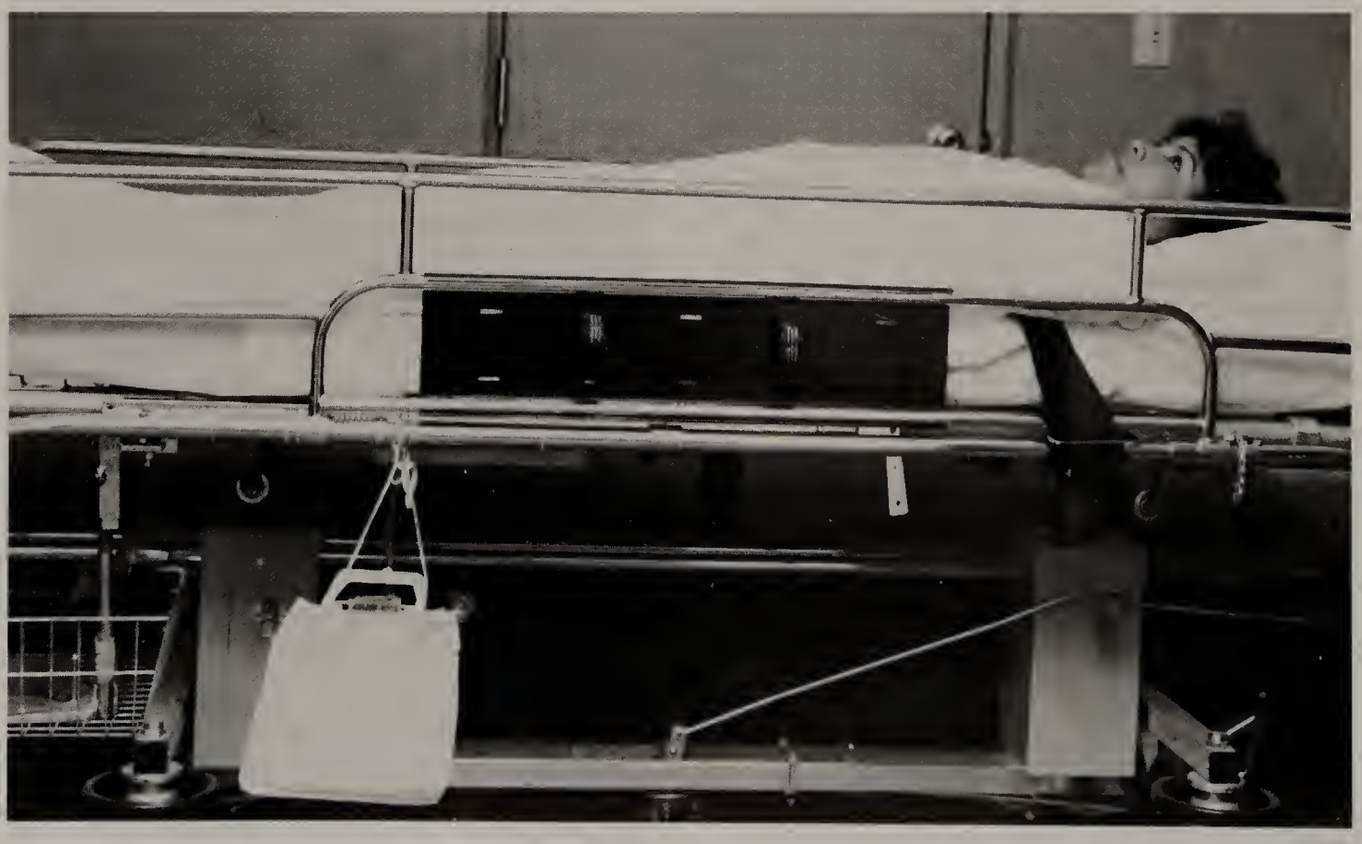
4. Wrap the catheter in the toweling and place it and the drainage set into the nonpermeable bag. Before placing the catheter in the bag, measure the urine in the collecting bag and empty it. Place the soiled equipment into the container for contaminated waste, remove your gloves, and wash your hands.
5. Return to the patient to make certain that he is comfortable.

Catheter Care in the Radiographic Imaging Department

Often patients must be transported to the diagnostic imaging department with the indwelling catheters in place. If this is the case, the radiographer must keep the drainage bag below the level of the urinary bladder so that the gravity flow is maintained (Fig. 14–5*A*). The drainage tubing must be placed over the patient's leg and coiled on the gurney or table top, not below the level of the patient's hips. If urine is allowed to flow back into the bladder, or if drainage is obstructed, a urinary tract infection may result. If the drainage bag is to be lifted above the patient during a move, the drainage tubing should be clamped and the drainage bag emptied before the move is begun in order to prevent a backflow of urine.

If the bag is to be emptied, equipment needed will be six alcohol sponges; clean disposable gloves; and a measuring receptacle. The emptying spout should be withdrawn from its housing, and wiped several times with alcohol sponges from top to bottom. The clamp that keeps the spout closed is then released, and the urine allowed to drain into the graduated receptacle (see Fig. 14–5*B*). When the drainage bag is empty, the spout is reclamped, cleaned again with alcohol wipes, and replaced in the housing.

When moving a patient with a catheter in place, care must be taken to avoid undue tension on the catheter. Pulling on the catheter can cause the patient great discomfort or injury if it becomes dislodged.



A

Figure 14–5
(**A**) The drainage bag from an indwelling catheter must be positioned below the level of the urinary bladder. (**B**) To empty the drainage bag, release the clamp that closes the spout and allow the urine to drain into a graduated flask.



B

Figure 14–5 ***(Continued)***

If the patient with an indwelling catheter is transported by wheelchair, the drainage bag should be attached to the underpart of the wheelchair. The tubing must be coiled at the level of the patient's hips. Care must be taken not to allow the tubing or drainage bag to touch the floor. Never place a drainage bag on the patient's lap or abdomen during transport, because this may cause a reflux of urine into the bladder.

Disconnecting the catheter from its closed drainage system should be avoided. Maintenance of a closed urinary drainage system is essential if infection is to be prevented. Once the closed drainage system has been invaded, it should not be reconnected. The patient must have a new catheter with new closed system drainage reinserted if catheter drainage of the bladder is to be continued.

Cystography

Cystography is radiographic imaging of the urinary bladder. Using fluoroscopy and radiography, the urinary bladder is visualized as it fills and empties in order to diagnose pathological changes in its function. The pathology may be due to tumors inside or outside the bladder, trauma, or vesicoureteral reflux (abnormal backflow of urine into the ureters).

The types of cystography examinations that may be scheduled are cystourethrography, voiding cystograms, or voiding cystourethrography. One or all of these may be scheduled for a patient.

PATIENT EDUCATION PRIOR TO CYSTOGRAPHY

The patient must be informed that he will be catheterized and an iodinated contrast agent and possibly air will be instilled into his bladder. He should be prepared to expect some discomfort and a feeling of the need to void. He must be instructed not to move unless directed to do so during the examination. The patient is usually advised to restrict his intake to liquids for several hours before the examination. The patient must be assessed for allergic reaction to drugs and iodinated contrast agents, as well as for other health problems. However, it should be noted that the incidence of anaphylactic reaction to an iodinated contrast medium is not as great in this examination, since the contrast agent is administered into the bladder, not intravenously. Pregnancy is generally a contraindication for this procedure, and patients with urinary tract infections must have a special consideration. It is usually required that an informed consent be signed.

CARE DURING CYSTOGRAPHY

When the patient arrives in the examining room, he is instructed to disrobe and put on a patient gown. He may be asked to urinate prior to the catheterization in order to assess his ability to void normally. He is then placed in a supine position and preliminary radiographs are taken. The patient is then catheterized with a retention catheter as described earlier in this chapter and as directed by the physician. In some institutions, the radiographer is expected to do this. Male patients are protected by a gonadal shield during the procedure. Female patients are not able to have this protection as the bladder would not be visualizable with such a shield in place.

All patients are draped to maintain privacy. To prevent infection, strict surgical aseptic technique must be followed as the examination is being performed.

The bladder is filled with a contrast agent (200 to 300 mL for an adult, 50 to 100 mL for a child). Air may be used to provide contrast on some occasions. Films are taken with the patient in varying positions. The bladder is drained or the patient is asked to urinate so that the radiographer can examine his ability to empty his bladder in a normal manner. The catheter is removed and more films may be taken as the patient voids and the contrast agent passes through the urethra. This is called a *voiding cystourethrogram.*

This procedure may cause a great deal of stress and embarrassment for the patient. The radiographer participating in this examination must take great care to preserve the patient's dignity and privacy while it is in progress.

PATIENT CARE FOLLOWING CYSTOGRAPHY

Following cystography, the patient is told that he may resume normal activities as his physician prescribes. He should be instructed to report any symptoms of chills, fever, excessive blood in his urine, any changes in ability to urinate, or pain on urination to his physician immediately.

He should also be instructed to increase his fluid intake for 24 hours to aid in elimination of contrast agent from his bladder. He must be informed that he will experience some burning on urination and there will be a small amount of pink-tinged urine for a few hours following the examination.

Cystourethrograms may be performed on patients who are paralyzed due to spinal cord injury or disease. These patients are susceptible to a condition called *autonomic dysreflexia*. This is a condition in which a stimulus, such as a full rectum or an overdistended bladder, creates an exaggerated response by the sympathetic nervous system. In such cases, the patient may complain of a sudden, severe headache that results from sudden, severe hypertension. Other symptoms of this condition include sweating and flushing of the face while other areas of the body may be cold and pale; tachycardia or bradycardia; and nasal stuffiness and a feeling of apprehension.

If a paralyzed patient, especially a patient with paraplegia or quadriplegia, is being cared for and complains of a sudden headache, the radiographer must take the following action:

Stop the procedure and notify the physician; prepare to call the emergency team and have the emergency cart at hand.

Place the patient in a Fowler's position.

Monitor the patient's blood pressure and apical pulse.

Remove the source of the stimulus; if the bladder is distended with contrast agent or urine, empty it immediately.

Hydralazine hydrochloride or diazoxide are administered by the physician cautiously to prevent hypotension.

Propantheline bromide may be administered.

Failure to respond to these symptoms may result in myocardial infarction or cerebral hemorrhage.

Retrograde Pyelography

Retrograde pyelography is a radiographic technique performed to visualize the ureters and the kidneys following injection of an iodinated contrast agent. This procedure is usually accomplished in a cystoscopy laboratory where the radiographer must be present to take necessary radiographic films and to provide fluoroscopic examination of the patient as ordered. This examination is done to assess the ureters for obstruction resulting from strictures, tumors, stones, scarring, or other pathological processes when other methods are contraindicated.

PATIENT EDUCATION AND PREPARATION

To ensure adequate visualization during this procedure, the patient may be instructed to have enemas to clear the bowel just before the examination is to be done. The radiographer will instruct the patient as described in Chapter 2 if this is the case. This examination may be done under a light general anesthesia or under local anesthesia. If a general anesthesia is to be given, the patient will be instructed to have no food or fluids by mouth after midnight the night before the examination. For local anesthesia, the patient may have a liquid breakfast. The patient must be informed that he may receive a mild sedative and a drug to reduce bladder spasm during the examination. An informed consent must be signed, and the patient must be screened for pregnancy and allergies to drugs and iodinated contrast media.

THE PROCEDURE

The patient may be placed in a lithotomy position. To prevent impaired circulation, care must be taken to keep pressure off the legs while the patient is in this position. The radiographer will be responsible for fluoroscopy and radiographs during this procedure, and a nurse and the physician will monitor the patient.

A contrast medium is injected into a ureteral catheter, which is passed into the ureters through a cystoscope. Films are taken to demonstrate the ureters and the structure of the renal pelvis. The catheters are withdrawn and more contrast agent is injected to visualize the ureters. This procedure usually will take an hour.

Following the procedure, the patient is instructed to notify the physician if he observes bleeding, fever, chills, or other signs of infection. If he has had a general anesthetic, he will be observed in a recovery area until his vital signs are

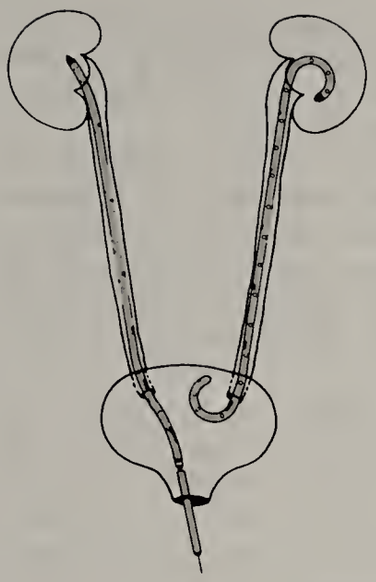


Figure 14–6
Retrograde passage of ureteral stent. The double-J ureteral stent is shaped to resist migration. The proximal J hooks into the lower calix or renal pelvis, and the distal J curves into the bladder. (Courtesy of Medical Engineering Corporation, Racine, WI.)

stable and he is awake and alert. He may resume a regular schedule as soon as his physician gives permission. Fluids should be increased for 24 hours to aid in elimination of the contrast agent.

URETERAL STENTS

If the patient has an obstructed ureter due to a stricture, edema, or an advanced malignant tumor, a stent may be inserted into the ureter on a temporary or permanent basis to relieve the problem. Stents are soft, pliable, and made of silicone, and they may be placed surgically or during a retrograde pyelogram (Fig. 14–6).

There are complications associated with the presence of any foreign body in the ureter, stents included. These are infection and obstruction from encrustation and clot formation. The radiographer will be responsible for the radiographic aspects of this procedure; however, patient care and instruction will be the responsibility of the physician and the nurse. The patient will usually receive a general anesthetic for this procedure and be allowed to recover in the recovery suite.

Alternative Methods of Urinary Drainage

There are two common methods of dealing with urinary drainage on a temporary or permanent basis. These are the suprapubic catheter (also called a cystocatheter) and the condom catheter. The radiographer must recognize both methods.

The *suprapubic catheter* is placed directly into the bladder by means of an abdominal incision. This method is sometimes chosen to divert the flow of urine from the urethral route following gynecologic surgery, urethral injuries, or prostatic obstructions, or for chronic incontinence or loss of bladder control. Suprapubic catheters are believed to reduce the risk of infection as a long-term method of bladder drainage and to facilitate normal urination following surgical procedures. The catheter is attached to a closed urinary drainage system and is secured with sutures, tape, or a body seal system (Fig. 14–7).

The radiographer caring for a patient with a suprapubic catheter must guard against placing tension on the catheter. He must also follow the same rules of asepsis as for patients with other closed-system urinary drainage. That is, the drainage bag must be kept below the patient's bladder level at all times and not lifted over the patient.

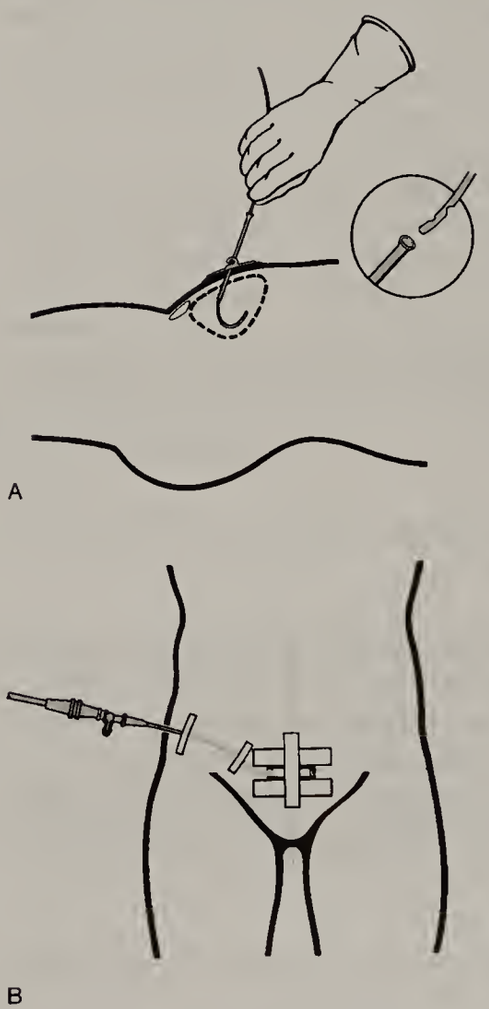


Figure 14–7
(**A**) Introduction of suprapubic catheter. (**B**) The body seal and catheter are taped to the abdomen. (Brunner L, Suddarth DM: Lippincott Manual of Nursing Practice. Philadelphia, JB Lippincott, 1986. Courtesy of Dow Corning Corp.)



Figure 14–8
A condom catheter. (Taylor C, Lillis C, LeMone P. Fundamentals of Nursing: The Art and Science of Nursing Care. Philadelphia, JB Lippincott, 1989.)

The bag must be emptied before moving the patient under the direction of the nurse in charge of the patient.

The *condom catheter* is an externally applied drainage device used for male patients who are incontinent or comatose and whose bladder continues to empty spontaneously (Fig. 14–8). The condom catheter is a soft rubber sheath that is placed over the penis and secured with a special type of adhesive material. The distal end of the condom has an opening that fits onto a drainage tube and terminates in a drainage bag that attaches to the patient's thigh. The drainage bag can be emptied easily when necessary.

The condom catheter is changed every 24 to 48 hours and has the advantage of reducing urinary tract infections in men who are unable to urinate normally. The radiographer caring for patients who have condom catheters in place must guard against dislodging the catheter from the drainage tube or twisting the condom and causing pain or skin irritation.

Summary

It is the responsibility of all health care workers to practice infection control when inserting catheters into the urinary bladder and caring for patients with catheters in place. The radiographer will work with patients who have catheters in place and, on some occasions, will be responsible for performing the catheterization procedure. He must be able to maintain surgical aseptic technique when performing this procedure, and he must learn appropriate catheter care when the patient has a retention catheter.

Catheterization of the urinary bladder is the process of inserting a plastic, rubber, or silicone tube through the urethral meatus into the urinary bladder. There are two types of catheters: the straight catheter and the indwelling catheter. Catheter insertion and removal require a physicians's order.

The same type of equipment is required for catheterization of both males and females, although the procedure varies slightly because of anatomic differences. (A larger catheter is required for the adult male.) Prior to a catheterization procedure, the patient must be given adequate explanation, reassurance, and privacy to reduce embarrassment and anxiety.

Correct care of the indwelling catheter while the patient is being transported to the diagnostic imaging department or cared for there is necessary for the prevention of urinary tract infection or injury. The radiographer must be certain that the drainage bag remains below the level of the urinary bladder in order to ensure gravity flow of urine. Closed-system drainage of the urinary bladder should not be broken, and tension on the catheter must be avoided.

The radiographer is a member of the health care team when cystography, retrograde pyelography, and placement of ureteral stents are being performed. He must learn his obligations concerning patient teaching and care during these procedures and take all precautions to maintain infection control and patient safety while these procedures are in progress.

Caution should be used when cystourethrograms are performed if the patient is paralyzed. *Autonomic dysreflexia*, a life-threatening complication, may result from the stimulus of a full urinary bladder. The radiographer must familiarize himself with the symptoms of this problem and be prepared to respond should these symptoms occurs.

Alternative methods of urinary drainage are by suprapubic catheter and external condom catheter. Patients who have these types of urinary drainage require precautionary care to prevent urinary tract infections and injury.

Chapter 14, Pre–Post Test

_____ **1.** The most common nosocomial infections are
- **a.** Bloodborne infections
- **b.** Respiratory tract infections
- **c.** Wound infections
- **d.** Urinary tract infections

_____ **2.** The best way to prevent urinary tract infections during catheterization of the urinary bladder is
- **a.** By maintaining strict surgical aseptic technique
- **b.** By increasing the patient's fluid intake
- **c.** By requesting that the physician initiate antimicrobial therapy
- **d.** By keeping the patient isolated

_____ **3.** When performing a urethral catheterization, how will the radiographer know that the catheter is in the bladder?
- **a.** The patient will relax.
- **b.** There will be a mucoid discharge.
- **c.** Urine will start to flow.
- **d.** There is no way of knowing.

_____ **4.** When inserting a retention catheter, after the radiographer has placed the sterile drape, prepared the lubricant, and poured antiseptic solution over the cotton balls, the next step is to
- **a.** Insert the catheter
- **b.** Inflate the balloon
- **c.** Cleanse the meatus
- **d.** Put on sterile gloves

_____ **5.** When removing a retention catheter, the most important consideration is
- **a.** Deflate the balloon
- **b.** Cleanse the meatus
- **c.** Maintain privacy
- **d.** Explain the procedure to the patient

_____ **6.** When transporting a patient with a retention catheter with closed-system drainage in place, the radiographer must remember
- **a.** To keep the drainage bag below the level of the bladder
- **b.** To prevent tension on the catheter
- **c.** To keep the excess tubing coiled at the level of the patient's hips, not below
- **d.** a and b
- **e.** a, b, and c

_____ **7.** The radiographer may disconnect the catheter from the closed-system drainage before transporting the patient.
- **a.** True
- **b.** False

_____ **8.** When caring for a patient with a suprapubic catheter, the radiographer does not need to follow the same rules of asepsis as for a retention catheter.
- **a.** True
- **b.** False

_____ **9.** If a urinary drainage bag must be lifted over a patient in order to prepare for transport, the radiographer must
- **a.** Empty the drainage bag
- **b.** Disconnect the drainage bag

c. Do it quickly
d. a and b

_____ **10.** If a retention catheter is to be taped onto a male patient, it must be taped
a. To the inside of the leg
b. To the scrotum
c. To the lateral aspect of the thigh
d. To the lower abdomen

_____ **11.** During a cystogram, the radiographer must assist in maintaining
a. The patient's privacy
b. The patient's dignity
c. The patient's comfort
d. a and b
e. a, b, and c

12. List the radiographer's responsibilities prior to and during a retrograde pyelogram.

13. List the symptoms of autonomic dysreflexia and explain the radiographer's response if these symptoms should occur.

_____ **14.** Patient care instruction following a cystourethrogram will include
a. Discouraging fluid intake for 24 hours
b. Informing the patient that he will have bleeding and to disregard this
c. Informing the patient that he must increase his fluid intake for the next 24 hours
d. Instructing the patient in measuring intake and output

15. List the precautions a radiographer must take if the patient has a condom catheter.

○ *Laboratory Reinforcement*

1. Demonstrate in the school laboratory on the female or the male mannequin (depending on the student's sex; use mannequin of opposite sex) a catheterization procedure.
2. Using a mannequin, demonstrate in the school laboratory the removal of a Foley catheter.
3. Using a mannequin, demonstrate in the school laboratory the proper means of transporting a patient who has a retention catheter with closed-system drainage and who is to be transported by gurney to the diagnostic imaging department.

Critical Thinking Problems

1. John Silicone is a 24-year-old quadriplegic male who has come to the radiographic imaging department for a cystogram because he is having difficulty emptying his bladder when he voids. You are the radiographer assigned to be present for this examination. You are requested by the radiologist to prepare Mr. Silicone for the procedure including inserting a retention catheter. How will you proceed?
2. You have just completed instilling 300 mL of iodinated contrast agent into Mr. Silicone's bladder in preparation for the procedure. He begins to complain of a severe headache, and you notice that his face is flushed and he is perspiring rather profusely. How will you proceed?

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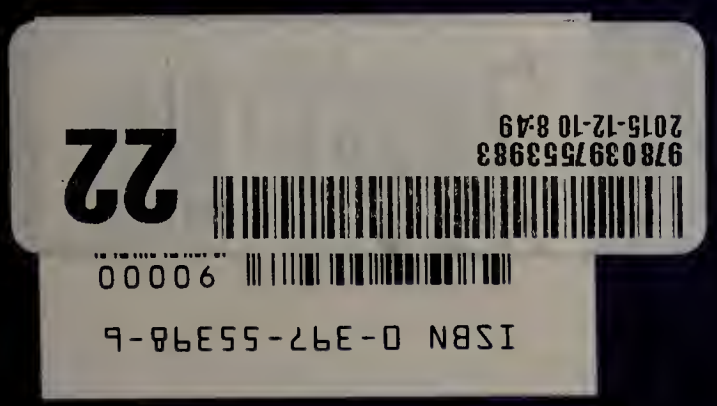
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