

Radiologist Assistant Curriculum

*Sponsored by the American Society of Radiologic Technologists, 15000 Central Ave. SE,
Albuquerque, NM 87123-3917.*

*© Copyright 2011, by the American Society of Radiologic Technologists. All rights reserved.
Request to reprint all or part of this document is prohibited without advance written permission
of the ASRT. Send reprint requests to the ASRT Education Department at the above address.*

Introduction

The goal of this curriculum is to provide the professional community with a cognitive base supporting the development of radiologist assistant education programs. A radiologist assistant is an advanced-practice radiologic technologist who works under the supervision of a radiologist to enhance patient care by assisting the radiologist in the diagnostic imaging environment. The radiologist assistant is an ARRT-certified radiographer who has successfully completed an advanced academic program encompassing a nationally recognized radiologist assistant curriculum and a radiologist-directed clinical preceptorship. Under radiologist supervision, the radiologist assistant performs patient assessment, patient management and radiology procedures. The title “radiologist assistant” reflects the nature of the relationship between the radiologist and the radiologist assistant working in an advanced clinical role. The title clearly places the radiologist assistant’s professional role and clinical responsibilities within the radiology environment as a radiologist physician extender. The curriculum is suitable for programs offered at a baccalaureate and postbaccalaureate level.

The content and objectives should be organized to meet the mission, goals and needs of each radiologist assistant program. Faculty members are encouraged to expand and broaden these fundamental objectives as they incorporate them into their curricula. Specific instructional methods for the didactic setting were intentionally omitted to allow for programmatic prerogative as well as creativity in instructional delivery.

The radiologist assistant has three primary areas of responsibility, all performed with the supervision of a radiologist.

1. Participate in patient assessment, patient management and patient education.
2. Perform radiology procedures.
3. Participate in the systematic analysis of the quality of patient care delivered within the radiology environment.

The radiologist assistant is expected to perform each function competently, and to understand how each activity fits into the entire continuum of a patient’s care. The radiologist assistant is unique because of extensive medical imaging expertise and radiation safety and dose reduction knowledge.

The curricula that arise from this document will provide a foundation of knowledge and experience supporting continued career growth of technologists, a format for advanced level education and a cultural change within the radiology community that will lead to the building of meaningful professional dependencies.

The Foundations Section located in Appendix B of the document represents content taken from the ASRT Bachelor of Science in Radiologic Sciences (B.S.R.S.) Core Curriculum.

Radiologist Assistant Curriculum

Table of Contents

| | |
|--|-----------|
| Foundations | 1 |
| Core Content | 3 |
| Patient Assessment, Management and Education | 4 |
| Pharmacology and Clinical Decision-Making in Radiology | 11 |
| Contrast Media | 18 |
| Pathophysiology | 21 |
| Radiologic Procedures | 27 |
| Modality and Image Management | 31 |
| Radiation Safety, Radiobiology and Health Physics | 45 |
| Image Correlation with Anatomy, Physiology and Pathology | 51 |
| Clinical Pathways Related to Best Practice Imaging | 59 |
| Report of Findings and Validation of Clinical Practice | 62 |
| Research and Professional Development | 65 |
| Legal, Professional Standards, Governmental Standards | 67 |
| Radiologist Mentored Clinical Experience | 75 |
| Appendix A | 76 |
| The following is supplemental information to link core instructional content to the application of knowledge and activities in clinical practice | 76 |
| Clinical Knowledge and Activities Associated with Patient Assessment, Management and Education | 77 |
| Clinical Knowledge and Activities Associated with Radiology Procedures | 79 |
| Clinical Knowledge and Activities Associated with Image and Procedure Observations and Communication | 81 |
| Implementation Strategies for Mentored Clinical Experience | 82 |
| Appendix B | 84 |
| Appendix includes content descriptions and learning objectives for items in the Foundations section | 84 |
| Advanced Patient Care | 85 |
| Advanced Sectional Anatomy | 86 |
| Communication | 87 |
| Ethics and Diversity | 88 |
| Health Care Delivery | 89 |
| Health Care Law and Compliance | 90 |
| Pathophysiology | 91 |
| Patient Information Management | 92 |
| Pharmacology | 93 |
| Quality Management | 94 |
| Research Methods and Information Literacy | 95 |
| Teamwork | 96 |
| Resources | 97 |

Foundations

Advanced Patient Care

As the role of the medical imaging professional continues to expand, more knowledge is needed in all areas. Patient care is no exception. Advanced patient care skills are essential elements of providing high-quality patient care. This course focuses on patient education, assessment, communication, preprocedural and postprocedural care and proper charting and documentation. Technologists' responsibilities and intervention in cases of critical patient need also will be discussed.

Advanced Sectional Anatomy

The ability to locate and identify structures in the axial (transverse), sagittal, coronal and orthogonal (oblique) planes is critical in all imaging modalities. Volumetric data sets and three-dimensional reconstruction of the body structures are increasingly important to the critical diagnosis and treatment of diseases. To enhance patient care and assist physicians with the prognosis, radiologic science professionals must understand cross-sectional anatomy in each of the imaging modalities.

Communication

Communication is important because the radiologic technologist needs to effectively relate and communicate with patients and other health care professionals. This content focuses on expanding the knowledge base and skills necessary for interpersonal, internal, external and written communications. Sensitivity to human diversity will be emphasized.

Ethics and Diversity

Ethics and diversity are important because all health care providers work in a global community that is increasingly diverse and complex. Health care providers must interact with individuals from a variety of backgrounds both ethically and with respect for their beliefs and values. This content focuses on ethical and diverse issues that affect the radiologic technologist's interactions with patients, co-workers, and the community.

Health Care Delivery

It is important for the radiologic technologist to understand the various methods of health care delivery to remain knowledgeable in the changing face of technology. The political context of health care organization and delivery, with specific focus on the mechanisms for policy formulation and implementation will be discussed.

Health Care Law and Compliance

Health care law and compliance is important because of its financial and emotional impact on technologists, patients and health care facilities. This content is geared toward legal and compliance issues that affect the employee and employer directly regarding accreditation and compliance issues. In addition this content gives guidance on risk management techniques, including reporting, that can help mitigate noncompliance.

Pathophysiology

A rich appreciation of the characteristics and manifestations of diseases caused by alterations or injury to the structure or function of the body are essential to the radiologic science professional. The in-depth study of pathophysiology allows the professional to communicate better with other health care professionals, including physicians and scientists, as well as with the patient, for the history and physical assessment.

Patient Information Management

Patient information management is important because of the integral role the radiologic technologist has within the health care team. It is essential for the radiologic technologist to provide all members of the team with a thorough patient record to ensure quality patient care.

Pharmacology

An exploration of pharmacology is necessary to provide the student with comprehensive knowledge concerning drugs and their applications in medical imaging. Drug regulations, types of drugs and drug administration are included. Discussions will integrate the selection of drugs with their appropriate use and possible effects.

Quality Management

Quality management is important to ensure the proper functioning of equipment and compliance with government and accreditation standards. Thus, technologists should have an understanding of the activities and their role in the quality management (QM) process. This content is designed to expand the QM skills of the technologist to include digital imaging systems and the application of QM principles in an imaging department.

Research Methods and Information Literacy

Research methods and information literacy are important because the health care profession is continually changing, which requires the radiologic technologist to possess new knowledge to function competently. The radiologic technologist should contribute to the body of knowledge and be able to effectively analyze resources to promote growth in the profession. The attitude of lifelong learning enables the radiologic technologist to stay in step with the current health care environment and be prepared to help foster the future and increase awareness of the profession in the global community. This content is geared to increase and disseminate intellectual inquiry, information literacy and the use of scholarly research methods.

Teamwork

Teamwork is a vital component of all health care teams. To promote an effective team, the radiologic technologist must be able to exercise the ability to function within an interdisciplinary team. It is highly recommended for this information to be applied throughout the curriculum to ensure adequate understanding based on various situations.

Core Content

ASRT

Patient Assessment, Management and Education

Description

Content reinforces the use of the clinical thinking model to aid in patient assessment that includes interviewing skills and assessment techniques. The focus is on the application of anatomy and physiology and pathophysiology knowledge to assist in patient assessment and management.

Prerequisite or Corequisite

It is required that radiologist assistants possess or obtain certification in advanced cardiac life support (ACLS) in support of their role in the patient care setting.

Objectives

1. Apply radiologic clinical analysis process in the patient care setting.
2. Conduct interviews to confirm and document a patient's medical history.
3. Perform a physical assessment of the patient undergoing radiologic procedures and document findings.
4. Obtain and analyze a patient's vital signs.
5. Document initial observations made during an examination and contribute to the planning and management of the patient.
6. Participate in patient education.
7. Adapt communications techniques to address patient needs.
8. Review patient medical data for indications and alterations in patient procedure.

Content

I. The Radiologic Clinical Analysis Model

- A. Identify abnormal findings
- B. Anatomically localize findings
- C. Interpret findings in terms of probable causes
- D. Develop one or two hypotheses about the nature of the patient's problem
 1. Select the most specific and central finding
 2. Match findings against conditions
 3. Weigh competing possibilities
 4. Give attention to potentially life-threatening and treatable conditions or conditions that influence the radiologic procedure
- E. Identify steps and procedures to test the hypothesis
- F. Establish a working definition of the problem

II. Interviewing and Patient History

- A. Structure and purposes of the medical history
- B. Setting the stage for the interview
- C. Learning about the patient's illness
 1. Interviewing skills
 2. Challenges
 - a. Patients at different ages, comprehension abilities and cultural backgrounds
 - b. Adaptations and alterations based on patient status
 3. Components of a comprehensive history
 - a. Preliminary data
 - 1) Date and time of history
 - 2) Identifying data
 - 3) Reliability
 - b. Chief complaint
 - c. Present illness
 - d. Past history
 - e. Current health status
 - f. Medical analysis and interpretation of data
 - g. Review of systems for indications/contraindications to procedure or change in patient management as related to the radiologic procedure
 - 1) General
 - 2) Skin
 - 3) Respiratory
 - 4) Cardiac
 - 5) Gastrointestinal (GI)

- 6) Urinary
- 7) Peripheral vascular
- 8) Musculoskeletal
- 9) Neurologic
- 10) Hematologic
- 11) Endocrine
- 12) Cognitive and mental health

III. Performing the Patient Assessment of Vital Signs

- A. Method and technique for obtaining a patient's vital signs
 1. Temperature
 2. Respiration
 3. Pulse
 4. Blood pressure
 5. Pain

IV. Assessment of the Abdomen

- A. Abdominal pain
 1. Physical assessment findings
 2. Association to disease processes (differential diagnosis)
- B. Inspection
 1. General vital signs
 2. Visual changes
 3. Palpation
 4. Symmetry
- C. Percussion
 1. Technique
 - a. Superficial
 - b. Deep
 2. Interpretation
 - a. Flat or dull
 - b. Normal
- D. Auscultation
- E. Characteristics of common signs and symptoms associated with causes of abdominal pain such as:
 1. Peptic ulcer
 2. Biliary colic and acute cholecystitis
 3. Renal colic
 4. Hematuria

V. Assessment of the Thorax and Lungs

- A. Chest pain

1. Physical assessment finding
 2. Association to disease processes (differential diagnosis)
- B. Inspection
1. General vital signs
 2. Visual changes
 3. Palpation
 4. Symmetry
- C. Percussion
1. Technique
 2. Interpretation
 - a. Flat or dull
 - b. Normal
 - c. Hyper-resonant
- D. Auscultation
1. Posterior chest
 2. Anterior chest
 3. Interpretation
 - a. Crackles
 - b. Wheezes
 - c. Rhonchi
- E. Oxygen saturation
- F. Characteristics of common signs and symptoms associated with causes of chest pain, such as
1. Angina pectoris
 2. Myocardial infarction
 3. Pneumothorax
 4. Pulmonary embolus
- G. Characteristics of common signs and symptoms associated with shortness of breath, such as:
1. Left ventricular failure and pulmonary edema
 2. Bronchial asthma
 3. Chronic obstructive airway disease
 4. Infection

VI. Assessment of the Cardiovascular System

- A. Inspection
1. General vital signs
 2. Visual changes
- B. Auscultation

- C. Characteristics of common signs and symptoms associated with cardiovascular disease processes such as
 1. Congestive heart failure
 2. Interruption
 3. Hypertension
 4. Mitral valve stenosis

VII. Assessment of the Musculoskeletal System

- A. Inspection
 1. Visual changes
 2. Symmetry
- B. Palpation
 1. Normal variants
 2. Detection of abnormalities
- C. Range of motion and function
- D. Characteristics of common signs and symptoms associated with causes of musculoskeletal pain and interruption of function, such as
 1. Arthritidis
 2. Infection
 3. Fracture
 4. Tumor
- E. Sensory-motor function

VIII. Assessment of the Peripheral Vascular System

- A. Inspection and palpation
 1. Arms
 2. Legs
 3. Pulses
- B. Arterial pulses
 1. Rate and rhythm
 2. Amplitude and contour
 3. Auscultation of bruits and thrills
 4. Blood pressure
 - a. Interpretation
 - b. Problems/situations
 - 1) Apprehensive patient
 - 2) Obese arm
 - 3) Leg pulse and pressures
 - 4) Weak or inaudible sounds
 - 5) Arrhythmias

- C. Jugular venous pressure (JVP)
 - 1. Pulsations
- D. Evaluation for edema
- E. Characteristics of common signs and symptoms associated with causes of vascular diseases such as
 - 1. Deep venous thrombosis
 - 2. Atherosclerosis

IX. Assessment of the Nervous System

- A. Mental status and speech
- B. Knowledge of neurology and assessment data interpretation
- C. Characteristics of common signs and symptoms associated with sudden loss of consciousness, such as
 - 1. Vasovagal response
 - 2. Epilepsy
 - 3. Postural hypotension
 - 4. Cerebrovascular accident (CVA)

X. Assessment of the Breasts and Axillae

- A. Breast inspection
 - 1. Skin appearance
 - 2. Size and symmetry
 - 3. Contour
 - 4. Nipple characteristics
- B. Breast palpation — clinical exam
 - 1. Consistency of tissues — lumps, cysts
 - 2. Tenderness
 - 3. Nodules — lymph, size, shape, adherence
 - 4. Nipple
 - 5. Lumps, thickness
- C. The axillae
 - 1. Inspection
 - 2. Palpation

XI. Documentation of Findings

- A. Characteristics required to describe a symptom
 - 1. Site
 - 2. Severity
 - 3. Quality
 - 4. Time course

5. Setting
6. Aggravating and relieving factors
7. Associated

ASRT

Pharmacology and Clinical Decision-Making in Radiology

Description

This content is designed to enhance the radiologist assistant's knowledge of pharmaceuticals commonly used by and given to radiology patients. The content addresses the intent of the drug and its effect on diseases, conditions and physiology. After learning this content and possessing the appropriate clinical skills, the radiologist assistant will analyze the patient's current condition with regards to medications and other therapies and determine the significance to the radiology procedure. He or she will suggest the appropriate action plan for the procedure for the specific patient. The radiologist assistant will be responsible for the administration and documentation of procedure-related pharmaceuticals. He or she will assess contraindications and monitor the patient for adverse events. It is essential the radiologist assistant have a clear understanding of the laws and policies related to pharmaceuticals in his or her practice setting.

Objectives

1. Identify key drug laws affecting consumer safety.
2. Identify the five schedules of controlled substances.
3. Identify the roles of the Food and Drug Administration (FDA) and Drug Enforcement Administration (DEA) in the regulation and control of consumer drugs.
4. Explain strategies for health care workers involved in dispensing medications to comply with the restrictions of drug laws.
5. Identify common abbreviations and symbols used for medication orders.
6. Differentiate among drug names (generic, chemical, trade, official).
7. Explain the restrictions of drug sales implied by the designation of: over-the-counter, legend drug and controlled substance.
8. Research drug reference information from standard pharmacological resources.
9. Describe the biological processing of drugs in the body.
10. List common variables affecting drug action within the body.
11. Describe common unexpected responses to drugs.
12. Describe the purposes for and principles of clinical drug trials.
13. Accurately perform calculations for drug dose delivery.
14. Describe various forms of drug preparations and supplies.
15. Incorporate the principles of responsible drug administration in the patient care setting to prevent medication error.
16. Use proper medical techniques of drug administration for common routes of delivery.
17. Describe dose modifiers for pediatric and geriatric patients.
18. Identify factors that may lead to cumulative effects in the elderly.
19. List the categories of drugs that frequently cause adverse side effects in older adults.
20. Identify guidelines and competencies for sedation and analgesia according to Joint Commission requirements.
21. Describe the side effects and cautions associated with preprocedure medications.
22. Describe the administration, indications, contraindications and adverse effects related to moderate sedation and local anesthetics. Assess the patient and patient's records prior to and manage the patient during examinations requiring moderate sedation.

23. Recognize and explain the indications, contraindications and adverse effects for drugs related to sedation, analgesia, antineoplastics, antiseizure, psychotropics, diuretics, steroids, diabetes, hormone replacements, antiarrhythmics, antihypertensives, gastrointestinal, cardiovascular, anticoagulants, respiratory, anti-infectives .
24. Explain precautions in caring for the patient receiving radioactive isotopes.
25. Describe the uses of and precautions necessary with oxygen therapy.

ASRT

Content

I. Consumer Safety and Drug Regulations

- A. Laws and regulations
 1. 1906 Pure Food and Drug Act
 2. 1938 Federal Food, Drug, and Cosmetic Act
 3. 1970 Controlled Substances Act

- B. Roles of the FDA and the DEA

II. Medication Orders

- A. Common abbreviations for medication orders

- B. Policies and regulations
 1. Verbal, written and standing orders
 2. Order verification

- C. Medication order components

III. Pharmaceutical Terminology References

- A. Classifications

- B. Identifying names (i.e. generic, trade)

- C. Legal terms referring to drugs (i.e., over-the-counter)

IV. Sources of Drug Information

- A. Drug references (i.e., PDR, USP)

V. Pharmacotherapeutic Decision-making

- A. Drug effects and indications

- B. Pharmacokinetics
 1. Absorption
 2. Distribution
 3. Metabolism
 4. Excretion
 5. Other variables (i.e., age, weight, sex, psychological state)
 6. Drug interactions
 - a. Synergism
 - b. Potentiation
 - c. Antagonism
 7. Dosage
 - a. Minimum and maximum dose
 - b. Loading dose
 - c. Maintenance dose
 - d. Toxic dose
 - e. Lethal dose

- f. Therapeutic dose
- 8. Route
 - a. GI tract/enteral
 - b. Parenteral
 - c. Inhalation respiratory
- C. Contraindications, warnings, side effects, adverse reactions and interactions
 - 1. Teratogenic effect
 - 2. Tolerance
 - 3. Dependence
 - 4. Hypersensitivity
 - 5. Anaphylactic reaction

VI. Clinical Drug Trials

- A. Principles of the controlled trial
- B. Protection of subjects
- C. Research design (i.e., single-blind, double-blind)

VII. Safe Dosage Preparation (i.e., Calculation Guidelines, Pediatric and Geriatric Dose)

- A. Anatomic and physiologic variables (i.e., renal and hepatic function)
- B. Factors affecting dose
 - 1. Body surface area
 - 2. Weight
 - 3. Age
- C. Considerations with neonates (i.e., blood-brain barrier permeability)
- D. Considerations with geriatrics
 - 1. Cumulative effect of drugs
 - 2. Mental impairment
 - 3. Polypharmacy

VIII. Principles of Drug Administration

- A. Accurate drug administration
- B. Medication error avoidance
- C. Administration routes
 - 1. GI
 - 2. Parenteral
- D. Appropriate documentation of administration and patient outcomes
 - 1. Dose

2. Time
3. Route
4. Location of injections
5. Sign or initial record
6. Documentation involving narcotics and any medications

IX. Pediatric Considerations

- A. Pharmacokinetic and pharmacodynamic considerations

X. Geriatric Considerations

- A. Anatomic and physiologic variables
- B. Pharmacokinetic and pharmacodynamic considerations

XI. Procedural Medication and Local Anesthetics

- A. Sedation and analgesia policies and procedures
- B. Moderate sedation goals
 1. Altered level of consciousness and mood
 2. Maintenance of consciousness
 3. Cooperation
 4. Elevation of pain threshold
 5. Minimal variation of vital signs
 6. Rapid degree of amnesia
 7. Safe, prompt recovery and ambulation
- C. Assessment of patient and documentation of medications related to procedure
 1. Informed consent
 2. Procedural assessment (i.e., vital signs, laboratory values, level of consciousness)
- D. Airway management
- E. Patient recovery period (i.e., airway, vital signs, level of function)

XII. Nonprescription and Dietary Supplements, Anti-infective and Antineoplastic Drugs

- A. Impact on procedures
- B. Interactions

XIII. Drugs by Body System

- A. Autonomic nervous system drugs
 1. Adrenergics (sympathomimetics)
 2. Adrenergic blockers (alpha and beta blockers)
 3. Cholinergics (parasympathomimetics)
 4. Cholinergic blockers (anticholinergics)

- B. Central nervous system (CNS) drugs
 1. Analgesics, sedatives, and hypnotics
 2. Anticonvulsants, antiparkinsonian drugs, and medications for Alzheimer disease
 3. Psychotropic medications,
 4. Alcohol and drugs of abuse

- C. Urinary system drugs
 1. Diuretics
 2. Gout medications
 3. Antispasmodics
 4. Cholinergics
 5. Analgesics
 6. Prostatic medications
 7. Alpha blockers
 8. Overactive bladder medications

- D. GI drugs
 1. Antacids
 2. Reflux, ulcerative and inflammatory bowel disease medications
 3. Antispasmodics/anticholinergics
 4. GI motility and function medications
 5. Antiemetics

- E. Endocrine system drugs
 1. Pituitary hormones
 2. Adrenal corticosteroids
 3. Thyroid medications
 4. Diabetic medications

- F. Reproductive system drugs
 1. Hormones
 2. Erectile dysfunction medications

- G. Cardiovascular drugs
 1. Cardiac glycosides
 2. Antiarrhythmic medications
 3. Antihypertensives
 4. Coronary vasodilators
 5. Antilipemic medications
 6. Vasoconstrictors
 7. Anticoagulants
 8. Platelet inhibitor therapy

- H. Respiratory system drugs
 1. Oxygen
 2. Respiratory stimulants

3. Bronchodilators
 4. Corticosteroids
 5. Mucolytics and expectorants
 6. Antihistamines
 7. Decongestants
 8. Smoking cessation aids
- I. Musculoskeletal and anti-inflammatory drugs
1. Skeletal muscle relaxants
 2. Anti-inflammatory drugs
 3. Osteoporosis therapy
 4. Injectable steroids

ASRT

Contrast Media

Description

Content imparts an understanding of contrast media used during diagnostic procedures. Topics include an overview of the chemical makeup and physical properties of contrast agents. The radiologist assistant selects contrast agents for procedures, based on patient risk factors, premedication strategies and indicators of contrast media reaction. He or she participates in the care and treatment of patients experiencing adverse contrast media reactions.

Objectives

1. Determine the use of contrast media based on patient factors and procedural requirements.
2. Describe the physical properties, structural differences and pharmacologic characteristics of contrast media.
3. Identify patients at risk of an adverse reaction to contrast media.
4. Identify the response strategies for patients with a predisposition for allergic reaction to contrast media.
5. Classify the indicators and symptoms associated with mild, moderate or severe reaction to contrast media.
6. Implement protocols for treating a patient experiencing an adverse reaction to contrast media.
7. Discuss patient counseling and recommended follow-up care for patients undergoing a procedure requiring the use of contrast media.

Content

I. Contrast Media Selection

- A. Barium, iodinated soluble contrast, paramagnetic and echogenic agents
 - 1. Procedural requirements
 - 2. Occurrences and causes of reactions and complications
 - 3. Risk factors (i.e., renal function)
 - 4. Special considerations (i.e., Glucagon, Metformin administration)

II. Contrast Media and Preparations

- A. Negative agents
- B. Positive agents
- C. Paramagnetic agents
- D. Echogenic agents

III. Characteristics of Iodinated Contrast Materials

- A. Water solubility and hydrophilicity
- B. Osmolality
 - 1. High and low osmolar contrast media
 - a. Molecular structure
 - b. Advantages
 - c. Disadvantages
- C. Viscosity
- D. Calcium binding
- E. Chemical stability

IV. Media in Use

V. Allergic Reaction Risk Reduction

- A. Patient Assessment
- B. Premedication and hydration protocols
- C. Dosage
- D. Alternative procedure consultation

VI. Patient Care Following Contrast Media Administration

- A. Patient counseling

- B. Postprocedure instructions
- C. Follow-up communication

ASRT

Pathophysiology

Description

Content focuses on the characteristics and manifestations of disease caused by alterations or injury to the structure or function of the body. Concepts basic to pathophysiology as well as common disease conditions are studied and serve in understanding alterations that occur in the major body systems. Emphasis is placed on the image correlation with these pathologies.

Objectives

1. Define terminology used in the study of disease.
2. Describe the general principles and mechanisms of disease.
3. Describe the physiological response in inflammation and cell injury due to pathological insult.
4. Differentiate between the processes of various types of cellular and tissue injury and adaptive mechanisms.
5. Describe the disorders of fluid and electrolyte balance.
6. Differentiate between the mechanisms of tissue repair and healing.
7. Identify common tests used to diagnose disease or injury.
8. Examine the role of nutrition and genetics in disorders.
9. Describe the common etiology, signs and symptoms, diagnostic tests, typical course and management of common diseases and disorders of body systems.
10. Discuss the common effects of aging on each of the body systems.

Content

I. Alterations in Cell Function and Growth

- A. Cell and tissue characteristics
- B. Cellular adaptation and injury
- C. Genetic and congenital disorders
- D. Alterations in cell differentiation: neoplasia
- E. Tissue repair and wound healing

II. Alterations in Body Defenses

- A. Stress and adaption
- B. Alterations in temperature regulation
- C. Infectious processes
- D. Inflammation and repair
- E. The immune response
- F. Alterations in the immune response
- G. Acquired immunodeficiency syndrome (AIDS)
- H. White blood cell and lymphoproliferative disorders
- I. Alterations in hemostasis and blood coagulation

III. Alterations in Oxygenation of Tissues

- A. Composition of blood and blood formation
- B. The red blood cell and alterations in oxygen transport
- C. The circulatory system and control of blood flow
- D. Alterations in blood flow
- E. Control of arterial blood pressure
- F. Alterations in blood pressure
- G. Control of cardiac function

- H. Alterations in cardiac function
 - 1. Disorders of the pericardium
 - 2. Coronary artery disease
 - 3. Dysrhythmias and conduction disorders
 - 4. Disorders of the endocardium
 - 5. Valvular disease
 - 6. Cardiomyopathies
 - 7. Congenital heart disease
 - 8. Diagnosis and treatment

I. Heart failure

J. Circulatory shock

K. Control of respiratory function

IV. Alterations in Respiratory Function

A. Respiratory infections

B. Disorders of the pleura

C. Obstructive lung disorders

D. Interstitial lung disorders

E. Pulmonary vascular disorders

F. Cancer of the lung

G. Ventilation disorders

H. Respiratory failure

I. Diagnosis and treatment

V. Alterations in Body Fluids

A. Alterations in body fluids and electrolytes

B. Alterations in the distribution of body fluids

C. Alterations in acid-base balance

D. Control of renal function

E. Alterations in renal function

1. Congenital disorders

2. Urinary tract infections and pyelonephritis
3. Obstructive disorders
4. Disorders of the nephron and glomerulus
5. Neoplasms
6. Renal failure
7. Diagnosis and treatment

VI. Alterations in Reproductive Function

- A. Structure and function of the reproductive system
- B. Alterations in the structure and function of the reproductive system
 1. Disorders of the testes and prostate
 2. Disorders of the uterus, ovaries and breasts
- C. Diagnosis and treatment

VII. Alterations in Endocrine Function, Metabolism

- A. Mechanism of endocrine control
- B. Control of metabolism
- C. Alterations in endocrine control of growth and metabolism
- D. Control of diabetes
- E. Diagnosis and treatment

VIII. Alterations in GI Function

- A. Control of gastrointestinal function
- B. Alterations of GI function
 1. Manifestations of GI tract disorders
 2. Disorders of the esophagus
 3. Disorders of the stomach
 4. Disorders of the small and large bowel
 5. Disorders of the peritoneum
 6. Malabsorption
- C. Alterations in function of the hepatobiliary system and pancreas
- D. Diagnosis and treatment

IX. Alterations in Neuromuscular Function

- A. Properties of the nervous tissue
- B. Control of neuromuscular and autonomic nervous system function

C. Development and segmental organization of the nervous system

D. Disorders of cerebral function

1. Increased cranial pressure
2. Infections
3. Seizures
4. Consciousness and unconsciousness
5. Organic brain syndrome

E. Alterations in motor function

1. Control of motor function
2. Alterations in cerebral circulation
3. Disorders of the myelin
4. Spinal cord injury
5. Alterations in neuromuscular function

F. Pain

1. Pain mechanisms and response
2. Pain disorders
3. Treatment for pain

G. Diagnosis and treatment

X. Alterations in Skeletal Support and Movement

A. Structure and function of the skeletal system

B. Alterations in skeletal function: trauma and infection

1. Injury and trauma of musculoskeletal structures
2. Bone infections

C. Alterations in skeletal function:

1. Arthritidis
2. Congenital disorders
3. Metabolic bone disease
4. Neoplasms

D. Diagnosis and treatment

XI. Alterations in Skin Function and Integrity

XII. Alterations in Structure and Function Related to Aging

A. Physiologic changes of aging

B. Functional considerations of aging

1. Incontinence

2. Instability and falls
3. Sensory and cognitive impairment
4. Depression
5. Dementia
6. Delirium

ASRT

Radiologic Procedures

Description

Content establishes a framework for radiologist assistant participation in patient examinations for the purpose of diagnostic inspection and therapeutic treatment. Examination procedures should follow American College of Radiology guidelines for principles and practices, producing high-quality radiographic care.

Objectives

1. Identify the information, materials and equipment required in preparation for conducting diagnostic imaging examinations.
2. Describe the protocol for performing imaging examinations.
3. Identify factors requiring an alteration or modification to examinations.
4. Identify risk factors (patient/operator) related to examinations.
5. Under radiologist supervision, perform patient examinations for diagnostic inspection and therapeutic treatment.
6. Evaluate examination outcomes against examination requirements.
7. Compose an internal memorandum of initial observations made during the examination following prescribed protocols.
8. Describe postexamination patient care and instructions.

Content

I. Procedural Guidelines and Examination Protocols

- A. Anatomy and pathophysiology
- B. Indications and contraindication for procedure
- C. Patient assessment and preparation for the procedure
- D. Alternative and complementary procedures
- E. Patient management during the procedure
- F. Safe operation of radiation producing equipment
- G. Devices and supplies
- H. Administration of contrast media and drugs
- I. Evaluation of image quality for diagnostic utility
- J. Image enhancement and postprocessing
- K. Complications and response to emergencies
- L. Postprocedure patient care
- M. Outcomes measurement
- N. Electronic health record (EHR)
 - 1. ICD and CPT coding

II. Chest Procedures

- A. Fluoroscopy

III. Gastrointestinal Procedures

- A. Cholangiography
- B. Defecography
- C. Enema with barium, air or water soluble contrast
- D. Esophageal study
- E. Nasoenteric, enteric and orogastric tube placement
- F. Small bowel study

- G. Small bowel study via enteroclysis tube
- H. Swallowing function studies
- I. T-tube cholangiography
- J. Upper GI study

IV. Genitourinary Procedures

- A. Antegrade urography through an existing catheter (i.e., nephrostography)
- B. Cystography
- C. Hysterosalpingography – imaging only
- D. Hysterosalpingography – procedure and imaging (physician participation required)
- E. Loopography through an existing catheter
- F. Retrograde urethrography or urethrocystography
- G. Voiding cystourethrography

V. Invasive Nonvascular Procedures

- A. Abscess drainage
- B. Arthrogram (radiography, CT and MR)
- C. Fistula or sinus tract study
- D. Catheter placement for pneumothorax
- E. Change of percutaneous tube or drainage catheter
- F. Image-guided procedures
 - 1. Biopsies
 - a. Liver
 - b. Thyroid
 - 2. Breast
 - a. Needle localization
- G. Joint aspiration
- H. Joint injection
- I. Lumbar puncture

J. Myelography — imaging only

1. Cervical
2. Lumbar
3. Thoracic

K. Paracentesis

L. Sentinel node localization

M. Thoracentesis

VI. Invasive Vascular Procedures

A. Peripherally inserted central catheter (PICC) lines

1. Nontunneled catheter
2. Tunneled catheter

B. Vascular access

1. Extremity venography
2. Port injection

ASRT

Modality and Image Management

Description

Content is designed to establish a knowledge base in the fundamentals of fluoroscopy, computed tomography, magnetic resonance, medical sonography, positron emission tomography and image postprocessing. Content promotes awareness of the advantages and limitations of each area. Procedures and techniques to optimize image quality while minimizing radiation exposure are included.

Objectives

1. Make prudent judgment for the use of equipment as a diagnostic tool.
2. Identify the advantages and limitations of equipment and various exposure settings as a diagnostic tool.
3. Identify the functional components involved in the operation of the devices.
4. Identify features of the equipment designed to minimize radiation exposure to patients and operators.
5. Employ methods and techniques in the operation of the equipment to maximize the diagnostic value of a given examination while minimizing patient radiation exposure.
6. Following guided practice, operate the device, including recording images, to satisfy the protocol for routine studies.
7. Provide direction regarding radiation protection practices to others present during an exam.
8. Provide patient education regarding the operation and benefits of the equipment.
9. Verify quality assurance (QA) and quality control (QC) procedures to ensure that equipment is operating safely and in a standardized manner prior to patient exposure and on a daily basis.

Content

I. Fluoroscopy

- A. Clinical advantages
 - 1. Demonstration of motion — dynamic anatomy (peristalsis)

- B. Components of fluoroscopic units
 - 1. Table
 - 2. Radiation source
 - 3. Image intensifier carriage
 - a. Table controls
 - b. Fluoro controls
 - c. Image controls
 - 4. Optics system
 - a. Video interface
 - b. Image recording devices
 - c. Video monitor
 - 5. Locks and angle indicators (mobile)
 - 6. Structural provisions for radiation shielding
 - a. When used routinely in one area for both fixed and mobile equipment
 - 7. Equipment provisions
 - a. Source-to-skin distance (SSD) control
 - b. Control of radiation field
 - c. Maximum exposure rate
 - d. Lead apron requirements
 - e. Maximum entrance dose vs. equipment setup and technique
 - f. Scatter/isodose curves in relation to mobile equipment setup and personnel placement
 - 8. Limiting the use of “high level control” or “boost position” during fluoroscopy
 - 9. Personnel monitoring of radiation exposure
 - 10. Image recording, archiving and retrieval

- C. Technical factors affecting the radiation dose rate for patients and operators
 - 1. Direct factors
 - a. Milliamperage (mA)
 - b. Peak kilovoltage (kVp)
 - c. Collimation
 - 1) Impact on integral dose
 - d. Filtration
 - 1) Inherent and added
 - e. Exposure time
 - f. Source-to-skin distance
 - g. Grids
 - h. Pulse fluoroscopy
 - 2. Indirect factors
 - a. Fluoroscopic room lighting
 - b. Poor image receptor quality

- c. Low-absorption tabletop
- 3. Patient and/or operator dose reducers
 - a. Gonadal shielding
 - b. Lead drape
 - c. Bucky slot cover
 - d. Lead apron
 - e. Thyroid shield
 - f. Leaded glasses
 - g. Three-phase and high-frequency generators
 - h. Protective barriers
 - i. Cumulative timer
 - j. Mobile equipment setup
- 4. Image intensifier
 - a. Image quality considerations
 - b. Quantum mottle
 - c. Contrast resolution
 - 1) Low contrast
 - 2) High contrast
 - d. Image resolution
 - e. Image distortion
 - f. Lag
 - g. Vignetting
 - h. Magnification
- 5. Ancillary equipment
 - a. Optics system
 - b. Television systems
 - 1) Camera device
 - 2) Camera control unit
 - 3) Monitor
 - a) Brightness control
 - b) Contrast control
 - c. Cinefluorography
 - 1) Synchronous
 - 2) Framing frequency
 - 3) F-number of the optical system
 - 4) Framing and patient radiation dose
 - d. Videotape and video disc recording
 - e. Pulsed fluoroscopy
 - f. Limiting use of high-level control fluoroscopy
 - g. Cassette spot filming
 - h. Photofluorospot film camera
 - i. Contrast media
 - j. Accessories
 - k. Gonadal shields
 - l. Grids vs. dose and procedures
 - m. Cassettes

- 1) Low attenuation front
 - 2) Intensifying screens
 6. Image processing
 7. Digital systems
 - a. Image storage and retrieval
 - b. Image archiving
 8. Emulsion-based images
 - a. Spot films
 - 1) Film speed vs. resolution
 - b. Cine film
 - 1) Influences of film processing
 9. Patient and patient position
 - a. Patient characteristics
 - b. Absorption of scatter
 - 1) Scatter radiation isodose curves
 10. Ancillary factors
 - a. Automatic brightness control vs. dose
 - b. X-ray generator
 11. Operator controls of the fluoroscopic unit
 - a. Control panel setting(s) for fluoroscopy vs. dose
 - b. Fluoro tower movement
 - c. Tabletop movement
 - d. Collimator control
 - e. Compression devices
 - f. Fluoro grid device
 - g. Exposure switch(es)
 - h. Spot-film device
 - 1) Cassette
 - 2) Spot-film camera
 - a) Frame rate
 - 3) Fluoro carriage locks
 - a) Vertical lock
 - b) Park position
 12. Patient supports/restraints
 - a. Footboard
 - b. Shoulder restraints
 - c. Other restraining apparatus
- D. Patient dose and image quality comparisons
1. Spot-film image
 2. Digital or photospot
 3. Cine
 4. Videotape/disc
 5. Risks of low-level radiation exposure
 6. Somatic dose indicators
 - a. Definition of somatic injury

- 1) Local injuries
 - 2) General injuries
 - b. Injuries to superficial tissue
 - 1) High-dose examinations offering superficial tissue risks
 - a) Cardiac-interventional procedures
 - b) Vascular-interventional procedures
 - c. Cataract formation
 - 7. Personnel radiation protection
 - a. As low as reasonably achievable (ALARA) applied to fluoroscopy
 - b. Sources of potential exposure to the operator
 - c. Operator protection during the fluoroscopic exam
 - 8. Protective apparel and accessories
 - a. Lead apron
 - b. Overhanging shields
 - c. Mobile screens
 - d. Protective curtain
 - e. Protective gloves
 - f. Thyroid shields
 - g. Protective goggles/glasses
 - 9. Other safety hazards
 - a. Electrical hazards
 - 1) Frayed cables
 - 2) Broken switches
 - b. Physical hazards
 - 1) Wet floor
 - 2) Faulty locks/interfaces
 - c. Standard precautions
- E. Pediatrics
- 1. Grid
 - 2. Automatic brightness control (ABC)
 - 3. Anesthesia
 - 4. Spot film vs. camera

II. Computed Tomography

- A. Patient preparation
- B. Patient assessment
- C. IV procedures
 - 1. Venipuncture
 - 2. Injection modes
- D. Radiation safety and dosimetry
 - 1. Technical factors affecting patient dose
 - a. kVp
 - b. mAs

- c. Pitch
 - d. Collimation
 - e. mA modulation techniques
 - f. Multidetector configuration
 - g. Gating
 - 2. Radiation protection
 - 3. Dose measurement
 - a. CT dose index (CTDI)
 - b. Multiple scan average dose (MSAD)
 - c. Dose length production (DLP)
 - 4. Patient dose reduction
 - a. Pediatric
 - b. Adult
- E. Image processing
 - 1. Reconstruction
 - a. Filtered back projection reconstruction
 - b. Reconstruction filters (algorithms)
 - c. Raw data vs. image data
 - d. Prospective/retrospective reconstruction
 - e. Effective slice thickness
 - f. Reconstruction interval
 - 2. Postprocessing
 - a. Multiplanar reformation
 - b. 3-D rendering (maximum intensity projection [MIP], shaded surface display [SSD], VR)
 - c. Quantitative analysis (e.g., distance, diameter, calcium scoring, ejection fraction)
- F. Image Quality
 - 1. Spatial resolution
 - 2. Contrast resolution
 - 3. Temporal resolution
 - 4. Noise and uniformity
 - 5. QA
 - 6. CT number
 - 7. Linearity

III. Magnetic Resonance

- A. MR screening and safety
 - 1. Patient screening
 - 2. Safety (i.e., nonferromagnetic ancillary equipment, quenching)
 - 3. Environment (i.e., magnetic and radiofrequency [RF] shielding)
 - 4. Biological considerations
 - a. RF field
 - 1) Specific absorption rate (SAR)

- 2) Biological effects
 - 3) FDA guidelines
 - b. Static and gradient magnetic fields
 - 1) Biological effects
 - 2) FDA guidelines
 - c. Acoustic noise
- B. Pulse sequences
 - 1. Spin echo
 - 2. Inversion recovery
 - 3. Gradient recall echo (GRE)
- C. Postprocessing
 - 1. Maximum intensity projection (MIP)
 - 2. Multiplanar reconstruction techniques (MPR)
 - 3. Cardiac analysis
- D. Functional imaging
 - 1. Magnetic resonance angiography (MRA)/magnetic resonance venography (MRV)
 - 2. Techniques
 - a. Diffusion
 - b. Perfusion
 - c. Spectroscopy
 - d. fMRI
 - 3. Dynamic imaging
- E. Sequence parameters and options
 - 1. Imaging parameters
 - a. Repetition time (TR)
 - b. Echo time (TE)
 - c. Inversion time (TI)
 - d. Field of view (FOV)
 - 2. Imaging options (i.e., suppression techniques, physiologic gating and triggering, saturation pulse)
- F. Tissue characteristics
 - 1. T1 relaxation
 - 2. T2 relaxation
 - 3. T2 (susceptibility artifact)
 - 4. Proton (spin) density
 - 5. Flow
 - 6. Diffusion
 - 7. Perfusion

IV. Medical Sonography

- A. Physics principles

1. Properties of ultrasound waves
 2. Interactions of sound with tissue
 3. Power, intensity and amplitude
 4. Units of measurement
- B. Ultrasound transducers
1. Transducer construction and characteristics
 2. Transducer types (sector, linear, phased arrays, etc.)
 3. Spatial resolution
 4. Transducer selection
- C. Pulse-echo instrumentation
1. Display modes and their formation (A-mode, B-mode, M-mode, 3-D, etc.)
 2. Transmission of ultrasound
 3. Reception of ultrasound (preprocessing)
 4. Beam former
 5. Postprocessing of ultrasound signals
 6. Pulse-echo imaging artifacts
 7. Tissue harmonic imaging
 8. Real-time ultrasound instrumentation
 9. Recording and storage devices
- D. Doppler instrumentation and hemodynamics
1. Ability to acquire color flow image
 2. Ability to acquire a Doppler spectral image
 3. Ability to take measurements from the spectral waveform
 4. Hemodynamics
- E. QA and QC of equipment
1. Preventive maintenance
 2. Malfunctions
 3. Performance testing with phantoms
- V. Positron Emission Tomography**
- A. PET radiopharmaceutical principles
1. Positron decay
 2. Positron energy and effect on resolution
 3. Coincidence events
 4. Bremsstrahlung radiation
 5. Decay factors
 6. Exposure rates
 7. Half-value layer (HVL) — lead and concrete
 8. Branching fraction
- B. Radiation safety with positron decay
1. Hot cells

2. Facility monitoring considerations
 3. Personnel monitoring considerations
 4. Exposure from patients
- C. Radionuclide production
1. Cyclotron
 2. Basic concept
 3. Targets
 4. Large and small volume
 5. Liquid or gas
- D. Synthesis of radiopharmaceuticals
1. Basic chemistry
 2. Synthesis modules
- E. Rubidium generators
1. Regulations
 2. Quality control
 3. Dose assay
 4. Dose administration
 5. Storage
 6. Disposal
- F. Survey meter
1. Operating principles
 2. Quality control consistent with National Regulatory Commission (NRC) regulations
 3. Source selection
 4. Interpretation of QC results
- G. Dose calibrator
1. Operating principles
 2. Types of quality checks
 3. Frequency of quality checks
 4. Source selection
 5. Interpretation of results
- H. Scintillation detector systems
1. Principles of scintillation detection
 2. Properties of detector materials
 3. PET detector materials
 - a. Sodium iodide (NaI)
 - b. Bismuth germinate (BGO)
 - c. Lutetium oxyorthosilicate (LSO)
 - d. Gadolinium oxyorthosilicate (GSO)

- I. Theory of operation
 - 1. Principles of coincidence detection
 - a. True coincidence
 - b. Lines of response (LOR)
 - c. Randoms
 - d. Scatter
 - e. Delayed event
 - f. Coincidence window and timing
 - 2. Image formation and reconstruction
 - a. Sinograms
 - 1) 2-D
 - 2) 3-D
 - 3) Fourier rebinning
 - 4) Single slice rebinning
 - b. Data processing and corrections
 - 1) Normalization corrections
 - 2) Decay corrections
 - 3) Dead time corrections
 - 4) Arc corrections
 - 5) Random corrections
 - 6) Scatter corrections
 - 7) Attenuation corrections
- J. Diagnostic procedures
 - 1. Radiopharmaceutical characteristics
 - 2. Administration of radiopharmaceuticals
 - 3. Gated procedures
 - 4. Acquisition modes
 - 5. Imaging procedures (i.e., cardiology, neurology, oncology)
 - 6. Image artifacts
 - 7. Computerized data processing
 - 8. Image fusion and registration

II. Image Postprocessing

- A. Processing techniques
 - 1. 2-D display tools
 - 2. 3-D display tools
 - a. MIP
 - b. Minimum intensity projection (MinIP/minIP)
 - c. Shaded surface display (SSD)
 - d. Volume rendering technique (VRT)
 - e. Ray sum projection
 - 3. Segmentation tools (i.e., cutting, region growing, dilation/erosion)
- B. Data volume
 - 1. Voxel-based models

2. Grid-based models
 3. 3-D sampling function
 4. Secondary raw data set
 - a. Image noise
- C. Cine viewing
1. Uses
 2. Disadvantages
- D. Multiplanar reformations
1. Principle
 2. Artifacts
 3. Applications
 - a. Anatomically corrected datasets
 - b. Problem-solving
 - c. Noise reduction in standard displays
 4. Image analysis and documentation
- E. Maximum intensity projection (MIP) and minimum intensity projection (MinIP)
1. Principle
 - a. Defining the volume of interest (VOI)
 - b. Preserving attenuation information
 - c. Image background
 - d. Image contrast
 - e. Viewing angle
 - f. Cine loop to improve 3-D orientation
 - g. Image noise
 2. Thin-slab MIP
 - a. Improvement in spatial orientation
 3. MinIP
 - a. Tracheobronchial imaging
 - b. Image contrast, noise and VOI
 - c. Imaging volume and viewing angle
 4. Artifact pitfalls
 - a. CT angiography
 - 1) Intravascular lesions
 - 2) Intimal flaps
 - 1) Calcifications
 - b. Pulmonary MIP and MinIP
 - 1) Endobronchial lesions
 - 2) Vascular pulsations
 5. Applications of MIP and MinIP
 - a. CT angiography
 - b. Pulmonary lesions
 - c. Central tracheobronchial system
 - d. Intrahepatic bile ducts

- e. Pancreatic duct
- F. 3-D surface rendering (SSD)
- 1. Principle
 - a. Segmentation
 - b. Illumination with virtual light source(s)
 - c. Shadowing effect
 - d. Color encoding
 - e. Rendering the image
 - 1) Orthographic rendering
 - 2) Perspective rendering
 - f. Threshold selection and size representation
 - 1) Impact of lowering or raising the threshold
 - a) Appearance of
 - (1) “Flying pixels”
 - (2) “Pseudostenosis”
 - 2. Applications
 - a. Clarification of complex 3-D relationships
 - b. Image rotation and viewing angle
 - c. Presurgical planning
 - d. Presentation of findings
 - e. Virtual endoscopy
- G. Volume rendering techniques
- 1. Principle
 - a. Opacity curve
 - b. Transmission display
 - c. Surface display
 - d. Reflectivity constant
 - e. Color coding
 - f. Spatial resolution and matrix size
 - g. Interactive rendering — movies
 - 2. Special Techniques
 - a. Air casts (inverted opacity curves)
 - b. Tissue transition projections
 - c. MPR-like rendering
 - 3. Artifacts and pitfalls
 - a. Venetian blind artifacts
 - b. Image noise
 - 4. Applications
 - a. CT angiography
 - b. Skeletal imaging
 - c. Tracheobronchial imaging
 - d. Liver
 - e. Lungs
 - f. Colon

- H. Segmentation
 - 1. Principle
 - a. Positive and negative editing
 - b. Cutting functions
 - c. Threshold techniques
 - d. Connectivity
 - e. Morphologic operators
 - 1) Erosion
 - 2) Dilation
 - 2. Automated techniques, computer-assisted diagnosis
 - a. Bone removal
 - b. Lung extraction
 - c. Vessel analysis
 - 3. Applications

- I. Virtual endoscopy
 - 1. Principle
 - a. Perspective rendering along a path
 - 2. Alternative viewing techniques
 - a. Casts
 - b. Tissue transition projections
 - c. Thick MPR
 - d. Sliding thin-slab VRT
 - e. Coned-down VRT
 - f. Virtual dissection
 - g. Panoramic view
 - h. Multiplanar reformations
 - 3. Artifacts and pitfalls
 - a. Poor patient prep
 - b. Breathing and pulsations
 - 4. Applications
 - a. Virtual colonoscopy
 - b. Virtual bronchoscopy
 - c. Virtual cystoscopy
 - d. Virtual angiography

III. Equipment Safety

- A. Equipment safety regulations
- B. Safety
 - 1. Hazard identification and control
 - 2. Policies and procedures
 - a. Occupational Safety and Health Administration (OSHA)
 - b. Centers for Disease Control and Prevention (CDC)
 - c. Facility

- d. State
- 3. Employee training
- 4. Fire, electrical and chemical safety
- 5. Magnetic fields and radio frequency safety
- 6. Injury prevention
- 7. Safety/quality improvement committees
- 8. Risk management

ASRT

Radiation Safety, Radiobiology and Health Physics

Description

Content is designed to expand on prior knowledge to enhance an understanding of protection of individual and population groups against the harmful effects of ionizing radiation. This includes an overview of the regulatory bodies and patient radiation safety regulations affecting the modern diagnostic imaging environment. The effect of ionizing radiation on biological samples will be included. Interaction of ionizing radiation with matter, units of exposure and dose, radiation detection and measurement devices will be discussed. Practical techniques and QA/QC procedures for reducing patient and operator risk of exposure to ionizing radiation will be introduced.

Objectives

1. Identify organizations that set standards for radiation safety.
2. Describe the mechanism by which radiation interacts with matter.
3. Explain the quantitative relationships between radiation exposure and biological damage.
4. Describe the probability of select interactions with radiation.
5. Identify instruments used for measuring accumulated dose, measured dose and dose rate.
6. Describe the operating principles of common radiation measuring devices.
7. Distinguish between radiation exposure and radiation absorbed dose.
8. Apply techniques for reducing exposure to external and internal sources of radiation to the patient and personnel.
9. Evaluate the design of radiologically safe equipment, processes and environments.
10. Describe surveillance methods for maintaining a radiation safe environment for personnel and the general public.
11. Describe the QA/QC procedures employed to establish that the radiographic/fluoroscopic equipment is operating in a safe/standardized manner prior to patient examinations.

Content

I. Standard-setting Organizations

- A. International Commission on Radiological Protection (ICRP)
- B. International Commission on Radiation Units and Measurements (ICRU)
- C. National Council on Radiation Protection and Measurements (NCRP)
- D. United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR)
- E. National Academy of Sciences/National Research Council Committee on Biological Effects of Ionizing Radiation (NAS/NRC-BEIR)
- F. Environmental Protection Agency (EPA)
- G. Food and Drug Administration (FDA)
- H. Occupational Safety and Health Administration (OSHA)
- I. Nuclear Regulatory Commission (NRC)
 - 1. Radiology
 - 2. Nuclear medicine
 - a. Radioactive materials
 - 3. State regulatory and public health agencies

II. Philosophy of Radiation Protection

- A. Public health and radiation protection
 - 1. Genetically significant dose and population mutation rate
 - 2. Patient education
 - a. Image gently www.imagegently.org
- B. Dose limitation system
 - 1. Patient
 - 2. Personnel

III. Basic Radiation Safety Criteria

- A. Occupational exposure
 - 1. Monitoring options
 - 2. Exposure limits
- B. Medical exposure
- C. Effective dose equivalent
- D. Exposure to individuals in the general public

- E. Exposure to populations
- F. Annual limit of intake

IV. Radiation Detection and Measurement Devices

- A. Dose measuring devices
 - 1. Personal monitoring
 - 2. Pocket dosimeters
 - 3. Film badge
 - 4. Thermoluminescent dosimeters
 - 5. Optically stimulated luminescence device
 - 6. Electronic dosimeters
 - 7. Survey meters: ion current chamber
- B. Personnel dosimetry report
 - 1. Exposure period
 - 2. Report identification of individuals
 - 3. Dosimeter type
 - 4. Exposure for the reporting period
 - 5. Cumulative totals (year to date, total dose equivalent)

V. Dose-Response Characteristics

- A. Direct action
- B. Indirect action

VI. Radiation Effects

- A. Acute effects
 - 1. Cataract formation
 - 2. Repair of damage
 - 3. Linear energy transfer
 - 4. Oxygen effect
 - 5. Hyperthermia
 - 6. Mitotic block
- B. Treatment of acute overexposure
- C. Delayed effects
 - 1. Life span shortening
 - 2. Thyroid
 - 3. Survival
 - 4. Cell cycle effects
 - 5. Repopulation
 - 6. Cancer and mutation risk
- D. Mental retardation

E. Genetic effects

VII. Expressing Cancer Risks

A. Absolute risk

B. Excess risk

C. Relative risk

VIII. Interaction of Ionizing Radiation With Matter

IX. Stochastic Effects vs. Nonstochastic Effects

X. Fetal /Child-related Irradiation

A. Prenatal death

B. Neonatal death

C. Congenital malformation

D. Diminished growth and development

E. Childhood malignancy

F. Lactating mothers

XI. System Response to Irradiation

A. Hematopoietic syndrome

1. High-dose examinations with potential bone marrow risks
 - a. Barium enema
 - b. Upper GI series
 - c. Abdominal angiography

B. Skin

1. Erythema
2. Desquamation

C. GI syndrome

D. CNS syndrome

E. Immune system

F. Reproductive system

1. Female

2. Male
3. Examinations yielding a potential for high dose to the gonads
 - a. Barium enema
 - b. Intravenous urography
 - c. Pelvis
 - d. Hips
 - e. Upper femur
4. Genetically significant dose (GSD)

XII. Personnel Dosimetry Report

- A. Exposure period
- B. Report identification of individuals
- C. Dosimeter type
- D. Exposure for the reporting period
- E. Cumulative totals (year to date, total dose equivalent)

XIII. Radiation Measurement Dose and Equipment

- A. Roentgen and coulombs/kg
- B. Radiation absorbed dose and grays
- C. Dose equivalent and sieverts
- D. Absorbed dose
- E. Exposure
- F. Exposure measurement equipment
 1. Free air chamber
 2. Solid state crystal detector
 3. Exposure-dose relationship
 4. Absorbed dose measurement: Bragg-Gray Principle
 5. Kerma

XIV. Practical Techniques for Reducing Dose

- A. External radiation protection
 1. Time
 2. Distance
 3. Shielding
 4. Optimization and ALARA
- B. Internal radiation protection (radioactive)

1. Control the source:
 - a. Confinement
 - b. Environmental control
 2. Control of the worker:
 - a. Protective clothing
 - b. Respiratory protection
- C. Waste management
1. Airborne wastes
 2. High-level waste
 3. Intermediate and low-level wastes

ASRT

Image Correlation with Anatomy, Physiology and Pathology

Description

Content imparts an understanding of methods and techniques for the systematic observation of static and dynamic diagnostic images for the purpose of evaluating the presence of abnormalities, anomalies and pathological conditions.

Objectives

1. Implement a systematic method or technique for observing static and dynamic patient images for the purpose of recognizing normal anatomical and physiological appearances, and those variations in appearance that may indicate pathology or injury.
2. Make recommendation(s) for additional images or alternative imaging procedures as warranted for diagnostic purposes.
3. Formulate initial observations presented to the radiologist.

ASRT

Content

I. Chest Imaging

- A. Systematic observation of the chest radiograph

- B. Clinical presentation related to differential diagnosis

- C. Pulmonary infection
 - 1. Pneumonia patterns
 - a. Lobar pneumonia
 - b. Bronchopneumonia
 - c. Cavitating or necrotizing pneumonia
 - d. “Ground glass” pneumonia pattern
 - 2. Pulmonary tuberculosis (TB)
 - a. Primary pulmonary TB
 - b. Secondary or postprimary TB
 - c. Miliary TB
 - 3. Abscess

- D. Lung masses
 - 1. Solitary pulmonary nodule
 - 2. Hilar mass
 - 3. Multiple masses
 - 4. Asbestos

- E. Pleural and extrapleural disease
 - 1. Pleural effusions
 - 2. Empyema
 - 3. Pleural mass

- F. Rib lesions

- G. Chest trauma
 - 1. Blunt trauma
 - a. Bony injury
 - b. Pneumothorax
 - c. Hemothorax
 - d. Pulmonary lesions
 - e. Vascular injuries
 - f. Trauma to the tracheobronchial tree
 - g. Diaphragmatic injury
 - 2. Penetrating trauma
 - 3. Airway obstruction

- H. Pediatric chest
 - 1. Neonatal chest patterns
 - a. Hyaline membrane disease (HMD)

- b. Bronchopulmonary dysplasia (BPD)
- c. Pulmonary interstitial emphysema (PIE)
- 2. Childhood pneumonia patterns
 - a. Round pneumonia
 - b. Primary TB pattern

I. Cardiac disease

- 1. Cardiomegaly congestive heart failure (CHF)

J. Mediastinal masses

- 1. Superior mediastinum
- 2. Anterior mediastinum
- 3. Middle mediastinum
- 4. Posterior mediastinum

K. Diaphragmatic lesions

- 1. Eventration/elevation
- 2. Phrenic nerve palsy
- 3. Subphrenic mass
- 4. Diaphragmatic injury

II. Musculoskeletal Images

A. Systematic observation of the chest radiograph

B. Clinical presentations related to differential diagnosis

C. Bone lesions

- 1. Aggressive or nonaggressive
- 2. Solitary or multiple lesions
- 3. Tumor characteristics
- 4. Periosteal reaction

D. Infection

- 1. Osteomyelitis
- 2. Septic arthritis

E. Trauma

- 1. Fracture and dislocation localization and description
- 2. Indirect signs of trauma
- 3. Union characterization
- 4. Complications associated with musculoskeletal (MSK) trauma (i.e., avascular necrosis (AVN), neurovascular injury)
- 5. Stress fractures
- 6. Immature skeleton
 - a. Physeal injury
 - b. Incomplete fractures

- c. Nonaccidental trauma
- 7. Pelvic fracture
 - a. Stable/unstable
- 8. Spine
 - a. Stable/unstable
 - b. Jefferson fracture
 - c. Odontoid fracture
 - d. Hangman fracture
 - e. Clay shoveler
 - f. Teardrop fracture
 - g. Facet dislocation
 - h. Thoracolumbar (i.e., burst, wedge, Chance)
- 9. Appendicular trauma
 - a. Radial head
 - b. Tibial plateau
 - c. Colles
 - d. Smith
 - e. Supracondylar
 - f. Jones
 - g. Scaphoid
 - h. Maisonneuve
 - i. Lisfranc

III. Images of the GI and Urinary Tracts

- A. Systematic observation of the abdominal radiograph
- B. Clinical presentations related to differential diagnosis
- C. The acute abdomen
 - 1. Pneumoperitoneum
 - 2. Intramural gas pattern
 - 3. Extramural gas
 - 4. Bowel obstruction pattern
 - 5. Paralytic ileus
 - 6. Cholecystitis
 - 7. Pancreatitis
 - 8. Abdominal fluid collections and abscesses
 - 9. Appendicitis
- D. GI tract patterns
 - 1. Esophagus
 - a. Ulcer patterns
 - b. Reflux esophagitis pattern
 - 1) Esophageal webs
 - 2) Carcinoma
 - 3) Benign stricture

- 4) Corrosive strictures
- 5) Extrinsic compression
- c. Carcinoma of the esophagus
- d. Esophageal varices
- e. Hiatal hernia
- 2. Stomach
 - a. Mass lesions
 - 1) Single gastric mass
 - a) Polyp leiomyoma or leiomyosarcoma
 - b) Bezoar
 - c) Extrinsic tumor: pancreatic adenocarcinoma
 - 2) Multiple gastric masses
 - a) Polyps
 - b) Fundal varices
 - c) Gastric cancer
 - d) Lymphomas
 - b. Thickened stomach folds
 - c. Ulcers
- 3. Small bowel
 - 1) Small bowel stricture
 - 2) Small bowel wall thickening
 - 3) Nodular small bowel pattern
- 4. Colon
 - a. Colon stricture pattern
 - 1) Neoplastic
 - 2) Inflammatory: diverticular disease, ulcerative colitis, Crohn
 - 3) Radiation
 - 4) Ischemia
 - 5) Extrinsic compression from tumors or inflammatory masses
 - b. Colonic mass pattern
 - 1) Polyps: adenomas, hamartomas
 - 2) Carcinoma
 - 3) Lymphoma
 - c. Megacolon
 - d. Diverticular disease
- E. Pediatric abdomen
 - 1. Esophageal and duodenal atresia
 - 2. Neonatal bowel obstruction
 - 3. Necrotizing enterocolitis
 - 4. Intussusception
 - 5. Malrotation
 - 6. Hirschsprung
- F. Urinary tract patterns
 - 1. Renal

- a. Unilateral small kidney
- b. Unilateral small irregular kidney
- c. Bilateral small kidneys
- d. Bilateral large smooth kidneys
- e. Unilateral large smooth kidney
- f. Renal masses
 - 1) Unilateral renal mass
 - a) Benign and malignant solid renal tumors
 - b) Simple cyst
 - c) Inflammatory mass (abscess)
 - d) Focal hydronephrosis
 - 2) Bilateral renal masses
 - a) Polycystic kidney disease
 - b) Acquired cystic kidney disease
- 2. Pelvicaliceal and ureteral patterns
 - 1) Dilatation
 - 2) Ulcers
 - 3) Displacement
 - 4) Filling defects
 - 5) Reflux
 - 6) Perforation
- 3. Bladder patterns
 - a. Small bladder
 - b. Large bladder
 - c. Prostate enlargement
 - d. Filling defects
- 4. Urethra
 - a. Filling defects
 - b. Dilatation
 - c. Perforation
- 5. Variants and developmental anomalies
 - a. Number
 - b. Size
 - c. Fusion
 - d. Position

IV. Neurological Imaging Patterns

- A. Systematic observations of CNS
- B. Clinical presentation related to differential diagnosis
- C. Brain
 - 1. Mass effect
 - 2. Hemorrhage
 - 3. Hydrocephalus
 - 4. Herniation

- D. Spinal cord
 - 1. Stenosis
 - 2. Compression
 - 3. Tethering
 - 4. Mass
 - 5. Cerebrospinal fluid (CSF) leak

V. Reproductive and Breast Imaging Patterns

- A. Systematic observations of CNS
- B. Clinical presentation related to differential diagnosis
- C. Uterus, fallopian tubes and ovaries
 - 1. Fibroids
 - 2. Anatomic anomalies
 - 3. Tubal patency
 - 4. Torsion
 - 5. Masses and cysts
 - 6. Infection
- D. Prostate, scrotum, testes
 - 1. Benign prostatic hypertrophy
 - 2. Masses
 - 3. Torsion
 - 4. Inguinal hernia
 - 5. Infection
- E. Breast
 - 1. Fibrocystic disease
 - 2. Infection
 - 3. Masses and cysts
 - 4. Calcifications
 - 5. Postsurgical

VI. Vascular Imaging Patterns

- A. Systematic observations of CNS
- B. Clinical presentation related to differential diagnosis
- C. Arteries
 - 1. Patency (i.e., thrombus, stenosis)
 - 2. Aneurysm
 - 3. Dissection
- D. Veins

1. Patency (i.e., thrombus, stenosis)
2. Varices

E. Shunts

F. Postsurgical

G. Anomalies

ASRT

Clinical Pathways Related to Best Practice Imaging

Description

Content is designed to introduce clinical pathways as multidisciplinary plans of best clinical practice for specific groups of patients with a particular diagnosis that aid the coordination and delivery of high-quality care. Clinical pathway components include a timeline, the categories of care or activities and their interventions, intermediate and long-term outcome criteria, and the variance record. Clinical pathways differ from practice guidelines, protocols and algorithms as they are used by a multidisciplinary team and have a focus on quality and coordination of care.

Objectives

1. Define clinical pathways as related to radiology.
2. Identify the rationale for the use of clinical pathways in the patient care setting.
3. Compose a model clinical pathway related to a radiologic diagnostic/therapeutic procedure.
4. Implement the use of clinical pathway knowledge in the clinical setting.
5. Identify criteria for evaluating clinical pathways.
6. Explain variance analysis as it relates to clinical pathway assessment.
7. Participate in the analysis of clinical pathway variance.
8. List the outcomes created through the implementation of clinical pathways in radiology.
9. Explain the relationship between clinical pathways and quality improvement in radiology.

Content

I. Clinical Pathways Defined

- A. Alternative phrases
 - 1. Care maps/paths
 - 2. Collaborative plans of care
 - 3. Multidisciplinary action plans
 - 4. Anticipated recovery paths
- B. Features
 - 1. Patient outcomes
 - 2. Timeline
 - 3. Collaboration
 - 4. Comprehensive aspects of care

II. Rationale for Developing Clinical Pathways

- A. Patient benefits
- B. Health care provider benefits
- C. Health care agency/system benefits
- D. Cost-effective health care delivery benefits

III. Clinical Pathway Development Plan

- A. Identification of expected patient outcomes
- B. Clinical pathway selection
 - 1. High-volume, high-cost, high-risk procedures
 - 2. Problem-prone procedures
 - 3. Insurance denials
 - 4. Quality improvement initiatives

IV. Clinical Pathways in Imaging

- A. Patient condition and status
- B. Radiologist expertise
- C. Equipment availability
- D. Clinical presentation
- E. Necessity of procedure for care plan
- F. Sequencing of imaging

G. ACR Appropriateness Criteria

H. Radiation exposure

V. Clinical Pathway Implementation Plan

A. Personnel involvement

B. Institution policy review

C. Contribution to patient care

VI. Clinical Pathway Evaluation Plan

A. Variance analysis

B. Outcomes analysis (i.e., infection rates, complication rates, mortality and morbidity rates)

ASRT

Report of Findings and Validation of Clinical Practice

Description

Content introduces guidelines for reporting initial observations made by the radiologist assistant during radiology procedures and image assessments. The radiologist assistant's role focuses on the systematic analysis of clinical practice — the diagnosis and treatment, resources, evidenced-based decision making, procedures and resulting outcomes, including the patient's quality of life.

Objectives

1. Provide initial observations to the radiologist based on practice guidelines.
2. Identify the required legal components of a report of findings following diagnostic testing.
3. Establish and evaluate the benchmarks as they apply to diagnostic testing.
4. Explain the rationale for performing clinical audits.
5. Identify audit schemes applied to the clinical setting.
6. Identify measurement criteria and instruments employed during a clinical audit.
7. Describe how sensitivity and specificity measurements apply to diagnostic testing.
8. Distinguish between positive and negative predictive values when evaluating the results of diagnostic testing.
9. Discuss the importance of sampling and biases on the internal and external validity of audits of diagnostic accuracy.

Content

I. Clinical Reporting

- A. Legal considerations and requirements

- B. Composing, recording and archiving a report of initial observations
 - 1. Demographics
 - 2. Patient name and identification source
 - 3. Name of referring physician
 - 4. Name or type of examination
 - 5. Date of the examination
 - 6. Time of the examination
 - 7. Date of report of initial observations
 - 8. Body of report
 - a. Procedures and materials
 - 1) Contrast media
 - 2) Medications
 - 3) Catheters and devices used
 - 4) Any patient reaction or complication
 - b. Observation details
 - c. Potential limitations
 - d. Clinical issues
 - e. Comparative data (i.e., previous examinations or reports)
 - f. Observation summary

II. Evaluation of Diagnostic Accuracy

- A. Benchmarks

- B. Sensitivity and specificity

- C. Predictive values

- D. Prior probability

- E. Bias

III. Clinical Audit

- A. Rationale

- B. Audit schemes
 - 1. External quality assessment
 - 2. Internal quality assessment
 - 3. Accreditation
 - 4. Clinical governance (i.e., credentialing)

- C. Audit categories
 - 1. Access

2. Process
3. Output
4. Outcome
5. Use of resources

D. Measurement criteria and instruments (i.e., ACR Appropriateness Criteria)

ASRT

Research and Professional Development

Description

Content aids in the development of inquiry, professional growth and research skills in support of evidence-based practice. Learning research skills and conducting research projects benefits the individual and the profession. The individual benefits by learning new knowledge and skills; the profession benefits by adding to the professional body of knowledge. One method of meeting this professional obligation is to review and synthesize professional literature or conduct research.

Objectives

1. Improve professional knowledge and clinical performance through research and self-reflection.
2. Evaluate current trends in health care and medical imaging.
3. Develop research skills.
4. Improve patient care and clinical outcomes through integration and dissemination of evidence-based research.
5. Apply ethical principles and legal requirements of research.
6. Conduct a comprehensive literature review for evidence of best practices.
7. Critique the research results for bias and study validity.
8. Analyze the validity of references.

Content

I. Intellectual Inquiry and Analysis of Research

- A. Source and quality of publications
- B. Relevance of background
- C. New knowledge created
- D. Application of new knowledge
- E. Research design
- F. Research bias and study validity, including significance tests and confidence intervals
- G. Application for future research and recommendations
- H. Implications for evidence-based professional practice
- I. Bibliography/reference documentation

II. Elements of Scholarship

- A. Ethical principles and legal consideration
- B. Research plan
- C. Qualitative and quantitative research
- D. Types of research design
 - 1. Literature review
 - 2. Experimental
 - 3. Descriptive/survey research
 - 4. Case study projects
 - 5. Randomized clinical trials

Legal, Professional Standards, Governmental Standards

Description

Content provides a fundamental background in the law and regulatory issues of today's health care culture. Advanced legal terminology, concepts and principles will be presented, discussed and applied in relation to clinical practice. Content includes basic concepts of patient information management. Medical records management, including privacy and regulatory issues, will be examined.

Objectives

1. Compare civil and criminal law.
2. Explain civil procedures.
3. Describe the concept of standard of care.
4. Distinguish between the different types of consent.
5. Describe the client or patient's legal responsibilities.
6. Describe the employer's legal responsibilities.
7. Describe the employee's legal responsibilities.
8. Discuss regulatory and accreditation issues related to health care.
9. Discuss the Joint Commission standards regarding the accountability and protection of patient information.
10. List the requirements of a patient consent document.
11. Identify challenges to the protection of patient information.
12. Discuss privacy and regulatory issues related to patient information.
13. Apply the Health Insurance Portability and Accountability Act (HIPAA) to patient information systems.
14. Identify potential abuses of confidential patient information.
15. Adhere to health information and medical informatics policies and procedures, including those related to the use of electronic health record systems.

Content

I. Scope of Practice

II. Practice Standards

III. Legal Issues

- A. Civil liability
- B. Intentional torts
 - 1. Elements
 - 2. Assault
 - 3. Battery
 - 4. False imprisonment
 - 5. Emotional distress
 - 6. Fraud
 - 7. Invasion of privacy
 - 8. Defamation
 - a. Slander
 - b. Libel
 - 9. Vicarious liability
- C. Unintentional torts/negligence
 - 1. Elements
 - 2. Contributory
 - 3. Comparative
- D. Criminal law
 - 1. Criminal negligence
 - 2. Falsification of records
 - 3. Drugs
 - 4. Fraud
 - 5. Patient abuse
 - 6. Theft

IV. Civil Procedures

- A. Pleadings
- B. Summons and complaint
- C. Discovery
- D. Evidence
- E. Motions
- F. Trial procedure

G. Evidence

H. Verdict

I. Appeals

V. Standard of Care

A. Scope of practice and practice standards

B. State statutes

C. Institutional policy

VI. Legal Doctrines

A. Burden of proof

B. Res ipsa loquitur

C. Respondeat superior

D. Personal liability

E. Good samaritan

VII. Consent

A. Informed

B. Uninformed

C. Implied

VIII. Patient Directives

A. Living wills and advanced directives

B. Do-not-resuscitate orders (DNR)

C. Power of attorney for health care

IX. Employer and Employee Responsibilities

A. Labor laws

B. Unions

C. Discrimination laws

- D. Harassment in the workplace
 - 1. Quid pro quo
 - 2. Hostile work environment
 - 3. Protected persons
 - 4. Unwelcome conduct
 - 5. Employer's liability
 - 6. Sexual harassment
 - 7. Harassment
 - 8. Assault and battery
 - 9. Infliction of emotional distress
 - 10. Invasion of privacy
 - 11. Wrongful discharge

- E. Conditions of employment
 - 1. Position descriptions
 - 2. Drug screening
 - 3. Background checks
 - 4. Misrepresentation

- F. Liability coverage
 - 1. Employer
 - 2. Personal

- G. Equipment operation and safety
 - 1. Hazard identification and control
 - 2. Policies and procedures
 - a. OSHA
 - b. CDC
 - c. Facility
 - d. State
 - 3. Employee training
 - 4. Fire, electrical and chemical safety
 - 5. Magnetic fields and radio frequency safety
 - 6. Injury prevention
 - 7. Safety/quality improvement committees
 - 8. Risk management

- H. Whistleblower protection

- I. Risk management

- X. Accreditation and Regulatory Issues**
 - A. Purpose of accreditation

 - B. Education program accreditation
 - 1. Programmatic accreditation

2. Regional accreditation
3. National proprietary agencies
4. State agencies and others

C. Health care facility accreditation

1. Federal
 - a. Nonvoluntary
 - b. Voluntary
2. State
 - a. Nonvoluntary
 - b. Voluntary

D. Health care professional credentialing

1. Certification
2. Licensure
3. Registration
4. Practice privileges

E. Regulatory agencies

1. FDA
2. NRC
3. OSHA
4. U.S. Department of Transportation
5. EPA
6. DEA
7. Office for Civil Rights
8. Centers for Medicare and Medicaid Services (CMS)
9. State agencies

F. Advisory agencies

1. International Commission on Radiation Units and Measurement (ICRP)
2. NCRP
3. NAS/NRC-BEIR
4. UNSCEAR
5. American National Standards Institute (ANSI)
 - a. Radioactive materials (RAM) licenses

XI. Joint Commission Standards

A. Accountability for protecting patient information

1. Information collection
2. Information maintenance
3. Use of personally identifiable health information
4. Contractual agreements
 - a. Confidentiality clause
5. Monitoring compliance

- B. Demonstrating compliance
 - 1. Audits
 - 2. External reviews
 - 3. Internal reviews
- C. Medication management and reconciliation
- D. Consents
 - 1. Informed
 - 2. Specific
 - 3. Voluntary
 - 4. Release of information
 - a. Purposes
 - b. Types of information released
 - c. Recipients of information
- E. Education regarding policies, rights and responsibilities
 - 1. Patient education
 - 2. Provider education

XII. Medical Record Content: Paper and Electronic

- A. Patient identification
- B. History
- C. Physical exam
- D. Psychosocial needs
- E. Treatment plan
- F. Physician orders
- G. Informed consent
- H. Clinical observations
 - I. Progress notes
 - J. Consultation requests and reports
- K. Surgical and invasive procedure reports
- L. Diagnostic procedure reports

- M. Transplant information
- N. Diagnosis
- O. Discharge summary and instructions
- P. Living will and advance directives
- Q. Patient education
- R. Interventions
- S. Outcomes

XIII. Techniques and Procedures for Proper Documentation

- A. Location
- B. Date
- C. Time
- D. Frequency
- E. Route
- F. Content
- G. Signature
- H. Corrections
- I. Abbreviations

XIV. Patient Information Standards

- A. Privacy issues
 - 1. HIPAA
 - 2. Electronic transactions and code sets for preauthorization of procedures
- B. Security standards
 - 1. Physical and technical safeguards for the storage and transmission of protected health information
 - 2. Unique identifiers
 - a. Providers
 - b. Employers
 - c. Health plans

- d. Individuals
 - 3. Electronic digital signature
 - 4. Internal review board approval
 - a. Experimental research protocols
 - b. Nonexperimental research protocols
- C. Medical informatics
- 1. Definition of informatics
 - 2. Application in medicine
 - 3. Telemedicine
 - 4. Management
 - a. Data
 - b. Information
 - c. Knowledge
 - 5. Information systems and standards
 - a. Hospital information system (HIS)
 - b. Electronic health records (EHR)
 - c. Radiology information system (RIS)
 - d. Picture archiving and communications system (PACS)
 - 1) Computed radiography (CR)
 - 2) Digital radiography (DR)
 - e. Digital imaging and communications in medicine (DICOM)
 - 6. Information as a commodity
 - a. Potential abuses

Radiologist Mentored Clinical Experience

Description

Mentored clinical experience is the cornerstone in the development of the radiologist assistant. RA students work closely with radiologist mentors to maximize the learning opportunities available in the clinical environment. It is recognized that no two diagnostic imaging centers will be exactly the same. The RA student and radiologist mentor collaborate to establish goals and expectations for this portion of the curriculum. A clear understanding of the degree of autonomy in the performance of diagnostic/ therapeutic procedures and the assistant's contribution to the radiologist's final diagnosis of these procedures is essential to the clinical experience.

Prerequisite or Corequisite

It is required that radiologist assistants possess or obtain certification in advanced cardiac life support (ACLS) in support of their role in the patient care setting.

Objectives

1. Demonstrate competence in performing diagnostic/therapeutic procedures under the supervision of a radiologist mentor.
2. Provide initial observations and outcomes of examinations performed for review, interpretation and approval by the radiologist mentor.
3. Assess, evaluate and formulate priorities in daily practice.
4. Establish patient-centered clinically effective service delivery strategies.
5. Implement and perform diagnostic/therapeutic procedures adhering to accepted departmental, institutional, governmental and professional standards.
6. Assess and evaluate the patient's status and condition prior to, during and after diagnostic/therapeutic procedures.
7. Apply the principles of radiation protection standards.
8. Apply principles of quality improvement.
9. Establish appropriate and effective written, oral and nonverbal communication with patient, family, health care providers and the public.
10. Respect and recognize the clinical significance of the patient's personal beliefs and values for adaptation to procedure protocols.
11. Function within the radiologist assistant scope of practice and practice standards in accordance with state regulations and institutional policies.
12. Assess and evaluate psychological and physical changes in the patient's condition and formulate appropriate actions.
13. Appraise cultural and age differences that influence patient compliance with procedural requirements.
14. Interact with the patient and family in a manner that provides the desired psychosocial support.
15. Document care in the patient's medical record in accordance with institutional and legal guidelines.

Appendix A

The following is supplemental information to link core instructional content to the application of knowledge and activities in clinical practice.

ASRT

Clinical Knowledge and Activities Associated with Patient Assessment, Management and Education

The radiologist assistant, with the supervision of a radiologist mentor, participates in and coordinates patient assessment, management and education functions in the radiology setting.

Patient Assessment

The radiologist assistant collects pertinent data about the patient and the procedure.

The radiologist assistant:

1. Uses consistent and appropriate techniques to gather relevant information from the medical record, significant others and health care providers (the collection of information is determined by the patient's needs or condition).
2. Reconfirms patient identification and verifies the procedure requested or prescribed.
3. Verifies the patient's pregnancy status when appropriate.
4. Determines whether the patient has been appropriately prepared for the procedure.
5. Assesses factors that may contraindicate the procedure, such as medications, medical or psychological indicators, insufficient patient preparation or artifacts.
6. Performs history and physical examination with radiologic procedure focus.

Patient Management

The radiologist assistant analyzes the information obtained during the assessment phase and develops an action plan for completing the procedure.

The radiologist assistant:

1. Selects the most appropriate action plan after reviewing all pertinent data and assessing the patient's abilities and condition.
2. Uses his or her professional judgment to recommend or adapt protocols for radiologic procedures to improve diagnostic quality and outcome.
3. Consults with the radiologist mentor to determine a modified action plan when necessary.
4. Determines the need for accessory equipment.
5. Modifies protocol to reduce patient exposure dose.
6. Monitors and documents the total fluoroscopy time for medical records.
7. Verifies QA/QC to ensure safely operating equipment before patient exposure.

Patient Education

The radiologist assistant provides information about the procedure to the patient, significant others and health care providers.

The radiologist assistant:

1. Verifies/obtains patient consent prior to initiating a procedure and verifies that the patient fully understands its risks, benefits, alternatives and follow-up.

2. Provides accurate explanations and instructions at an appropriate time and at a level the patient can understand.
3. Addresses and documents patient questions and concerns regarding the procedure.
4. Follows departmental protocols to provide appropriate information to authorized individuals involved in the patient's care.

ASRT

Clinical Knowledge and Activities Associated with Radiology Procedures

Implementing Examination Protocol

The radiologist assistant, with supervision of a radiologist mentor, implements the action plan.

The radiologist assistant:

1. Implements an action plan that falls within established protocols and guidelines.
2. Elicits the cooperation of the patient to execute the action plan.
3. Uses an integrated team approach as needed.
4. Modifies the action plan according to changes in the clinical situation.
5. Administers first aid or provides advanced life support in emergency situations.
6. Uses accessory equipment when appropriate.
7. Assesses and monitors the patient's physical and mental status.

Adapting Examination Protocol

The radiologist assistant implements the revised action plan.

The radiologist assistant:

1. Bases the revised plan on the patient's condition and the most appropriate means of achieving the intended outcome.
2. Takes action based on patient and procedural variances.
3. Measures and evaluates the results of the revised action plan.
4. Notifies appropriate health provider when immediate clinical response is necessary based on procedural findings and patient condition.

Measuring Outcomes

The radiologist assistant reviews and evaluates the outcome of the procedure.

The radiologist assistant:

1. Reviews all diagnostic or therapeutic data for completeness and accuracy.
2. Determines whether the actual outcome is within established criteria.
3. Evaluates the process and recognizes opportunities for future changes.
4. Assesses the patient's physical and mental status prior to discharge from the radiologist assistant's care.

Documentation

The radiologist assistant documents information about patient care, the procedure and the final outcome.

The radiologist assistant:

1. Documents diagnostic, treatment and patient data in the appropriate record.
2. Documents any exceptions from the established criteria or procedures.
3. Forwards a memorandum of initial observations made during the examination and evaluation of images to the radiologist mentor.

ASRT

Clinical Knowledge and Activities Associated with Image and Procedure Observations and Communication

Observing Images/Procedures

The radiologist assistant correlates the radiologic and patient findings to the patient's clinical presentation and symptoms.

The radiologist assistant:

1. Provides an analysis of images and makes recommendations to enhance diagnostic image quality.
2. Records observations or procedure data according to approved protocols.
3. Documents diagnostic, procedure and patient data in the appropriate record.
4. Documents any exceptions from the established criteria or procedures.

Communicating Observations

The radiologist assistant generates an internal memorandum containing a summary of observations to the interpreting radiologist.

The radiologist assistant:

1. Documents diagnostic and patient data in the appropriate medical record, according to departmental practices.
2. Ensures that the documentation is timely, accurate, concise and complete.
3. Communicates the report(s) of radiologist's findings to the referring physician or an appropriate representative with appropriate documentation.

Clinical Audit

The radiologist assistant participates in the systematic analysis of the quality of care including the diagnosis and treatment, resources, outcomes and patient quality of life.

The radiologist assistant:

1. Participates in the auditing of clinical services offered within the radiology department.
2. Assists in formulating a report of clinical audit findings to the radiologist mentor.

Implementation Strategies for Mentored Clinical Experience

Introduction

Each patient care setting offers a unique environment for RA student-radiologist mentored clinical experience. Each radiologist mentor must be afforded the latitude to facilitate RA student development and engage the student in the learning experience. Learning contracts combined with the development of individual RA student portfolios are recommended for structuring the content and critical assessment of this segment of the planned curriculum.

Learning Contracts

A learning contract is a practical arrangement between a “mentor” and “student” to enable both to make the most of learning opportunities in the time available. It spells out the objectives and responsibilities of each person in the situation so that both are clear about expectations and assignment of responsibility. It takes the form of a written statement.

Learning contracts focus on the process of learning. This feature is believed to be a key element in the development of radiologist assistants. The learning contract helps the radiologist mentor and RA student structure what is to be learned, how it is to be learned and how learning will be verified. Contracts, though not legally binding, are written agreements or commitments reached between the radiologist mentor and RA student.

A typical learning contract specifies the following:

1. The knowledge, skill, attitudes and values to be acquired by the learner.
2. How these objectives are to be accomplished through an identification of learning resources and strategies.
3. Plans for interim feedback to the learner, self-reflection on progress in accomplishing learning objectives, with the option to modify the learning contract if needed.
4. The target date for completion.
5. The evidence presented to demonstrate that the objectives have been accomplished.
6. How the evidence is to be judged or validated.

Throughout the mentored clinical experience, a fabric of learning contracts will ensure that the radiologist assistant is fully prepared to assume his or her advanced-level technical role in the patient care setting.

Student Portfolios

Portfolios are purposeful collections of examples of RA student work annotated with RA student reflective commentary. Examples may be drawn from assignments associated with a single clinical event, or from curricular and cocurricular activities spanning a broad period of time.

Portfolio development consists of five stages:

1. **Collection:** RA students learn to save artifacts that represent the successes (and “growth opportunities”) in their day-to-day teaching and learning.
2. **Selection:** RA students review and evaluate the artifacts they have saved, and identify those that demonstrate achievement of specific objectives and goals.
3. **Reflection:** RA students become reflective individuals, evaluating their own growth and their clinical achievements over time, as well as the gaps in their development.
4. **Direction:** Radiologist mentors and RA students compare their reflections to performance indicators and set learning goals for the future. This portion of individual professional development supports key elements of lifelong learning.
5. **Presentation:** RA students may share their portfolios with their peers, colleagues or future employers. This stage helps to encourage collaboration and commitment to professional development and lifelong learning.

RA student portfolios offer another bridge that deepens the RA student-radiologist mentor relationship. Portfolios also provide insights for tailoring learning contracts as the RA student progresses through the clinical experience.

Appendix B

Appendix includes content descriptions and learning objectives for items in the Foundations section.

ASRT

Advanced Patient Care

Description

As the role of the medical imaging professional continues to expand, more knowledge is needed in all areas. Patient care is no exception. Advanced patient care skills are essential elements of providing high-quality patient care. This course focuses on patient education, assessment, communication, preprocedural and postprocedural care and proper charting and documentation. Technologists' responsibilities and intervention in cases of critical patient need also will be discussed.

Objectives

1. Describe the areas required for patient education in medical imaging.
2. Contribute to treatment plan based on a patient assessment.
3. Define the types of communication and describe how each should or should not be used.
4. Perform proper charting and documentation using manual or electronic formats.
5. Analyze a situation requiring drug dispensing to determine the proper drug amount and route of administration.
6. List the parameters used in the current American Heart Association (AHA) Advanced Cardiac Life Support Guidelines.
7. Recognize normal and abnormal cardiac rhythms.

Advanced Sectional Anatomy

Description

The ability to locate and identify structures in the axial (transverse), sagittal, coronal and orthogonal (oblique) planes is critical in all imaging modalities. Volumetric data sets and three-dimensional reconstruction of the body structures are increasingly important to the critical diagnosis and treatment of diseases. To enhance patient care and assist physicians with the prognosis, radiologic science professionals must understand cross-sectional anatomy in each of the imaging modalities.

Objectives

1. Distinguish normal anatomical structures on CT, MR ,ultrasound, nuclear medicine, fusion interventional and cardiac catheterization lab images in the transverse axial, coronal, sagittal and orthogonal (oblique) cross-sectional imaging planes common to each modality within the:
 - a. Head
 - b. Neck
 - c. Thorax
 - d. Abdomen
 - e. Pelvis
 - f. Body imaging
 - g. Extremities – large joints
2. Distinguish common pathologies recorded on multiplanar images.

Communication

Description

Communication is important because the radiologic technologist needs to effectively relate and communicate with patients and other health care professionals. This content focuses on expanding the knowledge base and skills necessary for interpersonal, internal, external and written communications. Sensitivity to human diversity will be emphasized.

Objectives

1. Apply the appropriate interpersonal communication methods to a given health care relationship.
2. Apply intracommunication principles that affect health care relationships.
3. Develop an internal communication strategy for a small group and its organization.
4. Develop a presentation and deliver it to an audience.
5. Determine the appropriate communication tool for delivering information to a specific audience.
6. Compose written communication.

Ethics and Diversity

Description

Ethics and diversity are important because all health care providers work in a global community that is increasingly diverse and complex. Health care providers must interact with individuals from a variety of backgrounds both ethically and with respect for their beliefs and values. This content focuses on ethical and diverse issues that affect the radiologic technologist's interactions with patients, co-workers, and the community.

Objectives

1. Assess situations to determine if a radiologic technologist performed ethically based on personal, societal and professional standards within the United States.
2. Examine a situation to determine if the radiologic technologist interacts appropriately and respectfully with a diverse population.

ASRT

Health Care Delivery

Description

It is important for the radiologic technologist to understand the various methods of health care delivery to remain knowledgeable in the changing face of technology. The political context of health care organization and delivery, with specific focus on the mechanisms for policy formulation and implementation will be discussed.

Objectives

1. Debate historical perspectives and technological advances as they relate to the delivery of health care.
2. Discriminate between various policy formation mechanisms and the impact of each onto direct patient care.
3. Analyze the various influences of policy on direct patient care.
4. Compare and contrast the different types of health care delivery systems.
5. Characterize the sources of research and monitoring in health care delivery.
6. Examine the impact of imaging technology on health care delivery.

Health Care Law and Compliance

Description

Health care law and compliance is important because of its financial and emotional impact on technologists, patients and health care facilities. This content is geared toward legal and compliance issues that affect the employee and employer directly regarding accreditation and compliance issues. In addition this content gives guidance on risk management techniques, including reporting, that can help mitigate noncompliance.

Objectives

1. Analyze various scenarios involving roles and responsibilities of radiologic technologists to determine if they are working within the scope of practice and using appropriate practice standards.
2. Evaluate an existing risk management plan to determine if it complies with effective risk management principles.
3. Properly complete and investigate an incident report.
4. Analyze a case study to determine implications of civil and criminal law upon professional licensing/certification and accreditation.
5. Outline civil procedures followed when a complaint is filed against an R.T.
6. Given a legal complaint scenario, determine which party has the burden of proof and the party's responsibilities.
7. Analyze a situation to determine the type of patient consent granted.
8. Appraise a scenario to determine if the radiologic technologist is violating the patient's rights.
9. Differentiate between the employer's and employee's legal responsibilities.
10. Classify the accreditation and compliance issues relevant to health care facilities.

Pathophysiology

Description

A rich appreciation of the characteristics and manifestations of diseases caused by alterations or injury to the structure or function of the body are essential to the radiologic science professional. The in-depth study of pathophysiology allows the professional to communicate better with other health care professionals, including physicians and scientists, as well as with the patient, for the history and physical assessment.

Objectives

1. Discuss predictive factors influencing health and the development of disease, including genetics, lifestyle, age and environment.
2. Outline how the body responds to hereditary, lifestyle, and environmental influences on health.
3. Discuss the pathophysiology of the major body systems.
4. Describe clinical manifestations of disease processes occurring across the lifespan.

Patient Information Management

Description

Patient information management is important because of the integral role the radiologic technologist has within the health care team. It is essential for the radiologic technologist to provide all members of the team with a thorough patient record to ensure quality patient care.

Objectives:

1. Relate The Joint Commission standards and Health Insurance Portability and Accountability Act (HIPAA) regulations regarding the accountability and protection of patient information.
2. Evaluate the patient record to ensure The Joint Commission standards and HIPAA regulations are satisfied.
3. Judge the potential abuses in maintaining confidential patient information.

ASRT

Pharmacology

Description

An exploration of pharmacology is necessary to provide the student with comprehensive knowledge concerning drugs and their applications in medical imaging. Drug regulations, types of drugs and drug administration are included. Discussions will integrate the selection of drugs with their appropriate use and possible effects.

Objectives

1. Outline consumer safety and drug regulations.
2. Differentiate among various types of drugs and their proper application.
3. Administer drugs commonly used for medical imaging.
4. Assess various types of responses following drug administration.

ASRT

Quality Management

Description

Quality management is important to ensure the proper functioning of equipment and compliance with government and accreditation standards. Thus, technologists should have an understanding of the activities and their role in the quality management (QM) process. This content is designed to expand the QM skills of the technologist to include digital imaging systems and the application of QM principles in an imaging department.

Objectives

1. Differentiate between quality management (QM), quality assurance (QA) and quality control (QC).
2. Apply QM principles to a given scenario.
3. Analyze collected QM data and make appropriate recommendations.
4. Analyze the benefits of a QM program to the patient and to the department.
5. Develop a QM plan to collect data for digital imaging equipment.

Research Methods and Information Literacy

Description

Research methods and information literacy are important because the health care profession is continually changing, which requires the radiologic technologist to possess new knowledge to function competently. The radiologic technologist should contribute to the body of knowledge and be able to effectively analyze resources to promote growth in the profession. The attitude of lifelong learning enables the radiologic technologist to stay in step with the current health care environment and be prepared to help foster the future and increase awareness of the profession in the global community. This content is geared to increase and disseminate intellectual inquiry, information literacy and the use of scholarly research methods.

Objectives

1. Analyze research articles to determine the accuracy and validity of findings.
2. Integrate information literacy concepts into a research project.
3. Critique research projects to determine appropriateness and usefulness to the profession.

Teamwork

Description

Teamwork is a vital component of all health care teams. To promote an effective team, the radiologic technologist must be able to exercise the ability to function within an interdisciplinary team. It is highly recommended for this information to be applied throughout the curriculum to ensure adequate understanding based on various situations.

Objectives

1. Evaluate the elements of a team as they relate to the effectiveness of the team.
2. Debate the advantages and disadvantages of a team.
3. Justify the role of team members in the effectiveness of the team.

ASRT

Resources

Textbooks

Abrams AC. *Clinical Drug Therapy*. 7th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.

ISBN 0781739276

Barkauskas VH, Baumann LC, Darling-Fisher C. *Health and Physical Assessment*. 3rd ed. St. Louis, MO: Mosby; 2002.

ISBN 0323012140

Bickley LS. *Bates' Guide to Physical Examination and History Taking*. 10th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2009.

ISBN 0781780586

Brant WE, Helms, CA. *Fundamentals of Diagnostic Radiology*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.

ISBN 0781761352

Compendium of Drug Therapy (Physician's ed.). Secaucus, NJ: Compendium Publications Group; 1993-1994.

ISSN 10634487

Daffner RH. *Clinical Radiology: The Essentials*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2007.

ISBN 0781799686

Dähnert W. *Radiology Review Manual*. 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2007.

ISBN 0781766206

Davies SG. *Aids to Radiological Differential Diagnosis*. 5th ed. Edinburgh, NY: Saunders; 2009.

ISBN 0702029793

Dunnick NR, Sandler CM, Newhouse JH, Amis ES. *Textbook of Uroradiology*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2007.

ISBN 0781767504

Eisenberg RL. *Gastrointestinal Radiology: A Pattern Approach*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2002.

ISBN 0781737060

Eisenberg RL. *Gastrointestinal Radiology Companion: Imaging Fundamentals*. Philadelphia, PA: Lippincott Williams & Wilkins; 1999.
ISBN 0781719461

Erkonen WE, Smith WL. *Radiology 101: The Basics and Fundamentals of Imaging*. 3rd ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins Health; 2009.
ISBN 1605472255

Felson B. *Chest Roentgenology*. Philadelphia, PA: WB Saunders Co; 1973.
ISBN 0721635911

Gutierrez K. *Pharmacotherapeutics Clinical Decision-Making in Nursing*. 2nd ed. St. Louis, MO: Saunders Elsevier; 2008.
ISBN 1416032878

Helms CA. *Fundamentals of Skeletal Radiology*. 3rd ed. Philadelphia, PA: WB Saunders Co; 2005.
ISBN 0721605702

Houston JD, Davis M. *Fundamentals of Fluoroscopy*. Philadelphia, PA; Saunders Elsevier; 2001.
ISBN 0721694071

Judson K, Harrison C, Hicks SB. *Law & Ethics for Medical Careers*. 5th ed. Boston, MA: McGraw-Hill Higher Education; 2010.
ISBN 0073402060

Juhl JH, Crummy AB, Kuhlman JE. *Paul & Juhl's Essentials of Radiologic Imaging*. 7th ed. Philadelphia, PA: Lippencott-Raven; 1998.
ISBN 0397584210

Fauci A, Bruanwald E, Kasper DL, Hauser S. *Harrison's Manual of Medicine*. 17th ed. New York, NY: McGraw-Hill Medical; 2009.
ISBN 0071477438

Fauci A, Bruanwald E, Kasper DL, Hauser S. *Harrison's Principles of Internal Medicine*. 17th ed. New York, NY: McGraw-Hill Medical; 2008.
ISBN 0071391401

Keats TE, Anderson MW. *Atlas of Normal Roentgen Variants that may Simulate Disease*. 8th ed. St. Louis, MO: Mosby; 2006.
ISBN 0323043003

Lehne RA. *Pharmacology for Nursing Care*. 7th ed. St. Louis, MO: Saunders Elsevier; 2010.
ISBN 0721698433

Lipman JC. *Quick Reference to Radiology*. Norwalk, CN: Appleton & Lange; 1995
ISBN 083858196X

McCance KL, Huether S. *Pathophysiology: The Biologic Basis for Disease in Adults & Children*. 6th ed. Maryland Heights, MO: Mosby Elsevier; 2010.
ISBN 0323065848

McCloud TC. *Thoracic Radiology: The Requisites*. 2nd ed. Philadelphia, PA: Mosby Elsevier; 2010
ISBN 0323027903

Meredith PV, Horan NM. *Adult Primary Care*. Philadelphia, PA: WB Saunders Company; 2000.
ISBN 0721660371

Mukesh RM, ed. *Physicians' Desk Reference Companion Guide*. 57th ed. Montvale, NJ: Medical Economics; 2003.
ISBN 1563634503

Novelline RA. *Squire's Fundamentals of Radiology*. 6th ed. Cambridge, MA: Harvard University Press; 2004.
ISBN 0674012798

Raby N, Berman L, De Lacy G. *Accident and Emergency Radiology A Survival Guide*. 2nd ed. Philadelphia, PA: WB Saunders Company; 2005.
ISBN 0702026670

Resnick D, Kransdorf M. *Bone and Joint Imaging*. 3rd ed. Philadelphia, PA: WB Saunders Company; 2004.
ISBN 0721602703

Seidel HM, Ball JW, Dains JE, Flynn JA, Solomon BS, Stewart RW. *Mosby's Guide to Physical Examination*. 7th ed. St. Louis, MO: Mosby; 2010.
ISBN 0323055702

Silverman FN, Kuhn JP, eds. *Caffey's Pediatric X-Ray Diagnosis: An Integrated Imaging Approach*. 9th ed. St. Louis, MO: Mosby Year Book; 1993.
ISBN 0815114621

Statkewicz Sherer MA, Visconti PJ, Ritenour R. *Radiation Protection in Medical Radiography*. 6th ed. Maryland Heights, MO: Mosby Elsevier; 2010.
ISBN 0323066119

Zagoria RJ, Tung GA. *Genitourinary Radiology: The Requisites*. 2nd ed. St. Louis, MO: Mosby Year Book; 2004.
ISBN 0323018424

Websites

Harrison's Online

www.accessmedicine.com/resourceTOC.aspx?resourceID=4

Lexi-Comp Online TM

www.lexi.com

Micromedex

www.micromedex.com

WebMD Scientific American Medicine

www.medscape.com

ASRT