Limited X-Ray Machine Operator Curriculum

Sponsored by the American Society of Radiologic Technologists, 15000 Central Ave. SE, Albuquerque, NM 87123-3909.

Introduction

The ASRT defines a limited x-ray machine operator (LXMO) as an individual other than a radiologic technologist who performs diagnostic x-ray procedures on selected anatomical sites. LXMO is the term that replaces other terms including, but not limited to, radiologic technician, x-ray technician and limited permittee.

Although LXMOs perform imaging tasks within a limited scope, the ASRT believes that, within the specific area of radiography, the knowledge and cognitive skills underlying the intelligent performance of the LXMO must be equivalent to that of the general radiographer.

The ASRT does not endorse the adoption of provisions relating to limited x-ray machine operators unless these individuals are currently licensed by the state to perform limited medical imaging services. This curriculum document is intended to establish national, standardized educational guidelines for LXMOs, including clinical and didactic components. The document contains education appropriate to body areas as defined through the limited scope examinations offered by ARRT or other nationally recognized certifying agencies. The content is designed to ensure quality patient care, radiation protection and production of quality images.

This curriculum is divided into specific content areas that represent the essential components of a LXMO program. The content and objectives should be organized to meet the mission, goals and needs of each LXMO program. Proposed minimum hours of didactic instruction and clinical experience have been included to assist in program planning. Faculty members are encouraged to expand and broaden these fundamental objectives as they incorporate them into their curricula. Specific instructional methods were intentionally omitted to allow for programmatic prerogative as well as creativity in instructional delivery.

Advances in diagnostic imaging and employer expectations demand independent judgment by LXMOs. Consequently, critical thinking skills must be fostered, developed and assessed in the educational process. Critical-thinking has been incorporated in multiple content areas. It is expected that the faculty will develop and implement critical thinking throughout the curriculum.

In summary, the LXMO core curriculum is based on data relevant to today's health care environment. The curriculum offers a foundation for lifelong learning and transition to general radiography studies. It allows for faculty flexibility in the development of curriculum designed to meet the needs of individuals performing diagnostic x-ray procedures within a limited scope of practice.

LXMO Operator Curriculum

Table of Contents

Core Content

Clinical Practice

Description
Content and clinical practice experiences shall be designed for sequential development, application, critical analysis, integration, synthesis and evaluation of concepts and theories in the performance of radiologic procedures. Through structured sequential, competency-based assignments in a clinical setting, concepts of team practice, patient-centered clinical practice and professional development shall be discussed, examined and evaluated. Clinical practice experiences shall be designed to provide patient care and assessment and competent performance of radiologic imaging. Levels of clinical competency and outcomes measurement shall ensure the well-being of the patient preparatory to, during and following the radiologic procedure.

Clinical practice sites must be able to offer students an opportunity to experience patient procedures in a sufficient volume, variety and frequency within anatomic areas to develop skills that support competent exam performance. The proposed hours of clinical experience and number of procedures by anatomic area listed below, are an expression of minimum values that need to be factored into the selection of clinical sites and planning of student clinical assignments. Individual states that have existing provisions for limited x-ray machine operators may have eligibility requirements that exceed the clinical hours or number of exams listed here.

Proposed minimum hours of clinical experience and number of procedures within each anatomic area:

- **Chest and thorax – 160 hours and 100 procedures**
- **Extremities:**
  - **Upper extremity and pectoral girdle – 240 hours and 50 procedures**
  - **Lower extremity – 240 hours and 50 procedures**
- **Podiatric – 160 hours and 50 procedures**
- **Vertebral column – 240 hours and 50 procedures**
- **Cranium – 240 hours and 50 procedures**

Objectives

1. Execute imaging procedures under the appropriate level of supervision.
2. Adhere to concepts of team practice that focus on organizational theories, roles of team members and conflict resolution.
3. Adapt to changes and varying clinical situations.
4. Support patient-centered clinically effective service for all patients regardless of age, gender, disability, special needs, ethnicity or culture.
5. Integrate the use of appropriate and effective written, oral and nonverbal communication with patients, the public and members of the health care team (peers, licensed practitioners, administration, etc.) in the clinical setting.
6. Manage interactions with the patient and family in a manner that provides the desired psychosocial support.
7. Demonstrate skills in assessment and evaluation of psychological and physical changes in the patient's condition and carry out appropriate actions.

8. Examine gender, cultural, age and socioeconomic factors that influence patient compliance with procedures.
9. Adapt procedures to meet age-specific, disease-specific and cultural needs of patients.
10. Assess the patient and record patient histories.
11. Assess patient using the ABCs of cardiopulmonary resuscitation (CPR) and demonstrate basic life support procedures.
12. Respond appropriately to patient emergencies.
13. Document care in the patient's record.
14. Apply standard precautions.
15. Apply the appropriate medical asepsis.
16. Demonstrate competency in the principles of radiation protection standards to include time, distance, shielding and radiation monitoring.
17. Apply the principles of total quality management.
18. Report equipment malfunctions to assist with appropriate corrective actions.
19. Examine procedure orders for accuracy and follow-up to make corrective changes when applicable.
20. Support safe, ethical and legal practices.
21. Integrate the LXMO's scope of practice and practice standards into clinical practice setting.
22. Act consistently to maintain patient confidentiality standards (Health Insurance Portability and Accountability Act or HIPAA).
23. Carry out principles of transferring, positioning, immobilizing and restraining of patients.
24. Comply with departmental and institution procedures for response to emergencies, disasters and accidents.
25. Differentiate between emergency and nonemergency procedures.
26. Adhere to national, institutional and/or department standards, policies and procedures regarding care of patients, provision of radiologic procedures and the reduction of medical errors.
27. Ensure that performance reflects professional competence in the selection of technical factors to produce quality diagnostic images with lowest radiation exposure possible.
28. Critique images for appropriate clinical information, image quality and patient documentation.
29. Ensure that performance reflects professional competence in determining corrective measures to improve inadequate images.

Content

I. Clinical Practice

A. Code of ethics/professional behavior
   1. Scope of practice
   2. Practice standards
   3. Incident reporting mechanisms
   4. Standards for LXMO supervision in training
      a. Pre-competency assessment
      b. Post-competency assessment

B. Professional communication
   1. Patients
   2. Patient's family
   3. Health care team

C. Role of health care team members
   1. Technical
   2. Professional
   3. Patient's Bill of Rights

D. Scheduling and sequencing of exams

II. Procedural Performance

A. Order/requisition evaluation

B. Radiographic room setup

C. Patient assessment
   1. Patient monitoring
      a. Vitals
      b. Equipment
         1) Crash cart
         2) Oxygen
      c. Patient emergencies
         1) Cardiac/respiratory arrest
         2) Physical injury
         3) Seizures
         4) Diabetic emergencies
      d. Basic life support
   2. Interpretation of patient records
      a. HIPAA
      b. Confidentiality
   3. Documentation
   4. Special considerations
      a. Patient-focused care
      b. Standard precautions

c. Medical asepsis
5. Communication style
6. Age specific considerations
7. Cultural and socioeconomic sensitivity

D. Imaging
1. Positioning
a. Body mechanics
b. Positioning accessories
2. Technical considerations
a. Manual
b. Automatic exposure control (AEC)
c. Cassette-based and cassette-less systems
3. Image processing
4. Image analysis
a. Image quality
1) Density
2) Contrast
3) Recorded detail
4) Distortion
b. Image postprocessing
c. Legal requirements for image documentation

E. Patient/personnel protection
1. Radiation
a. Time
b. Distance
c. Shielding
d. Radiation monitoring
e. Exposure reduction techniques
2. Equipment/accessories
a. Beam restriction
b. Filtration
c. Positioning
d. Image receptor system
e. Scatter radiation control techniques
f. Technical factor selection
3. Medical error reduction

III. Competency (Mandatory, Elective)*

A. Chest and thorax
1. Lungs
2. Ribs

B. Extremities
1. Upper extremity

a. Thumb
b. Fingers
c. Hand
d. Wrist
e. Radius/ulna
f. Elbow
g. Humerus

2. Pectoral girdle
   a. Shoulder joint
   b. Clavicle
   c. Scapula
   d. Acromioclavicular joints
3. Lower extremity
   a. Toes
   b. Foot
   c. Ankle
   d. Calcaneus
   e. Tibia/fibula
   f. Knee/patella
   g. Distal femur

C. Cranium
   1. Skull
   2. Facial bones
   3. Nasal bones
   4. Orbits
   5. Pantomography mandible
   6. Paranasal sinuses

D. Vertebral column
   1. Cervical
   2. Thoracic
   3. Lumbar
   4. Scoliosis survey
   5. Sacrum
   6. Coccyx
   7. Sacroiliac joints

*Refer to Appendix A Inventory of Clinical Competencies for mandatory and elective requirements.

Digital Image Acquisition and Display

Description
Content is designed to impart an understanding of the components, principles and operation of cassette-based and cassette-less imaging systems found in diagnostic radiology. Factors that affect image acquisition, display, archiving and retrieval are discussed.

Proposed minimum hours of instruction: 40

Objectives
1. Define terminology associated with digital imaging systems.
2. Explain basic digital display characteristics with regard to pixel and matrix size.
3. Explain how pixels are assigned a shade of gray.
4. Describe the function of each component of a photostimulable phosphor (PSP) imaging plate.
5. Explain the response of PSP systems to background and scatter radiations.
6. Discuss how an image is retrieved from a photostimulable phosphor.
7. Describe the function of each component of a flat panel detector.
8. Compare the image acquisition and extraction of cassette-based vs. cassette-less systems.
9. Demonstrate how imaging plates are fed into an imaging plate reader device.
10. Compare the advantages and limits of each system.
11. Compare dynamic range to latitude of a screen/film receptor system to that of a digital radiography (DR) system.
12. Describe the importance of exposure field recognition for cassette-based and cassette-less imaging systems.
13. Link receptor exposure indicator (EI) values to technical factors, system calibration, part, beam and plate alignment and patient exposure.
14. Use appropriate means of scatter radiation control.
15. Analyze grid use errors associated with grid cutoff and Moiré effect.
16. Describe the histogram and the process of histogram construction and analysis as it relates to automatic rescaling.
17. Associate the impact of image processing parameters to image appearance.
18. Describe the conditions that cause quantum mottle in a digital image.
19. Employ appropriate beam, part and receptor alignment to avoid histogram analysis errors.
20. Apply the fundamental principles of image receptor exposure to digital detectors.
21. Examine the potential impact of digital radiographic systems on patient exposure and methods of practicing the as low as reasonably achievable (ALARA) concept with digital systems.
22. Describe picture archival and communications system (PACS) and its function.
23. Describe patient benefits gained through the use of teleradiology.
24. Describe the importance of the accession number associated with the patient exam data.
25. Describe the Worklist and correct usage.
26. Define digital imaging and communications in medicine (DICOM).
27. Describe HIPAA concerns with electronic information.

28. Describe the variations in image display characteristics between a Diagnostic Display Workstation and Clinical Display Workstation.

Content

I. Digital Data

A. Image display
   1. Pixel size
   2. Matrix size
   3. Spatial resolution

B. Grayscale
   1. Bit depth
   2. Contrast resolution

C. Signal
   1. Digital-to-analog conversion
   2. Analog-to-digital conversion

II. Basic Principles of Digital Radiography

A. Digital receptors
   1. Cassette-based systems
      a. PSP plates
         1) Turbid phosphors
         2) Structured phosphors
   2. Cassette-less systems
      a. Silicon or selenium and thin-film transistor (TFT) arrays
      b. Charge-coupled device (CCD) and complementary metal oxide semiconductor (CMOS) systems

B. Detector properties and evaluative criteria
   1. Defective quantum efficiency (DQE)
   2. Spatial resolution
      a. Cassette-based systems
         1) Sampling frequency – pixel pitch
         2) Receptor size vs. sampling frequency
         3) Light spread – phosphor construction
      b. Cassette-less systems – detector element size
   3. Advantages over film-screen
      a. Increased dynamic range
      b. More contrast resolution
   4. Limitation relative to film-screen
      a. Lower spatial resolution
      b. Strong dependence of image quality on
         1) Image processing
         2) Display characteristics

C. Dynamic range vs. latitude
   1. Dynamic exposure range of the detector
   2. Latitude – allowable error for optimal image acquisition

a. Wide exposure latitude
b. Beam-part-receptor alignment latitude compared to film-screen

III. Image Acquisition

A. Raw data acquisition – "latent image"
1. Positioning
2. Exposure field alignment and collimation
   a. Cassette-based system
   b. Cassette-less system
3. Exposure – technique selection

B. Image extraction – cassette-based system
1. Raw data acquisition – "latent image"
2. Feeding the plate reader device
3. Plate scanned by laser
4. Signal data digitized by analog-to-digital converter (ADC)
5. Histogram created and analyzed by software
6. Initial image processing
   a. Exposure field recognition
   b. Histogram analysis
      1) Exposure index determination
      2) Automatic rescaling

C. Image extraction – cassette-less system
1. Raw data acquisition – "latent image"
2. Rows and columns of detector elements read line by line
3. Data transferred to external electronics
4. Signal data digitized by ADC
5. Initial image processing
   a. Exposure field recognition
   b. Histogram analysis
   c. Automatic rescaling – risk of failure

D. Exposure indicators
1. Cassette-based systems
   a. Vendor specific values
   b. Relationship to patient exposure
   c. Reader calibration
   d. Centering and beam collimation
   e. Determining optimal value ranges
2. Cassette-less systems
   a. Vendor-specific values
   b. Relationship to patient exposure
   c. Determining optimal value ranges

IV. Image Acquisition Concerns

A. Exposure field recognition
    1. Single field patterns in CR
        a. Importance of collimation margins and alignment to image receptor
        b. Importance of light field to radiation field alignment

B. Histogram analysis error
    1. Incorrect anatomic menu selection
    2. Exposure field not detected
        a. Collimation border recognition
        b. Exposure field distribution – errors due to multiple fields/plate
    3. Unexpected material in data set, i.e., metal
    4. Large exposure error – plate saturation
    5. Inappropriate rescaling – dark or light image

C. Low-intensity radiation response
    1. Background radiation
        a. Storage phosphor plates
            1) Plate response to background exposure
            2) Problems associated with plates that are unused for more than 48 hours
        b. Cassette-less system image receptors constantly refreshed
    2. Response to scatter intensity

D. Scatter control
    1. Beam limiting
    2. Optimal exposure
    3. Grid use
        a. Kilovoltage (kVp) conversion
        b. Grid cutoff effects
        c. Compare short dimension (SD) grid and long dimension (LD) grid
            1) Positioning latitude
            2) Beam alignment forgiveness
        d. Moiré effect

V. Software (Default) Image Processing

A. Automatic rescaling
    1. Purpose
    2. Impact on display image
    3. Risk of patient overexposure

B. Effects of excessive processing

C. Recognition of image processing errors that affect image clarity

VI. Fundamental Principles of Exposure

A. Optimal receptor exposure
    1. Receptor exposure variables

2. Receptor exposure control

B. Receptor response – DQE

C. Selection of exposure factors
   1. Maintain consistent specific receptor exposure
   2. Control scatter
   3. Adjust for differences in:
      a. Patient structure/composition
      b. Source-to-image receptor distance (SID)
      c. Grid utilization

D. Control patient exposure
   1. Higher kVp levels
   2. Additional filtration
   3. Interfacing with AEC systems
   4. ALARA principles
   5. Assessment of image noise

E. Monitor patient exposure
   1. Part of quality assurance (QA) program
   2. Vendor-supplied software
   3. Logbook

VII. Image Evaluation

A. Evidence of appropriate exposure level
   1. Exposure indicator within appropriate exposure range
   2. Image appearance
      a. Low contrast due to overexposure
      b. Noise due to underexposure
   3. Evidence of exposure recognition failure or histogram analysis error
      a. Image brightness
      b. Low contrast
      c. Off focus/scatter outside exposure field

B. Brightness/density

C. Contrast/grayscale
   1. Appropriate for exam
   2. Evidence of processing error
   3. Contrast resolution

D. Recorded detail
   1. Image blur
   2. Spatial resolution
   3. Distortion

4. Mottle
5. Signal-to-noise ratio (SNR)
6. Contrast-to-noise ratio (CNR)

E. Image processing
   1. Algorithm selection
   2. Histogram analysis
   3. Look-up tables

F. Artifacts
G. Gross exposure error

VIII. Image Display

A. Monitor
   1. Monitor types
      a. Liquid crystal display (LCD)
      b. Cathode ray tube (CRT)
   2. Clinical display workstation monitors vs. diagnostic display workstation monitors

IX. Picture archiving and communication system (PACS)

A. PACS
   1. System components and function
      a. Access to report information
      b. Access from multiple locations
      c. Image retrieval
   2. Backup and disaster recovery
   3. Malfunction (e.g., inappropriate documentation, lost images, mismatched images, corrupt data)

B. DICOM

C. Teleradiology

D. LXMO's responsibilities
   1. Access order (worklist)
   2. Image acquisition
   3. Post processing – image manipulation
   4. Data integrity risks
   5. Annotation issues
   6. Transmitting image(s) to PACS
   7. HIPAA and patient confidentiality

X. Quality Assurance and Maintenance Issues

A. Initial acceptance testing

B. Cassette-based system reader preventive maintenance (PM)

C. Plate maintenance
    1. Erasing plates
    2. Cleaning and inspecting plates

D. Grayscale rendition or look-up table (LUT)

E. Noise suppression

F. Contrast enhancement

G. System malfunctions
    1. Ghost image
    2. Banding
    3. Erasure
    4. Dead pixels
    5. Readout problems
    6. Printer distortion

H. Uniformity of default processing codes

I. Reject analysis

Fundamentals, Ethics and Law of Health Care

Description
Content is designed to provide an overview of the foundations in radiologic science and the LXMO's role in the health care delivery system. Principles, practices and policies of health care organization(s) will be examined and discussed in addition to the professional responsibilities of the LXMO. The elements of ethical behavior will be discussed, as well as a variety of ethical issues and dilemmas found in clinical practice. An introduction to legal terminology, concepts and principles also will be presented. Topics include misconduct, malpractice, legal and professional standards. The importance of proper documentation and consent is emphasized.

Proposed minimum hours of instruction: 8

Objectives
1. Identify other health science professionals who participate in the patient's total health care.
2. Describe the relationship of health science professionals to the integrated care of patients.
3. Identify various settings involved in the delivery of health care.
4. Discuss the reimbursement/payment options for health care services.
5. Discuss the role and value of a mission statement to the operation of an institution.
6. Describe relationships and interdependencies within health care.
7. List patient services that may be available in a radiology department.
8. Define accreditation, credentialing, certification, licensure and regulations.
9. Discuss the general employment outlook for the graduate LXMO.
10. Discuss career advancement and opportunities for the LXMO.
11. Identify the benefits of continuing education as related to improved patient care and professional enhancement.
12. Describe the moral, social and cultural basis of ethics.
13. Explain the role of ethical behavior in health care delivery.
14. Differentiate between empathetic rapport and sympathetic involvement in relationships with patients and relate these to ethical conduct.
15. Explain concepts of personal honesty, integrity, accountability, competence and compassion as ethical imperatives in health care.
16. List legal/professional standards and their relationship to practice in health professions.
17. Identify specific situations and conditions that give rise to ethical dilemmas in health care.
18. Employ a basic system of examination, clarification, determination of alternatives and decision-making in addressing ethical questions.
19. Explain select concepts embodied in HIPAA, principles of patients' rights, the doctrine of patient consent and other issues related to patients' rights.
20. Explain the legal implications of LXMO liability, malpractice, negligence/carelessness and other legal doctrines applicable to limited-scope practice.
21. Describe the importance of accurate, complete, correct methods of documentation as a legal/ethical imperative.
22. Describe the scope of practice for the LXMO, the elements that comprise it and responsibilities of the LXMO.

23. Describe institutional and professional liability protection typically available to the LXMO.

Content

I. The Health Science Professions

A. Radiologic technology
   1. Radiography
      a. General diagnostic imaging
      b. Computed tomography
      c. Mammography
      d. Cardiovascular-interventional technology
      e. Bone densitometry
      f. Quality management
   2. Radiation therapy
   3. Nuclear medicine technology
   4. Diagnostic medical sonography
   5. Magnetic resonance imaging

B. Health care professions
   1. Health information technology
   2. Medical laboratory sciences
   3. Occupational therapy
   4. Pharmacy
   5. Physical therapy
   6. Respiratory therapy
   7. Social services
   8. Nursing
   9. Other

II. The Health Care Environment

A. Health care systems
   1. Hospitals
      a. Veterans Administration
      b. Not-for-profit
      c. For-profit
      d. System/network
   2. Clinics
   3. Independent facilities
   4. Mental health facilities
   5. Long-term/residential facilities
   6. Hospice

B. Health care delivery settings
   1. Outpatient/ambulatory care
   2. Inpatient
   3. Long-term care
   4. Preventive care
   5. Home health care
   6. Telehealth/telemedicine

C. Payment/reimbursement systems
    1. Self-pay
    2. Indemnity insurance
    3. Entitlement/government programs
        a. Medicare
        b. Medicaid
    4. Managed care

III. Facility Organization

A. Philosophy and mission
    1. Role within the community
    2. Commitment to education within the profession and community health
    3. Mission statement

B. Administrative services
    1. Management
    2. Personnel
    3. Procurement
    4. Accounting and billing
    5. Patient registration
    6. Information systems

C. Medical services
    1. Physician
    2. Clinical
    3. Nursing
    4. Support

IV. Radiology Organization

A. Professional personnel
    1. Radiographer
        a. Administrative director
        b. Radiologist assistant
        c. Chief/senior technologist
        d. Quality control/assurance officer/technologist
        e. Staff technologist
    2. LXMO
    3. R.T. aide
    4. Radiologist
    5. Radiation physicist
    6. Radiology nurse

B. Support personnel
    1. Clerical staff
    2. File room/image management

3. Information systems manager
    a. Radiology information systems (RIS)
    b. PACS

C. Patient services

V. Professional Credentialing

A. Definition

B. Agencies
1. National
    a. American Registry of Radiologic Technologists (ARRT)
    b. Nuclear Medicine Technology Certification Board (NMTCB)
    c. American Registry of Diagnostic Medical Sonographers (ARDMS)
    d. Other
2. State
    a. Licensure and certification
    b. LXMO

VI. Professional Organizations

A. Purpose, function, activities

B. Local organizations

C. State organizations

D. National
1. American Society of Radiologic Technologists (ASRT)
2. American Healthcare Radiology Administrators (AHRA)

E. International
International Society of Radiographers and Radiological Technologists (ISRRT)

F. Related associations organizations
1. American Board of Radiology (ABR)
2. American College of Radiology (ACR)
3. Radiological Society of North America (RSNA)

VII. Professional Development

A. Methods of advancement
1. Continuing education programs
2. General radiography programs
3. Postprimary certification

4. Collegiate/educational programs

B. Employment considerations
   1. Geographic mobility
   2. Economic factors
   3. Manpower issues

C. Additional career ladders
   1. Radiographer
   2. Education
      a. Administration
      b. Faculty
         1) Didactic
         2) Clinical
   3. Postprimary modalities
   4. Radiologist assistant
   5. Administration
   6. Physics
   7. Research

D. Continuing education and competency requirements
   1. Definition
   2. Rationale
   3. Requirements
      a. State
      b. Institution
   4. Opportunities

VIII. Ethics in Health Care

A. Moral reasoning

B. Personal behavior standards

C. Competence

D. Professional attributes
   1. Compassion
   2. Empathy
   3. Sympathy
   4. Honesty
   5. Integrity
   6. Accountability

E. Limited scope of practice defined
   1. Lines of authority
   2. Areas of responsibility

3. Limitations

F. Self-assessment and self-governance

G. Continuing professional education

H. Professional standards of clinical practice

I. Code of professional ethics

J. Ethical principles
   1. Beneficence
   2. Nonmalfeasance
   3. Respect for autonomy

K. Organizational ethics

L. Individual and societal rights
   1. Access and distribution of health care
   2. Justice
   3. Fairness
   4. Economics

M. Access to quality health care

N. Medical/health care research

O. End-of-life decisions
   1. Living wills
   2. Advanced directives
   3. Health care power of attorney
   4. Nonintervention

P. Ethical decision making
   1. Weighing data
   2. Alternatives
   3. Risks vs. benefits

IX. Legal Responsibilities

A. Parameters of legal responsibility
   1. Professional liability
      a. Direct
      b. Indirect
   2. Intentional misconduct
      a. Libel and slander
      b. Assault and battery

c. False imprisonment
d. Invasion of privacy
e. Breach of confidentiality

3. Negligence/malpractice
   a. Definitions
      1) Gross negligence
      2) Contributory negligence
   b. Elements of malpractice
      1) Duty
      2) Dereliction (breach)
      3) Causation
      4) Damage
4. Legal and professional standards
   a. Standard of care
   b. Patient's Bill of Rights
   c. HIPAA
      1) Individual
      2) Institutional
5. Legal doctrines (i.e., respondent superior, *res ipsa loquitur*)

B. Scope of practice and responsibilities of the LXMO
   1. Definition
   2. Supervision
   3. State statute
   4. Limitations
      a. Anatomic areas
      b. Radiographic procedures

X. Patient Consent

A. Rationale

B. Definition
   1. Implied
   2. Written
   3. Oral

C. Condition for legal consent
   1. Legal age
   2. Competence
   3. Capacity
   4. Voluntary
   5. Provision of adequate information regarding case, procedure, alternatives and risk
   6. American Hospital Association (AHA) and Joint Commission Standards for Disclosure

Human Structure and Function

Description
Content is designed to establish a knowledge base in anatomy and physiology. Components of the cells, tissues, organs and systems will be described and discussed.

Proposed minimum hours of instruction: 25

Objectives
1. Identify the location of anatomical structures using directional and orientation terms.
2. Indicate where various planes lie in relation to the body.
3. Demonstrate the use of topographical landmarks to locate internal structures.
4. Identify the structural limits, functions and contents of each of the body cavities.
5. Identify and locate the bones of the human skeleton.
6. Identify bony processes and depressions found on the human skeleton.
7. Describe articulations of the axial and appendicular skeleton.
8. Summarize the functions of the skeletal system.
9. Compare the types, locations and movements permitted by the different types of articulations.
10. Describe the function of the primary and accessory organs of the digestive system.
11. Describe the composition and characteristics of blood.
12. Label the parts of the human heart.
13. Describe the flow of blood through the body and identify the main vessels.
14. Describe the structure and function of arteries, veins and capillaries.
15. Label the components of the respiratory system.
16. Describe the physiology of respiration.
17. Describe the function of each organ of the urinary system.
18. Label the anatomy of the male and female reproductive organs.
19. Describe the functions of the different types of muscles.
20. Describe the functions of the nervous system.

Content

I. Body Cavities – Structural Limits, Function, Contents

A. Cranial

B. Thoracic

C. Abdominal/pelvic

II. Landmarks and Underlying Anatomy

A. Cranium

B. Neck

C. Spine

D. Thorax

E. Abdomen

F. Pelvis

G. Extremities

III. Skeletal System

A. Osseous tissue
   1. Structural organization
      a. Medullary cavity/marrow
      b. Compact bone
      c. Cancellous bone
      d. Periosteum
      e. Cartilage
   2. Development and growth
      a. Physis
      b. Diaphysis
      c. Diaphysis/epiphyseal line
      d. Metaphysis
   3. Classification and markings
      a. Long
      b. Short
      c. Flat
      d. Irregular
      e. Processes and bony projections
      f. Depressions/openings

B. Divisions
   1. Axial

a. Skull
b. Hyoid bone
c. Vertebral column
d. Thorax

2. Appendicular
   a. Pectoral girdle
   b. Upper extremities
   c. Pelvic girdle
   d. Lower extremities
3. Sesamoids
4. Functions

C. Articulations
1. Function/joint classifications
   a. Synarthroses, fibrosis
   b. Amphiarthroses, cartilaginous
   c. Diarthroses, synovial
2. Physiology

IV. Cardiovascular System

A. Blood
1. Composition
2. Clotting system
3. Hemopoiesis
4. Function

B. Heart and vessels
1. Anatomy
2. Function

V. Respiratory System

A. Components and structure
1. Nose and sinus cavities
2. Pharynx
3. Larynx
4. Trachea
5. Bronchi
6. Lungs
7. Thorax

B. Physiology
1. Pulmonary ventilation
2. Alveolar gas exchange
3. Transport of blood gases
4. Tissue gas exchange
5. Control and regulation of respiration

VI. Abdomen

A. Digestive system
   1. Primary organs – structure, function and location
      a. Oral cavity
      b. Esophagus
      c. Stomach
      d. Small intestine
      e. Large intestine
      f. Rectum
   2. Accessory organs – structure, function and location
      a. Salivary glands
      b. Pancreas
      c. Liver
      d. Gallbladder

B. Urinary system – structure, function and location
   1. Kidneys
   2. Ureters
   3. Bladder
   4. Urethra

C. Reproductive systems – structure, function and location
   1. Male
   2. Female

VII. Muscular System – Types, Characteristics and Functions

A. Smooth
B. Cardiac
C. Skeletal

VIII. Nervous System

A. Introduction
   1. Neural tissue
   2. Function
   3. Central nervous system
   4. Peripheral nervous system

B. Neural tissue
   1. Types, location, physiology
      a. Neurons
      b. Neuroglia

C. Anatomy, functions
   1. Central nervous system
   2. Peripheral nervous system

Film/Screen Image Production and Evaluation

Description
Content is designed to establish a knowledge base in factors that govern and influence the production and recording of radiologic images. Film/screen imaging with related accessories will be emphasized. Radiographic image analysis methods will be introduced using actual images. Included are the importance of minimum imaging standards, discussion of a problem-solving technique for image evaluation and the factors that can affect image quality. Class demonstrations/labs are recommended to demonstrate application of theory.

Proposed minimum hours of instruction: 50

Objectives
1. Discuss standards for acceptable image quality.
2. Analyze the relationships of factors that control and affect image density.
3. Assess radiographic density on radiographic images.
4. Critique the radiographic contrast within various radiographic images.
5. Differentiate between subject contrast and image receptor contrast.
6. Compare long-scale and short-scale contrast images.
7. Analyze the relationships of factors that control and affect radiographic contrast.
8. Critique recorded detail on various radiographic images.
9. Analyze the relationships of factors affecting recorded detail.
10. Differentiate between shape and size distortion.
11. Summarize the relationships of factors affecting distortion.
12. Formulate a plan of action to decrease image distortion.
13. Summarize the relationships of factors affecting exposure latitude.
14. Describe the operation and applications for different types of beam-limiting devices.
15. Select the most appropriate beam-limiting device to be used for a given clinical situation.
16. Explain beam filtration.
17. Summarize the relationships of factors affecting scattered and secondary radiation.
18. Evaluate the effects of scattered radiation on the image.
19. Compare types of grid.
20. Articulate the advantages and disadvantages of grid use.
21. Describe grid maintenance.
22. Select the most appropriate grid for a given clinical situation.
23. Evaluate grid artifacts.
24. Formulate a set of rules for grid use to prevent grid cut-off and artifacts.
25. Explain the use of standardized radiographic technique charts.
26. Explain exposure factor considerations involved in technique selection.
27. Compare fixed kilovolt peak (kVp) and variable kVp systems.
28. Formulate a technique chart using either a fixed kVp or variable kVp system.
29. Apply milliampere-seconds (mAs) reciprocity to clinical simulations.
30. Describe the function of each component of radiographic film.
31. Explain latent image formation in film/screen imaging.
32. Describe the features of the characteristic curve and explain its purpose.

33. Select the most appropriate image receptor to be used for given clinical situations.
34. Describe various types of image receptor holders.
35. Describe the function of each component of an intensifying screen.
36. Explain the classifications of intensifying screens and the applications of each.
37. Identify procedures that ensure a long screen life devoid of artifacts and distortion.
38. Discuss darkroom-related Occupational Safety and Health Administration (OSHA) standards for health and safety.
39. Discuss safelight illumination appropriate for specific image receptor systems.
40. Describe the effects of storage on image quality.
41. Describe the operation and use of wet and dry processing.
42. Analyze the effects of processing on image quality.
43. Demonstrate how various film sizes are fed into the film processor.
44. Analyze the steps of the image processing cycle providing the specific action and duration of time for each step.
45. Identify the purpose of a daily quality control program for processors.
46. Identify types of image artifacts and analyze the artifacts to determine the cause.
47. Describe an effective image analysis method.
48. Summarize the importance of proper positioning and centering.
49. Apply the process for evaluating images for adequate density, contrast, recorded detail and acceptable limits of distortion.
50. Discuss the impact of patient preparation on the resulting radiographic image.
51. Analyze images to determine the appropriate use of beam restriction.
52. Identify common equipment malfunctions that affect image quality.
53. Differentiate between technical factor problems, procedural factor problems and equipment malfunctions.

Content

I. Imaging Quality Standards

A. Licensed practitioner involvement in setting image standards

B. Patient care and safety concerns

C. Procedures for maintaining image standards

II. Characteristics of Image Receptors

A. Film types

B. Composition
   1. Components
   2. Structure
   3. Function

C. Definition, influence and application of image receptor properties
   1. Contrast
   2. Speed/sensitivity
   3. Film latitude
   4. Recorded detail

D. Latent image formation

E. Characteristic curves
   1. Speed
   2. Contrast
   3. Exposure latitude

III. Image Receptor Holders and Intensifying Screens

A. Image receptor holders
   1. Cassettes
      a. Purpose
      b. Construction
      c. Application
      d. Loading/unloading
      e. Maintenance

B. Intensifying screens
   1. Purpose
   2. Construction/composition
   3. Single vs. double film/screen system
   4. Principles of function
      a. Fluorescence
      b. Phosphorescence
      c. Quantum noise

d. Film/screen contact
e. Technical influences

5. Classification/applications
   a. Phosphor
   b. Speed/sensitivity
   c. Patient dosage
6. Maintenance
   a. Handling
   b. Cleaning

IV. Radiographic Density

A. Definition

B. Acceptable range

C. Factors
1. mAs
2. kVp
3. Distance
4. Film/screen image receptors
5. Grids
6. Beam limitation
7. Patient considerations
   a. Anatomic part
   b. Pathology
8. Film processing
9. Filtration
10. Heel effect

V. Radiographic Contrast

A. Definition

B. Types
1. Long scale, low
2. Short scale, high

C. Components
1. Subject
2. Image receptor system

D. Factors
1. kVp
2. Scattered radiation
3. Fog
4. Noise
5. mAs

6. Grids
7. Beam limitation
8. Filtration
9. Image receptor system
10. Patient considerations
    a. Anatomic part
    b. Pathology
11. Distance
12. Film processing

VI. Recorded Detail/Spatial Resolution

A. Definition

B. Components
1. Umbra
2. Focal spot blur

C. Factors
1. Geometric unsharpness
    a. Source-to-image distance (SID)
    b. Object-to-image distance (OID)
    c. Focal spot
    d. Structural shape
2. Materials unsharpness
    a. Image receptor system
    b. Screen/film contact
3. Motion blur
    a. Voluntary
    b. Involuntary
4. Image noise
    a. Quantum mottle
    b. Signal-to-noise ratio
5. Patient considerations
    a. Anatomic part
    b. Pathology

VII. Distortion

A. Definition

B. Types
1. Shape
    a. Foreshortening
    b. Elongation
2. Size (magnification)

C. Factors

1. Distance
2. Tube/part/image receptor relationships
3. Patient considerations
    a. Anatomic part
    b. Pathology

VIII. Exposure Latitude

A. Definition

B. Factors
1. kVp
2. Image receptor system

IX. Beam-limiting Devices

A. Definition

B. Purposes
1. Patient dose
2. Scatter production
3. Image density/brightness
4. Image contrast

C. Types, function and application of each
1. Apertures/diaphragms
2. Cones
3. Collimator
    a. Manual
    b. Positive beam limitation (PBL)
4. Lead masks
5. Light field alignment

X. Beam Filtration

A. Definition

B. Rationale

C. Composition

D. Types
1. Inherent
2. Added
3. Total
4. Compensatory
    a. Construction
    b. Applications

E. Image quality
   1. Density
   2. Contrast

F. Patient exposure

XI. Scattered and Secondary Radiation

A. Definitions

B. Factors
   1. kVp
   2. Patient considerations
   3. Beam limitation
   4. Grids
   5. Distance

C. Effects
   1. Patient dose
   2. Image quality
   3. Occupational exposure

XII. Control of Exit/Remnant Radiation

A. kVp selection

B. Grids
   1. Purpose
   2. Components
   3. Types/patterns
      a. Focused
      b. Parallel
      c. Linear
      d. Cross
   4. Terms/definitions
      a. Grid focusing distance
      b. Focal range
      c. Convergent line/point
   5. Efficiency
      a. Ratio
      b. Frequency (lead content)
   6. Selection
      a. kVp
      b. Patient considerations
      c. Distance
      d. Beam limitation
      e. Latitude
   7. Cut-off

a. Definition
b. Factors

8. Artifacts

XIII. Technique Formulation

A. Purpose
1. Standardization of exposure
2. Image consistency

B. Considerations
1. Choice of technique system
2. Patient measurement
3. Image processing
4. Anatomic and pathologic factors
5. Pediatrics

C. Types
1. Optimum kVp/variable mAs
2. Variable kVp/fixed mAs
3. Anatomic programmed radiography (APR)
4. AEC

XIV. Exposure Calculations

A. Factors
1. Distance
2. mAs
3. kVp
4. Grids
5. Image receptor system

B. Calculations
1. mAs reciprocity

XV. Image Receptor Handling and Storage

A. Processing considerations
1. Temperature
2. Humidity
3. Light
4. Radiation
5. Handling

B. Storage considerations
1. Temperature
2. Humidity
3. Light
4. Radiation

5. Gases/fumes
6. Handling
7. Fog
8. Pressure
9. Inventory control
    a. Purchasing consumables
    b. Expiration date
    c. Maximum storage time

C. Cleaning of image receptor system

XVI. Processing of the Images

A. Darkroom lighting
1. Safelights
    a. Definition
    b. Filters
    c. Bulb size/color
2. Warning/indicator lights

B. Processor systems/functions
1. Laser printers
2. Wet film processors
    a. Chemical
    b. Transport
    c. Replenishment
    d. Recirculation
    e. Temperature control
    f. Wash
    g. Dryer

C. Processing cycle
1. Image receptor feed
2. Development
3. Fixing
4. Wash
5. Dry

D. Maintenance/cleaning
1. Shut-down procedure
2. Start-up procedure
3. Cross-over removal and cleaning

E. Processor quality control

F. Material safety data sheets (MSDS)

XVII. Artifacts

A. Definition

B. Types
   1. Positive-density artifacts
   2. Negative-density artifacts

C. Causes
   1. Handling
   2. Static
   3. Exposure related (grids)
   4. Cleanliness

D. Effects

E. Preventive/corrective maintenance

XVIII. Imaging Standards

A. Purpose

B. Problem-solving process
   1. Determining cause of problems
   2. Recommending corrective action

C. Establishing acceptable limits

XIX. Image Quality Factors

A. Density

B. Contrast

C. Recorded detail

D. Distortion

XX. Procedural Factors

A. Image identification
   1. Patient information
   2. Date of examination
   3. Procedure(s) performed
   4. Proper use of identification makers
   5. Institutional data

B. Positioning
   1. Anatomical considerations

a. Anatomy of interest
b. Plane/baseline reference
c. Central ray angulation
d. Anatomical variations
e. Body habitus
f. Pathology

2. Positioning aids

C. Centering
1. Central ray location
2. Area of interest
3. Beam alignment and angulation

D. Radiation protection
1. Collimation/beam limitation
2. Shielding
3. Repeats
4. Image receptor
a. Size
b. Speed

E. Patient preparation

F. Artifacts

XXI. Corrective Action

A. Equipment
1. Radiographic unit
2. Image processing

B. Technical factors

C. Procedural factors

D. Artifacts

Imaging Equipment and Radiation Production

Description
Content is designed to establish a knowledge base in radiographic equipment and x-ray production. Topics include atomic structure, the nature and characteristics of radiation and the fundamentals of photon interactions with matter.

Proposed minimum hours of instruction: 40

Objectives
1. Define potential difference, current and resistance.
2. Describe electrical protective devices.
3. Identify the function of solid-state rectification.
4. Compare single phase, three phase, high frequency and falling load generators in terms of radiation production and efficiency.
5. Demonstrate operation of radiographic equipment including manual exposure controls.
6. Discuss the application of AEC devices.
7. Discuss the benefits of a quality management program to the patient and to the department.
8. Describe the structure of the atom.
9. Discuss the energy levels of the atom.
10. Explain the processes of ionization and excitation.
11. Describe the electromagnetic spectrum.
12. Define and describe wavelength and frequency and how they are related to velocity.
13. Identify the properties of x-rays.
14. State the principles of x-ray production.
15. Compare the production of bremsstrahlung and characteristic radiations.
16. Describe the conditions necessary to produce x-radiation.
17. Describe the x-ray emission spectra.
18. Identify the factors affecting the x-ray emission spectra.
19. Discuss various photon interactions with matter including the impact of attenuation.
20. Discuss relationships of wavelength and frequency, including the relationship to beam characteristics.
21. Discuss the clinical significance of the photoelectric and modified scattering interactions in diagnostic imaging.

Content

I. X-Ray Circuit

A. Units of measurement
   1. Potential difference
   2. Current
   3. Resistance

B. Protective devices
   1. Ground
   2. Circuit breaker

C. Transformers
   1. Step-up
   2. Step-down

D. Rectification
   1. Purpose
   2. Location

E. Generators

II. Radiographic Equipment

A. Permanent installation
   1. Tubes
   2. Collimators
   3. Tables
   4. Control panels
   5. Tube stands
   6. Wall units
   7. Manipulation of equipment

B. AEC devices
   1. Ionization chambers
   2. Minimum reaction time
   3. Back-up time
   4. Positioning considerations
      a. Cell locations
      b. Cell size
      c. Cell sensitivity
   5. Compensating for variations of patient size and pathology variations

III. Diagnostic X-Ray Tubes

A. Design and function
   1. Rotating anode
   2. Cathode
   3. Tube housing construction

4. Induction motor

B. Extending tube life
   1. Warm-up procedures
   2. Rotor considerations
   3. Filament considerations

IV. Electronic Imaging

A. Purpose

B. Principles
   1. Cassette-based systems
      a. Imaging plate (PSP)
   2. Cassette-less systems
      a. Flat panel detectors
         1) Description
         2) Function
      b. PSP
         1) Description
         2) Function
      c. CCD
         1) Description
         2) Function

V. Quality Control

A. Definitions

B. Benefits
   1. Patient
   2. Department/office

VI. Structure of the Atom

A. Atom
   1. Size
   2. Electrical charge

B. Nucleus
   1. Components
      a. Proton
      b. Neutron

C. Electron shells
   1. Components
   2. Arrangements
      a. Binding energy
      b. Valence shell
      c. Ionization

d. Excitation

VII. Nature of Radiation

A. Radiation
   1. Electromagnetic
      a. Spectrum
      b. Properties
      c. Ionization and excitation
   2. Nonionizing vs. ionizing

VIII. X-Ray Production

A. Principles
   1. Inverse square law
   2. Fundamental properties of x-rays

B. Types
   1. Bremsstrahlung
   2. Characteristic
   3. Percentage relationship with energy

C. Common terms related to the x-ray beam
   1. Primary beam
   2. Exit/remnant beam
   3. Leakage radiation

D. Conditions necessary for production
   1. Source of electrons
   2. Potential difference/acceleration
   3. Focusing of electron stream/concentration
   4. Target/deceleration

E. X-ray emission spectra
   1. Continuous spectrum
   2. Discrete spectrum
   3. Minimum wavelength

F. Factors affecting emission spectra
   1. kVp
   2. mA
   3. Time
   4. Atomic number of target
   5. Distance
   6. Filtration
   7. Voltage waveform

IX. Interaction of Photons With Matter

A. Transmission of photons
   1. Attenuated radiation
   2. Exit/remnant radiation

B. Unmodified scattering (coherent)
   1. Description of interaction
   2. Relation to atomic number
   3. Energy of incident photon and resulting product
   4. Probability of occurrence
   5. Application

C. Photoelectric effect
   1. Description of interaction
   2. Relation to atomic number
   3. Energy of incident photon and resulting product
   4. Probability of occurrence

D. Modified scattering (Compton)
   1. Description of interaction
   2. Relation to atomic number
   3. Energy
   4. Probability of occurrence

Medical Terminology

Description
Content is designed to provide an introduction to the origins of medical terminology. A word-building system will be introduced, and abbreviations and symbols will be discussed. Also introduced will be an orientation to the understanding of radiographic orders and interpretation of diagnostic reports. Related terminology is addressed.

Proposed minimum hours of instruction: 10

Objectives
1. Apply the word-building process.
2. Interpret medical abbreviations and symbols.
3. Critique orders, requests and diagnostic reports.
4. Define radiation science terms.
5. Translate medical terms, abbreviations and symbols into common language from a medical report.

Content

I. The Word-building Process

A. Basic elements
   1. Root words
   2. Prefixes
   3. Suffixes
   4. Combination forms

B. Parts of speech
   1. Nouns
   2. Verbs
   3. Adjectives
   4. Adverbs

C. Translation of terms into common language

D. Correct pronunciation of medical terms

II. Medical Abbreviations and Symbols

A. Role in communications

B. Abbreviations
   1. Examples
   2. Interpretations

C. Symbols
   1. Pharmaceutical symbols and terms
   2. Math and science symbols and constants
      a. Examples
      b. Interpretations

III. Radiologic Technology Procedures and Terminology

A. Radiography
B. Radiation oncology
C. Nuclear medicine
D. Sonography

IV. Understanding Orders, Requests and Diagnostic Reports

A. Radiographic orders and requisitions – components
   1. Procedures ordered
   2. Patient history
   3. Clinical information

B. Diagnostic reports
   1. Content
   2. Interpretation

Patient Care in Radiologic Sciences

Description
Content is designed to provide the basic concepts of patient care, including consideration for the physical and psychological needs of the patient and family. Routine patient care procedures will be described, as well as infection control procedures using standard precautions. The role of the LXMO in patient education will be identified. Content also will include the study of factors that influence relationships with patients and professional peers. Understanding human diversity assists the student in providing better patient care.

Proposed minimum hours of instruction: 30

Objectives
1. Identify the responsibilities of the health care facility and members of the health care team.
2. Describe the scope of practice for the LXMO as defined by state licensure.
3. Describe ethical, emotional, personal and physical aspects of death.
4. Identify methods for determining the correct patient for a given procedure.
5. Explain the use of various communication methods.
6. Explain specific aspects of a radiographic procedure to the patient.
7. Demonstrate correct principles of body mechanics applicable to patient care.
8. Demonstrate techniques for specific types of patient transfer.
9. Demonstrate select procedures for turning patients with various health conditions.
10. Describe select immobilization techniques for various types of procedures and patient conditions.
11. Explain the purpose, legal considerations and procedures for reporting an accident or incident.
12. Describe methods for evaluation of patient status.
13. List the information to be collected prior to patient examination.
14. Describe vital signs used to assess patient condition.
15. Assess patient vital signs.
16. Define terms related to infection control.
17. Describe the importance of standard precautions.
18. Explain sources and modes of infection and disease transmission.
19. List institutional/departmental procedures for infection control.
20. Describe methods for the prevention of infection to the health worker and patient.
21. Identify symptoms related to specific emergency situations.
22. Describe the emergency medical code system for the institution and the role of the LXMO during a medical emergency.
23. Explain the special considerations necessary when performing radiographic procedures on an infant or child.
24. Explain the special considerations necessary when performing radiographic procedures on an adult patient.
25. Explain the special considerations necessary when performing radiographic procedures on a geriatric patient.

26. Explain the types, immobilization devices and positioning for upper and lower extremity fractures.
27. Identify specific types of tubes, lines, catheters and collection devices.
28. Demonstrate competence in CPR.
29. Demonstrate select first-aid techniques.
30. Explain the influence a person's value system has on his or her behavior.
31. Describe how professional values influence patient care.
32. Differentiate between culture and ethnicity.
33. Explain how a person's cultural beliefs toward illness affect his or her recovery.
34. Discuss the societal factors that influence the quality of health care.
35. Describe the culture of poverty and its effect on health care.
36. Discuss family dynamics in a cultural, social, ethnic and lifestyle context.

Content

I. LXMO and Health Care Team

A. Responsibilities of the health care facility
   1. Caring for all patients regardless of condition
   2. Caring for the pediatric patient
   3. Caring for the adult patient
   4. Caring for the geriatric patient
   5. Promoting health
   6. Preventing illness
   7. Education
   8. Research
   9. Scope of practice
   10. Licensure

B. Responsibilities of the LXMO
   1. Review examination requisition
   2. Perform radiographic examination
   3. Assist the licensed practitioner
   4. Provide patient care

II. Attitudes and Communication in Patient Care

A. Health-illness continuum

B. Age-specific communication
   1. Neonates
   2. Pediatric
   3. Adolescent
   4. Young adult
   5. Adult
   6. Elderly

C. Communication
   1. Verbal
      a. Presentation of material
      b. Attitudes
      c. Voice tone and volume
      d. Effective listening
   2. Nonverbal communication
      a. Facial expression
      b. Physical appearance
      c. Touch
      d. Meta communication
      e. Eye contact
   3. Cultural variations
   4. Challenges of communication
      a. Non-English-speaking patients

b. Hearing, vision and speech impairments
c. Impaired mental function
d. Altered states of consciousness
e. Communicating with children and adolescents
f. Communicating with geriatric patients
g. Communicating under stress
h. Human diversity
i. Artificial speech
1) Transesophageal puncture (TEP)
2) Esophageal speech
3) Electrolarynx devices

5. Other factors that impede communication
a. Colloquialism/slang
b. Medical jargon
6. Feedback
7. Patient interactions
a. Establishing communication guidelines
b. Reducing distance
c. Listening
d. Using therapeutic silence
e. Responding to the feeling and the meaning of the patient's statement
f. Restating the main idea
g. Reflecting the main idea
h. Making observations
8. Communicating with families
9. Communicating with other health care professionals

D. Psychological considerations
1. Dying and death
a. Aspects of death
1) Emotional
2) Personal
3) Physical
b. Patient support services
2. Patient's emotional responses

III. Patient/LXMO Interactions

A. Patient identification methods
1. Interview/questioning
2. Chart/requisition
3. Wristband

B. Procedure questions and explanations
1. Positioning
2. Length of procedure
3. Audio and visual intercommunication systems

4. Room noises
5. Immobilization devices
6. Machine type
7. Machine movement
8. Machine-patient contact
9. Application of auxiliary equipment

IV. Safety and Transfer Positioning

A. Environmental safety
   1. Fire
   2. Electrical
   3. Hazardous materials
   4. Radioactive materials
   5. Personal belongings
   6. OSHA
   7. Environmental Protection Agency (EPA)

B. Body mechanics
   1. Proper body alignment
   2. Proper movement
   3. Proper balance
   4. Center of balance in the body

C. Patient transfer and movement
   1. Assessing the patient's mobility
   2. Rules for safe patient transfer
   3. Wheelchair transfers
   4. Stretcher transfers
      a. Sheet transfer
      b. Three-carrier lift
      c. Log roll
      d. Positioning for safety, comfort and/or exams
   5. Patients with disabilities
   6. Geriatric patients
   7. Adult patients
   8. Pediatric patients
   9. Patients with intravenous infusions
   10. Patients with tubes or catheters
   11. Metastatic disease

D. Patient positions
   1. Supine
   2. Protective side-lying
   3. Protective prone position
   4. Fowler's
   5. Semi-Fowler's

6. Sims'
7. Trendelenburg
8. Lithotomy
9. Knee-chest

E. Immobilization techniques
   1. Purpose
   2. Safety straps and rails
   3. Adult
      a. Types
      b. Applications
      c. Devices
   4. Pediatric
      a. Types
      b. Applications
      c. Devices

F. Accident and incident reporting
   1. Purpose
   2. Legal considerations
   3. Documentation
   4. Procedures

V. Evaluating Physical Needs

A. Assessing patient status
   1. Evaluation methodology
   2. Clinical information

B. Vital signs – ranges and values
   1. Temperature
   2. Pulse
   3. Respiration
   4. Blood pressure
   5. Normal values
   6. Interfering factors
   7. Terminology
   8. Adult vs. pediatric
   9. Documentation
   10. Pain assessment
   11. Weight

C. Acquiring and recording vital signs

D. Patient records
   1. Aspects of patient records
   2. Confidentiality of patient information

3. Retrieving specific information
4. Proper documentation in patient record
5. HIPAA

VI. Infection Control

A. Terminology
   1. Nosocomial
   2. Communicable
   3. Infectious pathogens

B. Centers for Disease Control and Prevention (CDC)
   1. Purpose
   2. Publications and bulletins

C. Cycle of infection
   1. Infectious pathogens – bloodborne and airborne
   2. Reservoir of infection
   3. Susceptible host
   4. Transmission of disease
      a. Direct
      b. Indirect
      c. Droplet
      d. Airborne/suspended
      e. Fomites
      f. Common vehicle
      g. Vector borne

D. Preventing disease transmission

E. Medical asepsis
   1. Definition
   2. Procedures
      a. Hand washing
      b. Chemical disinfectants

F. Environmental asepsis
   1. Handling linens
   2. Equipment disinfection
   3. Techniques
      a. Dress
      b. Hair
      c. Hand washing
      d. Gloves
      e. Eye protection
      f. Cleaning and proper disposal of contaminated waste
      g. Needles

G. Standard precautions
   1. Human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS)
   2. Hepatitis
      a. Type A
      b. Type B
      c. Type C (non-A or -B)
   3. Tuberculosis (TB)
   4. Respiratory Syncytial Virus (RSV)
   5. Other

VII. Medical Emergencies and First Aid

A. Basic first-aid technique

B. Emergency equipment

C. Latex reactions

D. Shock
   1. Signs and symptoms
   2. Types
      a. Hypovolemic
      b. Septic
      c. Cardiogenic
      d. Neurogenic
      e. Anaphylactic/allergic
   3. Medical intervention

E. Diabetic emergencies – signs, symptoms and interventions
   1. Hypoglycemia
   2. Ketoacidosis
   3. Hyperosmolar coma

F. Respiratory and cardiac failure – signs, symptoms and interventions
   1. Adult vs. pediatric
   2. Equipment

G. Airway obstruction – signs, symptoms and interventions

H. Cerebral vascular accident (stroke) – signs, symptoms and interventions

I. Fainting and convulsive seizures, signs, symptoms and interventions
   1. Types
      a. Nonconvulsive (Petit mal)
      b. Convulsive (Grand mal)

2. Reasons for fainting

J. Other medical conditions
1. Epistaxis
2. Nausea
3. Postural hypotension
4. Vertigo
5. Asthma

K. Trauma or physical injury

VIII. Tubes, Catheters, Lines and Collection Devices

A. Terminology

B. Nasogastric/nasointestinal

C. Tracheostomy

D. Chest tube

E. Tissue drains

F. Oxygen administration
1. Values
2. Oxygen therapy
3. Oxygen delivery systems
   a. Low-flow systems
   b. High-flow systems
4. Documentation
5. Special precautions

G. Urinary collection
1. Procedure
   a. Male
   b. Female
2. Alternative methods of urinary drainage
3. Documentation

H. Other ostomies
1. Ileostomy
2. Ureteroileostomy

IX. Values

A. Personal
1. Values development
2. Effect on medical care

3. Impact on patient care
4. Values clarification

B. Professional
   1. Values development
   2. Values conflict
   3. Impact on patient care

X. Culture, Ethnicity and Diversity

A. Societal and individual factors
   1. Socioeconomic
      a. Effects on health care
      b. Culture of poverty
      c. Relationship to disease occurrence
   2. Gender
      a. Social bias
      b. Medical treatment bias
      c. Cultural differences
   3. Family structure
      a. Two parent
      b. Single parent
      c. Nontraditional
      d. Extended
      e. Cultural differences
   4. Urban vs. rural living environment
      a. Availability of health care services
      b. Social acceptance of diverse cultural differences
   5. Religion
   6. Lifestyle choices and behaviors
   7. Mentally and physically challenged

Radiographic Anatomy, Procedures and Pathology

Description
Content is designed to provide a knowledge base necessary to perform standard radiographic procedures within a limited scope of practice. Consideration will be given to the production of images of optimal diagnostic quality. The LXMO will be introduced to clinical manifestations of pathologic processes, their radiographic appearance and relevance to radiographic procedures. Laboratory experience should be used to complement the didactic portion.

Note: It is recognized that the scope of practice for LXMOs will vary based on state statutes and licensing/permit restriction. The procedures taught and emphasis given to the scope of practice of the LXMO must not exceed the area of diagnostic study allowed by state license or permit.

Proposed minimum hours of instruction:

- **Chest and thorax –20**
- **Extremities:**
  - **Upper extremity and pectoral girdle – 20**
  - **Lower extremity – 20**
- **Podiatric – 10**
- **Vertebral column – 20**
- **Cranium – 20**

Objectives

1. Define standard positioning and procedure terminology.
2. Demonstrate body and radiographic positions.
3. Demonstrate proper use of anatomic relationships and locations.
4. Apply the proper use of body planes when positioning patients for radiographic examinations.
5. Demonstrate proper use of positioning aids.
6. Discuss general procedural considerations for radiographic examinations.
7. Adapt general procedural considerations to specific clinical settings.
8. Identify the structures demonstrated on routine radiographic images.
9. Adapt radiographic procedures based on patient assessment.
10. Simulate radiographic procedures on a person* or phantom in a laboratory setting.
11. Evaluate images for positioning, centering, appropriate anatomy and overall image quality.
12. Discuss equipment and supplies necessary to complete radiographic procedures.
13. List and explain the routine and special views for assigned radiographic procedures performed within limited scope(s) of practice.
14. Explain radiographic procedures to patients/family members.
15. Modify directions to patients with various communication problems.
16. Apply general radiation safety and protection practices associated with radiologic examinations.
17. Define basic terms related to pathology that are used to classify and identify diseases.
18. Classify diseases according to the disease process.

19. Describe the basic manifestations of pathological conditions.
20. Describe the radiographic appearance of selected diseases.
21. Describe adaptive techniques relevant to radiographic examination of selected diseases.

**Radiographs on people must be exposed for diagnostic purposes, not solely to demonstrate techniques or obtain experience, and must be prescribed by a licensed practitioner.*

Content

I. Standard Terminology for Positioning and Projection

A. Anatomic relationships and locations
1. Anterior
2. Caudal/caudad
3. Central
4. Cephalic/cephalad
5. Distal
6. Dorsal
7. External
8. Inferior
9. Internal
10. Lateral
11. Medial/mesial
12. Palmer
13. Parietal
14. Peripheral
15. Plantar
16. Posterior
17. Proximal
18. Superior
19. Ventral
20. Visceral

B. Body planes
1. Sagittal
2. Midsagittal/median
3. Coronal
4. Midcoronal/midfrontal
5. Transverse/horizontal

C. Body positions
1. Prone
2. Recumbent
   a. Dorsal
   b. Lateral
   c. Ventral
3. Supine
4. Upright
   a. Erect
   b. Standing
   c. Seated
5. Trendelenburg

D. Radiographic positions
1. Decubitus

a. Lateral
b. Dorsal
c. Ventral

2. Lateral
3. Lordotic
4. Oblique

E. Radiographic projections
1. Anteroposterior (AP)
2. Posteroanterior (PA)
3. Lateral
4. Oblique
5. Axial
6. Tangential

F. Joint movements
1. Abduct/abduction
2. Adduct/adduction
3. Evert/eversion
4. Extend/extension
5. Flex/flexion
6. Invert/inversion
7. Pronate/pronation
8. Supine/supination

G. Positioning aids
1. Sponges
2. Sandbags
3. Compression bands
4. Immobilization devices

H. Accessory equipment
1. Calipers
2. Lead strips
3. Lead shields or shadow shields
4. Lead markers
5. Image receptor holders

II. Evaluation of Radiographic Orders

A. Patient identification

B. Verification of procedure(s) ordered

C. Review of clinical history

D. Taking clinical history and patient assessment

1. Questioning/interviewing skills
2. Establish pregnancy status
3. Determining the chief complaint
    a. Localization
    b. Chronology
    c. Quality
    d. Severity
    e. Onset
    f. Aggravating or alleviating factors
    g. Associated manifestations
4. Special considerations for age, disability and cultural background

E. Patient preparation
1. Procedure explanation
2. Appropriate disrobing and gowning
3. Removal of items that may cause artifacts

F. Room preparation
1. Cleanliness, organization and appearance
2. Necessary supplies and accessory equipment available

G. Patient assistance

H. Patient monitoring

I. Patient dismissal

III. Positioning Considerations for Routine Radiographic Procedures

A. Patient instructions

B. Patient positioning

C. Part alignment
1. Lines of reference
2. Surface landmarks

D. Image receptor selection and orientation

E. Appropriate grid use

F. Tube, body part and image receptor alignment

G. Placement of radiographic markers

H. Beam alignment and angulation

I. Beam limitation and shielding

J. Special considerations
   1. Atypical conditions
   2. Age specific
   3. Special needs patients

K. Anatomy and positioning for the following studies:
   1. Chest and thorax
      a. Lungs
         1) AP/PA
         2) Lateral
         3) Apical lordotic
      b. Ribs
   2. Extremities
      a. Upper extremity
         1) Fingers
         2) Thumb
         3) Hand
         4) Wrist
         5) Radius/ulna
         6) Elbow
         7) Humerus
      b. Pectoral girdle
         1) Shoulder joint
         2) Clavicle
         3) Scapula
         4) Acromioclavicular joints
      c. Lower extremity
         1) Toes
         2) Foot
         3) Ankle
         4) Calcaneus
         5) Tibia/fibula
         6) Knee/patella
         7) Distal femur
   3. Podiatric
      a. Foot
      b. Ankle
      c. Calcaneous
   4. Vertebral column
      a. Cervical
      b. Thoracic
      c. Lumbar
      d. Scoliosis survey
      e. Sacrum
      f. Coccyx

g. Sacroiliac joints
5. Cranium
a. Skull
b. Facial bones
c. Nasal bones
d. Orbits
e. Pantomography mandible
f. Paranasal sinuses

L. Image evaluation

IV. Patient Communication

A. Barriers to communication
1. Types
2. Strategies

B. Clinical situations

C. Common radiation safety issues and concerns

V. Pathology

A. Disease classification
1. Acute
2. Chronic
3. Structural
4. Functional
5. Heredity
6. Congenital

B. Disease process
1. Inflammation
a. Edema
b. Degeneration
c. Atrophy
d. Hyperplasia
e. Hypertrophy
2. Neoplasms
a. Benign
b. Malignant
c. Metastasis

C. Fractures

D. Etiology

E. Diagnosis

1. Signs (objective)
2. Symptoms (subjective)

F. Prognosis

VI. Relevance of Pathology to Radiographic Procedures

A. Purpose of the procedure to evaluate pathology

B. Technical considerations

C. Patient considerations

D. Physical manifestations of pathology

E. Radiographic appearance
1. Chest and thorax
2. Extremities
3. Podiatric
4. Vertebral column
5. Cranium

Radiation Protection and Radiobiology

Description
Content is designed to present an overview of the responsibilities for protecting patients, personnel and the public from excessive radiation exposure. Radiation health and safety requirements of federal and state regulatory agencies, accreditation agencies and health care organizations are incorporated. An overview of the principles of the interaction of radiation in living matter and radiation effects of molecules, cells, tissues and the body as a whole are presented. Factors affecting biological response also are presented to include acute and chronic effects of radiation.

Proposed minimum hours of instruction: 60

Objectives
1. Identify and justify the need to minimize unproductive radiation exposure of humans.
2. Explain the objectives of a radiation protection program.
3. Define the units of radiation measurement in both the conventional and Système International d'Unités (SI).
4. Explain the importance of minimizing entrance skin dose.
5. Identify dose equivalent limits (DEL) for occupational and nonoccupational radiation exposure with reference to the latest National Council on Radiation Protection and Measurements (NCRP) reports.
6. Describe the ALARA concept.
7. Identify the basis for occupational exposure limits.
8. Distinguish between perceived risk and comparable risk.
9. Describe the concept of negligible individual dose (NID).
10. Identify ionizing radiation sources from natural and man-made sources.
11. Explain why a patient may be considered a source of radiation exposure.
12. Comply with legal and ethical radiation protection responsibilities of radiation workers.
13. Describe the operation of various interlocking systems for equipment and indicate potential consequences of interlock system failure.
14. Distinguish between controlled and noncontrolled areas and list acceptable exposure levels.
15. Describe "Radiation Area" signs and identify appropriate placement sites.
16. Describe the function of federal, state and local regulations governing radiation protection practices.
17. Express the need and importance of personnel monitoring for radiation workers.
18. Describe personnel monitoring devices, including applications, advantages and limitations for each device.
19. Interpret personnel monitoring reports.
20. Compare values for dose equivalent limits for occupational radiation exposures (annual and lifetime).
21. Identify anatomical structures that are considered critical for potential late effects of whole body irradiation exposure.
22. Identify dose equivalent limits for the embryo and fetus in occupationally exposed women.

23. Distinguish between primary and secondary radiation barriers.
24. Demonstrate how the operation of various x-ray and ancillary equipment influence radiation safety and describe the potential consequences of equipment failure.
25. Perform calculations of exposure with varying time, distance and shielding.
26. Identify emergency procedures to be followed during failures of x-ray equipment.
27. Demonstrate how time, distance and shielding can be manipulated to keep radiation exposures to a minimum.
28. Summarize the types and use of primary beam restrictors.
29. Discuss added and inherent filtration in terms of the effect on patient dosage.
30. Explain the purpose of, types of and rationale for patient shielding.
31. Use the appropriate method of shielding for a given radiographic procedure.
32. Explain the relationship of exposure factors to patient dose.
33. Identify the appropriate image receptor that will result in an optimum diagnostic image with the minimum radiation exposure to the patient.
34. Identify proper exposure index and/or dose-area product (DAP) value for equipment to ensure adherence to ALARA.
35. Select proper exposure factors to prevent dose creep in electronic imaging.
36. Select the immobilization techniques used to eliminate voluntary motion.
37. Describe the characteristics of a molecule.
38. Describe cellular biology of the human cell.
39. Discuss directly and indirectly ionizing radiations.
40. Describe radiation-induced chemical reactions and potential biologic damage.
41. Evaluate factors influencing radiobiologic/biophysical events at the cellular and subcellular level.
42. Identify methods to measure radiation response.
43. Describe physical, chemical and biologic factors influencing radiation response of cells and tissues.
44. Explain factors influencing radiosensitivity.
45. Recognize the clinical significance of LD50/60.
46. Examine effects of limited vs. total body exposure.
47. Relate short-term and long-term effects as a consequence of high and low radiation doses.
48. Differentiate between somatic and genetic radiation effects as well as discuss specific diseases or syndromes associated with them.
49. Classify radiation effects as stochastic or nonstochastic (deterministic).
50. Discuss risk estimates for radiation-induced malignancies.

Content

I. Introduction

A. Justification for radiation protection

B. Objectives of a radiation protection program
   1. Documentation
   2. Occupational and nonoccupational dose limits
   3. ALARA concept (optimization)
   4. Comparable risk
   5. NID

C. Sources of radiation
   1. Natural
   2. Man-made (artificial)
   3. Electromagnetic radiation
      a. X-rays
      b. Gamma rays
   4. Particulate radiations
      a. Alpha
      b. Beta
         1) Negatron
         2) Positron
      c. Fast neutrons
      d. Protons

D. Legal and ethical responsibilities

II. Radiation Units

A. Exposure
   1. Coulomb/kilogram (C/kg)
   2. Roentgen (R)

B. Absorbed dose
   1. Gray (Gy)
   2. Rad

C. Dose equivalent
   1. Sievert (Sv)
   2. Rem

D. Occupational dose
   1. Radiation weighting factor (Wr)
   2. Equivalent dose (EqD)

III. Regulations and Regulatory/Advisory Agencies

A. Regulated areas

1. Controlled/uncontrolled areas
2. Conditions
3. Recommendations
4. "Radiation Area" sign posting

B. Regulatory/advisory agencies
1. International Council on Radiation Protection and Measurements (ICRP)
2. National Commission on Radiation Protection and Measurements (NCRP)
3. Nuclear Regulatory Commission (NRC)
4. The Consumer-Patient Radiation Health and Safety Act of 1981
5. CARE Bill (Consistency, Accuracy, Responsibility and Excellence in Medical Imaging and Radiation Therapy)
6. State agencies

IV. Personnel Monitoring

A. Requirements for personnel monitoring
1. Deep dose equivalent (DDE)
2. Shallow dose equivalent (SDE)
3. Eye dose equivalent (EDE)

B. Methods and types of personnel monitors
1. Film badge
2. Thermo luminescent dosimeter (TLD)
3. Optically stimulable luminescent dosimeter (OSLD)

C. Records of accumulated dose
1. Purpose
2. Content
3. Interpretation/evaluation
4. Length of record-keeping
5. Retrieval from previous employers

D. Dose recommendations
1. Occupational
2. Nonoccupational limits
3. Critical organ sites
4. Embryo-fetus
5. Cumulative dose formula

E. Responsibilities for radiation protection
1. Facility
2. LXMO
3. Pregnant LXMO

V. Application

A. Materials

B. Primary barrier

C. Secondary (scatter and leakage) barrier

D. X-ray and ancillary equipment
   1. Beam-defining devices
   2. Exposure control devices
   3. On and off switches
   4. Interlocks
   5. Visual/audio monitors
   6. Emergency controls

E. Current regulations and recommendations
   1. NRC
   2. NCRP
   3. Applicable state regulations

F. Cardinal principles in protection
   1. Time
   2. Distance
   3. Shielding

VI. Patient Protection

A. Beam-limiting devices

B. Filtration

C. Shielding/protective devices
   1. Types
   2. Purpose
   3. Placement
   4. Attenuation properties
   5. Minimum lead equivalent

D. Exposure factors

E. Entrance skin exposure

F. Image receptor system
   1. Film/screen
   2. Electronic

G. Patient positioning and communication

H. Immobilization

I. Special considerations
   1. Pediatric patients
   2. 25 to 60 year old patients
   3. Geriatric patients
   4. Pregnant patients

VII. Elements of Radiation Biology

A. Review of cellular biology
   1. Basic unit of life
   2. Cell constituents
      a. Protoplasm and metabolism
      b. Organic and inorganic compounds
   3. Cell structure
      a. Cell membrane
      b. Cytoplasm
      c. Organelles
      d. Nucleus
   4. Cell growth
      a. Mitosis
      b. Meiosis
      c. Cell cycle
      d. Differentiation

B. Absorption and ionization
   1. Directly ionizing radiations
   2. Indirectly ionizing radiations

C. Sources of medical radiation exposure
   1. Diagnostic radiology
   2. Dental radiology
   3. Therapeutic radiology
   4. Nuclear medicine

VIII. Biophysical Events

A. Molecular effects of radiation
   1. Radiolysis of water
   2. Target theory
      a. Target molecules
      b. Cell death

B. The deposition of radiant energy
   1. Linear energy transfer (LET)
   2. Relative biological effectiveness (RBE)
   3. Factors influencing RBE

a. LET
b. Oxygen enhancement ratio (OER)

IX. Radiation Effects

A. Subcellular radiation effects
1. Radiation effects of DNA
a. Types of damage
b. Implications in humans
2. Radiation effects of chromosomes
a. Types of damage
b. Implications in humans

B. Cellular radiation effects
1. Types of cell death
a. Interphase death
b. Mitotic (genetic) death
2. Other effects
a. Mitotic delay
b. Reproductive failure
c. Interference of function
3. Cell survival and recovery

C. Individual radiation effects
1. Somatic effects
a. Short term
b. Long term
c. Stochastic effects
2. Genetic effects – mutations
a. Recessive genes
b. Dominant genes
c. Genetic significant dose

D. Factors influencing radiation response

X. Radiosensitivity and Response

A. Law of Bergonié and Tribondeau
1. Differentiation
2. Mitotic rate
3. Metabolic rate

B. Factors influencing cell survival
1. LET
2. OER
3. Fractionation

C. Systemic response to radiation

1. Hemopoietic system
2. Skin
3. Digestive
4. Urinary
5. Respiratory
6. Reproductive
7. Nervous
8. Other

D. Radiation dose-response curves
   1. Linear, nonthreshold
   2. Nonlinear, nonthreshold
   3. Linear, threshold
   4. Nonlinear, threshold

E. Total body irradiation
   1. Acute radiation syndrome
      a. Hemopoietic
      b. Gastrointestinal
      c. Central nervous system
   2. Stages of response and dose levels
   3. Factors influencing response
   4. Medical interventions of response

F. Late effects of radiation
   1. Somatic responses
      a. Mutagenesis
      b. Carcinogenesis
   2. Stochastic effects
   3. Nonstochastic (deterministic) effects
   4. Occupational risks for radiation workers
   5. Carcinogenesis

G. Comparative risk estimates

Recommendations for General Education

General education is an integral part of the development of the provider of patient care services. The content is designed to assist in the development of communication, human diversity, scientific inquiry, critical thinking and judgment skills required to perform the responsibilities of a LXMO. Knowledge gained from general education serves to enhance the content and application of the LXMO curriculum.

An additional goal of general education is to provide students with opportunities to explore broad areas of commonly held knowledge and to prepare them to contribute to society through personal, social and professional interactions with others. General education provides intellectual flexibility and knowledge to support lifelong learning that will prepare students for success in a rapidly changing world.

Recommended Postsecondary General Education:

- Mathematical/Logical Reasoning.
  - Develop skills in analysis, quantification and synthesis.
  - Apply problem-solving or modeling strategies.

- Communication.
  - Write, read, speak and listen critically.
  - Develop the ability to perceive, gather, organize and present information.
  - Locate, evaluate and synthesize material from diverse sources and points of view.

- Arts and Humanities.
  - Develop knowledge and understanding of the human condition.
  - Demonstrate respect for diverse populations.
  - Develop an understanding of ethics and the role they play in personal and professional lives.
  - Recognize and critically examine attitudes and values.

- Information Systems.
  - Develop knowledge base for use of computerized systems.
  - Use technology to retrieve, evaluate and apply information.

- Social/Behavioral Sciences.
  - Assist in adapting interactions to meet cultural/psychological needs of people.
  - Develop an understanding of individual and collective behavior.
  - Promote the development of leadership skills.
  - Develop capacity to exercise responsible and productive citizenship.
  - Function as a public-minded individual.

- Natural Sciences.
  - Develop understanding of scientific method.
  - Make informed judgments about science-related topics.
  - Develop a vocabulary of science.

Appendix A

LXMO Clinical Competencies and Assessment of Competency

The following is intended as a tool for documenting the successful completion of recommended mandatory and elective clinical competencies. It is recognized that within a given state the scope of practice of a LXMO may be restricted to one or two categories on this form.

Mandatory competencies are those felt to be particularly important to the role of the LXMO. The mandatory list represents a baseline of studies that will allow the student to demonstrate proficiency in a given category of patient exams. Observations generally are based on one sample of the student's performance, because it is impossible for the clinical instructor to be present in all clinical situations. Since inference on the student's competence cannot be made from one situation, an adequate number of observations need to be recorded by a variety of assessors. Multiple sampling of student performance can potentially make the assessment more valid and reliable. Students typically migrate through a sequence where they observe examples of a given exam being performed by a radiographer or licensed practitioner, assist in the performance of a number of the same exam, then perform the exam several times under the supervision of a radiographer or licensed practitioner. Programs, of course, have the prerogative to set values for the number of exams of a given type that students would be expected to observe, provide assistance and perform under supervision before a competency assessment is conducted.

The column heading is for indicating if the competency assessment was conducted during an actual patient exam or through simulation. It is recognized that in the clinical setting not all patient exams are requested with a frequency that would ensure competency testing can be conducted on patients only. Performing all required procedures under simulated conditions would not provide appropriate learning.

	Mandatory	Elective	Date and Time Completed	Patient or Simulated	Verified By
Chest	Proposed number of procedures within this category = 100				
Chest single view	☆				
Chest two view	☆				
Chest, age 6 years or younger		☆			
Chest, wheelchair		☆			
Apical lordotic		☆			
Ribs		☆			
Upper Extremity	Proposed number of procedures within this category = 100				
Finger	☆				

Hand	☆				
Wrist	☆				
Radius/ulna	☆				
Elbow	☆				
Humerus	☆				
Extremity, age 6 years or younger		☆			
Pectoral girdle	Included in upper extremity category				
Shoulder joint	☆				
Clavicle		☆			
Scapula		☆			
Acromioclavicular joints		☆			
Lower Extremity	Proposed number of procedures within this category = 50				
Toes	☆				
Foot	☆				
Ankle	☆				
Calcaneus	☆				
Tibia/fibula	☆				
Knee/patella	☆				
Distal femur	☆				
Extremity, age 6 years or younger		☆			
Podiatric	Proposed number of procedures within this category = 50				
Foot	☆				
Ankle	☆				
Vertebral column	Proposed number of procedures within this category = 50				
Cervical	☆				

Thoracic	☆				
Lumbar	☆				
Scoliosis series		☆			
Sacrum		☆			
Coccyx		☆			
Sacroiliac joints		☆			
Cranium	Proposed number of procedures within this category = 50				
Skull	☆				
Facial bones	☆				
Nasal bones		☆			
Orbits		☆			
Pantomography mandible		☆			
Paranasal sinuses	☆				

General Patient Care		
Students are to demonstrate competency in the following patient care simulations.	Date Completed	Verified By
CPR		
Vital signs (blood pressure, pulse, respiration, temperature)		

The evaluation of competence in the performance of clinical procedures is a key element in the development of the LXMO. Competency-based standards are basic statements of outcomes; they are attributes required to fulfill the LXMO role at the beginning level. They reflect the knowledge, attitudes, values and skills associated with each aspect of performance in the workplace and are expressed in terms of proficient practice.

Performing competently in the clinical setting is more than the demonstration of certain behaviors associated with the completion of a single task. Competence in clinical practice encompasses attributes of knowledge, problem solving, technical skills, comprehension, attitudes and ethics. It enables an individual or group to perform a role or set of tasks to an appropriate level, grade, quality or achievement, thus making the individual competent in that role.

Competency is a complex concept requiring multiple assessment strategies to evaluate the effectiveness of student learning. Assessment should not only be concerned with psychomotor skills, but also an understanding of the principles underlying professional practice.

Elements to consider in structuring the performance criteria for a clinical competency assessment are:

- Evaluation of requisition and patient assessment.
- Radiographic room readiness.
- Patient care and management.
- Equipment operation and technique selection.
- Positioning skills.
- Radiation protection for patient, self and others.
- Image processing and evaluating whether the resulting images demonstrate proper:
  - Anatomical part(s).
  - Alignment.
  - Radiographic techniques.
  - Image identification.
  - Radiation protection.

Each of these items should have a written definition and description of the criteria used to satisfy the expectations of student performance. Example: Images demonstrate effective use of beam collimation. Criteria: Evidence of effective beam collimation will be determined by the visible appearance of radiation field collimation to the part(s) of interest on finished radiographs and/or projections. Field borders shall not exceed 1.25" beyond the part of interest.

> Note: Some consideration should be given to the progression of student performance as experience is gained in the clinical setting. Expectation of student performance should be reasonable and obtainable during the early, middle and terminal periods of clinical exposure while at the same time incorporating increasing levels of skill improvement. Example: It may be reasonable to expect that early in the clinical experience a student would be able to place a patient in an oblique position of the wrist by the clinical evaluator for proper positioning. However, it would be expected that the same student would be consistent in positioning an oblique wrist properly without adjustment by the clinical evaluator in the final phases of clinical experience.

A student behavioral assessment can be a valuable component of an overall clinical assessment plan. Different from the competency assessment, the behavioral assessment is an opportunity to give students feedback on their development in the affective domain and in development of traits/characteristics valued by employers.

Radiologic Science Resources

This list of Radiologic Science Resources will assist educators in sampling the pool of references and study materials that pertain to medical radiography. The resources list should be viewed as a snapshot of available materials. Omission of any one title is not intentional. Because the creation of literature and media related to the field is dynamic, educators are encouraged to search additional sources for recent updates, revisions and additions to this collection of titles.

Textbooks

Adler A, Carlton R. *Introduction to Radiography and Patient Care*. 4th ed. St. Louis, Mo: Elsevier Saunders; 2007.
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Adler A, Carlton R, Finney WF. *Workbook W/Lab Exercises for Principles of Radiographic Imaging*. 3rd ed. Albany, NY: Delmar Thomson Learning; 2001.
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