Fluoroscopy Educational Framework for the Physician Assistant

This Educational Framework was created through the collaboration of the
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Introduction

The goal of this educational framework is to provide the professional community with a cognitive base supporting the development of an educational component for physician assistants (PA) who use fluoroscopic guidance in their practice. The PA is a graduate of an accredited PA program who has passed the NCCPA administered Physician Assistant National Certifying Exam (PANCE). This certification is required by all states for licensure to practice medicine with the supervision of a licensed physician. This educational framework is not intended for use by limited x-ray machine operators (LXMO), medical assistants, chiropractic technologists or other ancillary medical personnel.

The educational framework is divided into two sections. The didactic section covers patient history, contrast media, operation of the fluoroscopic unit and radiation safety. The second section is a clinical component. It is estimated that the didactic section will comprise 40 hours of instruction and the clinical component will encompass an additional 40 hours for a total of 80 hours.

The content and objectives should be organized to meet the mission, goals and needs of each physician assistant. 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 omitted intentionally to allow for flexibility and creativity in instructional delivery.

The clinical section of this educational framework lists the fundamental examinations that a physician assistant should be able to perform. The physician assistant should work closely with a preceptor or supervising physician to gain competence in each of these areas.

The physician assistant is expected to perform each examination in a competent manner and understand the rationale of the exam purpose and how it fits into the entire continuum of patient care. The physician assistant is encouraged to monitor his or her progress in the development of such competency through the maintenance of the Professional Development Portfolio developed by the American Academy of Physician Assistants.

Fluoroscopy Educational Framework for Physician Assistants

Table of Contents

Didactic Content

Digital Image Acquisition and Display

Description

Content imparts an understanding of the components, principles and operation of digital imaging systems found in diagnostic radiology. Factors that impact image acquisition, display, archiving and retrieval are discussed. Guidelines for selecting exposure factors and evaluating images within a digital system assist students to bridge between film-based and digital imaging systems. Principles of digital system quality assurance and maintenance are presented.

Objectives

1. Define terminology associated with digital imaging systems.
2. Describe the evaluative criteria for digital radiography detectors.
3. Use appropriate means of scatter control.
4. Associate the impact of image processing parameters on image appearance.
5. Describe the fundamental physical principles of exposure for digital detectors.
6. Examine the potential impact of digital radiographic systems on patient exposure.
7. Discuss the concept of as low as reasonably achievable (ALARA) as it applies to digital systems.
8. Describe the function of a picture archival and communication system (PACS).
9. Define digital imaging and communications in medicine (DICOM).

Content

I. Basic Principles of Digital Radiography

A. Digital image characteristics
1. Picture elements – pixels
2. Pixel size
3. Matrix size
4. Spatial resolution
5. Bit depth
6. Information content – megabytes/image

B. Digital receptors
1. Cassette-less systems
   a. Thin film transistor (TFT) arrays
   b. Charge-coupled device (CCD) and complementary metal oxide semiconductor (CMOS) systems
      1) Linear scanning arrays
         a) Fixed photostimulable phosphor (PSP) plates
      2) Optically coupled cameras
         a) Phosphor structure
         b) Detector characteristics

II. Image Acquisition Errors

A. Scatter control
1. Beam limiting
2. Optimal exposure – overexposure produces more scatter
3. Grid use
   a. Kilovoltage (kV) conversion preferred
   b. Grid cutoff produces low contrast
   c. Compare short dimension (SD) grid and long dimension (LD) grid
   d. Moiré effect
      1) Grid frequency approximately equal to Nyquist
      2) Reduce risk – unmatched frequencies
         a) Grid frequency less than Nyquist (178 lpi)
         b) Grid frequency greater than Nyquist (103 lpi)

III. Fundamental Principles of Exposure

A. Optimal receptor exposure
1. Receptor exposure variables
2. Receptor exposure control

B. Receptor response – DQE

C. Control patient exposure
1. Higher peak kilovoltage (kVp) levels
2. Additional filtration
3. Interfacing with automatic exposure control (AEC) systems
4. ALARA principles

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

IV. Image Evaluation

A. Exposure level
   1. Exposure indicator

B. Contrast
   1. Appropriate for exam
   2. Evidence of processing error

C. Recorded detail
   1. Image blur
   2. Spatial resolution
   3. Distortion
   4. Mottle

D. Artifacts

V. PACS

A. Terminology

B. System components and function

C. DICOM

D. Teleradiology

Contrast Media

Description
Content imparts an understanding of contrast media used during common diagnostic procedures. Topics include an overview of the chemical makeup and physical properties of select contrast agents; selection of contrast agents for given exams; patient risk factors; premedication strategies; indicators and symptoms of a patient contrast media reaction; and recommendations for care and treatment of patients experiencing an adverse reaction to a given contrast agent.

Objectives
1. Discuss the rationale for contrast media use.
2. Differentiate between negative and positive contrast agents.
3. Identify the physical properties of select contrast agents.
4. Describe the structural differences and characteristics of low and high osmolar injectable contrast media.
5. Identify the desired contrast agent employed for select exams.
6. Discuss the resources used to identify patients at risk of an adverse reaction to contrast media used during a given diagnostic procedure.
7. Identify patient indicators for altering the selection of contrast media used to perform a given procedure.
8. Recite the patient preparation necessary for various contrast and special studies.
9. Identify the strategies used for patients with a known history of allergic reaction.
10. Recognize the indicators and symptoms associated with a patient experiencing a mild, moderate or severe reaction to contrast media.
11. Implement strategies for treating a patient experiencing an adverse reaction to contrast media.
12. Discuss patient counseling and recommended follow-up care for patients undergoing a procedure requiring the use of contrast media.

Content

I. Rationale for Contrast Media Use

II. Agents

A. Negative agents
   1. Air
   2. Carbon dioxide
   3. Nitrous oxide

B. Positive agents
   1. Barium sulfate
   2. Iodinated agents
      a. Water soluble
      b. Oily

III. Contrast Preparations

A. Barium sulfate (Ba_2SO_4)
   1. Dry powder or premixed
   2. Suspension
   3. Paste
   4. Tablets

B. Iodinated water soluble
   1. Types
      a. Diatrizoic acid (Hypaque and Renografin)
      b. Iothalamate (Conray)
      c. Metrizamide (Amipaque)
      d. Iohexol (Omnipaque)
      e. Ioxaglate (Hexabrix)
      f. Iopamidol (Isovue and Niopam)
      g. Ioversol (Optiray)

IV. Characteristics of Iodinated Contrast Materials

A. Water solubility and hydrophilicity

B. Osmolality
   1. High osmolar contrast media (HOCM)
      a. Molecular structure
   2. Low osmolar contrast media (LOCM)
      a. Molecular structure
      b. LOCM advantages
      c. LOCM disadvantages

C. Viscosity

D. Calcium binding

E. Chemical stability

V. Media in Use

A. Barium sulfate
   1. Procedures requiring the use of barium
   2. Low occurrence of allergic reaction
   3. Causes of allergic reaction
   4. Patient risks following the administration of barium
   5. Characteristics of patients at risk
   6. Glucagon administration
      a. Rationale for use
      b. Administration

B. Iodinated contrast materials
   1. Procedures requiring iodinated contrast use
   2. Oily iodinated contrast
      a. Procedures requiring oily iodinated media use
   3. Contrast used for intrathecal injections
      a. Oily contrast
      b. Aqueous contrast
      c. Patient management to reduce the rate and severity of adverse reactions
   4. Instructions given to diabetic patients receiving antihyperglycemic agents (Metformin, Glucophage)

VI. Strategies for Dealing With Patients With a Known History of Allergic Reaction

A. Steroid premedication for intravascular contrast media

B. Indications for steroid premedication

C. Contraindications for steroid premedication

D. Dosage
   1. Nonemergency cases
      a. Two-dose regimen
   2. Emergency cases

E. Suggesting alternative procedures

VII. Adverse Reactions to Contrast Administration

A. Minor reaction
   1. Symptoms
   2. Recommended response

B. Moderate reaction
   1. Symptoms
   2. Recommended response

C. Severe reaction
   1. Symptoms
      a. Early symptoms

b. Late symptoms
2. Recommended response

D. Infiltration
1. Symptoms
2. Recommended response

VIII. Patient Counseling and Recommended Follow-up Care

A. Following barium procedures

B. Following iodinated contrast media procedures

C. Following adverse reactions to administered contrast agents

Fluoroscopic Unit Operation and Safety

Description

Content promotes the conscientious operation of the fluoroscopic device used in diagnostic and therapeutic patient exams. Content complements guided practice in operating the fluoroscopic device. Analysis of the functional components of fixed and mobile fluoroscopic devices heightens operator awareness of the features and limitations of this imaging medium. Procedures and techniques to optimize image quality while reducing potential radiation exposure to patients, operator and ancillary personnel are included.

Objectives

1. Identify the components of diagnostic x-ray tubes.
2. Explain protocols used to extend x-ray tube life.
3. Make prudent judgment for the use of the fluoroscopic unit as a diagnostic tool.
4. Identify the advantages and limitations of the fluoroscopic unit and various exposure settings (i.e., high-level control, or HLC) as a diagnostic tool.
5. Identify the functional components involved in the operation of both fixed and mobile fluoroscopic devices.
6. Identify features of the fluoroscopic unit designed to minimize radiation exposure to patients and operators.
7. Employ methods and techniques in the operation of the fluoroscopic device to maximize the diagnostic value of a given exam while minimizing patient radiation exposure.
8. Provide direction regarding radiation protection practices to others present during a fluoroscopic exam.
9. Provide patient education regarding the operation and benefits of the fluoroscopic device.
10. Verify QA/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.
11. List elements of a quality management (QM) program and discuss how each is related to the QM program.

Content

I. X-ray Tubes

A. Construction
   1. Design
   2. Function

B. Extending tube life
   1. Warm-up procedures
   2. Filament considerations
   3. Anode thermal capacity

II. Components of the Fixed Fluoroscopic Unit

A. Table

B. Radiation source

C. Image intensifier carriage
   1. Table controls
   2. Fluoroscopic controls
   3. Image controls

D. Image intensifier construction
   1. Design
   2. Function

E. Intensification principles and characteristics
   1. Brightness gain
   2. Flux gain
   3. Minification gain
   4. Conversion factor
      a. Conversion factor and brightness gain
   5. Automatic brightness control (ABC)
   6. Multifield intensifiers
      a. Magnification
      b. Dose
   7. Spatial resolution
   8. Distortion
   9. Noise

F. Viewing and recording systems
   1. Video camera tube
   2. CCD
   3. Television monitor
   4. Cassette spot film
   5. Film cameras
   6. Video recorders

G. Digital fluoroscopy

1. Types of acquisition
    a. Video analog to digital
    b. CCD
    c. Flat panel detector
2. Operations and technique

III. Components of the Mobile Fluoroscopic Unit

A. Control panel

B. Radiation source

C. Image intensifier/flat panel detector

D. Optics system

E. Video interface

F. Locks and angle indicators

G. Equipment provisions
    1. Source-to-skin distance (SSD) control
    2. Control of radiation field
    3. Maximum exposure rate
    4. Lead apron requirements
    5. Maximum entrance dose vs. equipment setup and technique
    6. Scatter/isodose curves with relation to mobile equipment setup and personnel placement

H. Limiting the use of “high level control” or “boost position” during fluoroscopy

I. Personnel monitoring of radiation exposure

IV. Technical Factors Affecting the Radiation Dose Rate for Patients and Operators

A. Direct factors
    1. Milliamperage (mA)
    2. kVp
    3. Collimation
        a. Impact on integral dose
    4. Filtration
        a. Inherent and added
    5. Exposure time
    6. SSD
    7. Grids

B. Indirect factors
    1. Fluoroscopic room lighting
    2. Poor image receptor quality
    3. Low-absorption tabletop

C. Patient and operator dose reducers
   1. Gonadal shielding
   2. Lead drape
   3. Bucky slot cover
   4. Lead apron
   5. Thyroid shield
   6. Leaded glasses
   7. Three-phase and high-frequency generators
   8. Protective barriers
   9. Cumulative timer
   10. Mobile equipment setup

D. Image intensifiers and flat panel detectors
   1. Image quality considerations
   2. Quantum mottle
   3. Contrast resolution
      a. Low contrast
      b. High contrast
   4. Image resolution
   5. Image distortion
   6. Lag
   7. Vignetting
   8. Magnification

V. Operator Controls of the Fluoroscopic Unit

A. Control panel settings for fluoroscopy vs. dose

B. Fluoroscopic tower movement

C. Table top movement

D. Collimator control

E. Compression devices

F. Fluoroscopic grid device

G. Exposure switches

H. Spot film device
   1. Cassette
   2. Spot film camera
      a. Frame rate
   3. Fluoroscopic carriage locks
      a. Vertical lock
      b. Park position

VI. Patient Supports and Restraints

A. Footboard

B. Shoulder restraints

C. Other restraining apparatus

VII. Patient Dose

A. Risks of low-level radiation exposure

B. Somatic dose indicators
   1. Definition of somatic injury
   2. Injuries to superficial tissue
      a. High-dose exams offering superficial tissue risks
         1) Cardiac-interventional procedures
         2) Vascular-interventional procedures
   3. Induction of cancer
   4. Cataract formation
   5. Impaired fertility
   6. Life span shortening
   7. Injuries to the developing embryo
   8. Bone marrow effects
      a. High dose exams offering bone marrow risks
         1) Barium enema
         2) Upper gastrointestinal (GI) series
         3) Abdominal angiography
   9. Thyroid
   10. Skin injury

C. Genetic dose indicators
   1. Definition of genetic injury
   2. Variation in radiosensitivity between spermatogonia and oocytes
   3. Exams yielding a potential for high dose to the gonads
      a. Barium enema
      b. Intravenous urography
      c. Lumbar spine
      d. Pelvis
      e. Hips
      f. Upper femur

D. Genetically significant dose (GSD)
   1. Definition GSD
   2. Modifiers
      a. Number of future children
      b. X-ray examination rate
      c. Mean gonad dose per exam

E. Personnel radiation protection
   1. ALARA applied to fluoroscopy
   2. Sources of potential exposure to the operator
   3. Operator protection during the fluoroscopic exam

F. Protective apparel and accessories
   1. Lead apron
   2. Overhanging shields
   3. Mobile screens
   4. Protective curtain
   5. Protective gloves
   6. Thyroid shields
   7. Protective goggles/glasses

G. Other safety hazards
   1. Electrical hazards
      a. Frayed cables
      b. Broken switches
   2. Physical hazards
      a. Wet floor
      b. Faulty locks/interfaces
   3. Standard precautions

VIII. Pediatric Considerations

A. Grid

B. ABC

C. Anesthesia

D. Spot film vs. camera

Image Analysis

Description
Content provides a basis for analyzing radiographic 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.

Objectives
1. Discuss the elements of a radiographic image.
2. Apply the problem-solving process used for image analysis.
3. Describe an effective image analysis method.
4. Describe the role of the physician assistant in image analysis.
5. Apply the process for evaluating images for adequate density/brightness, contrast, recorded detail/spatial resolution and acceptable limits of distortion.
6. Summarize the importance of proper positioning.
7. Discuss the impact of patient preparation on the resulting radiographic image.
8. Differentiate between technical factor problems, procedural factor problems and equipment malfunctions.
9. Critique images for appropriate technical, procedural and pathologic factors.

Content

I. Imaging Standards

A. Purpose

B. Problem-solving process

C. Role of the physician assistant
   1. Determining cause of problems
   2. Recommending corrective action

D. Establishing acceptable limits

II. Procedural Factors

A. Image identification
   1. Patient information
   2. Date of examination
   3. Proper use of identification markers
   4. Institutional data

B. Documentation of ordered exam
   1. Prescription
   2. Patient chart
   3. Telephone orders
   4. Faxed orders

C. 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
   3. Special concerns
      a. Age
      b. Patient condition
      c. Mobile radiography

D. Patient preparation
   1. Contrast agent
   2. Pre-examination preparation

E. Artifacts

III. Corrective Action

A. Equipment
   1. Radiographic system

        a. Film-screen
        b. Digital
    2. Fluoroscopic unit

B. Technical factors

C. Procedural factors

D. Artifacts

Radiation Biology

Description
Content provides an overview of the principles of the interaction of radiation with living systems. Radiation effects on molecules, cells, tissues and the body as a whole are presented. Factors affecting biological response are presented, including acute and chronic effects of radiation.

Objectives
1. Describe principles of cellular biology.
2. Identify sources of electromagnetic and particulate ionizing radiations.
3. Discriminate between the direct and indirect mechanisms of radiobiological effects.
4. Identify sources of radiation exposure.
5. Evaluate factors influencing radiobiologic and biophysical events at the cellular and subcellular level.
6. Describe physical, chemical and biologic factors influencing radiation response of cells and tissues.
7. Explain factors influencing radiosensitivity.
8. Recognize the clinical significance of lethal dose ($LD_{50/60}$).
9. Identify specific cells from most radiosensitive to least radiosensitive.
10. Employ dose response curves to study the relationship between radiation dose levels and the degree of biologic response.
11. Examine effects of limited vs. total body exposure.
12. Relate short-term and long-term effects as a consequence of high and low radiation doses.
13. Differentiate between somatic and genetic radiation effects.
14. Discuss stochastic (probabilistic) and nonstochastic (deterministic) effects.
15. Discuss embryonic and fetal effects of radiation exposure.
16. Discuss acute radiation syndromes.

Content

I. Introduction

- A. Molecule
  1. Ionic bond
  2. Covalent bond

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

- C. Types of ionizing radiations
  1. Electromagnetic radiations
     - a. X-rays
     - b. Gamma rays
  2. Particulate radiations
     - a. Alpha
     - b. Beta
       - 1) Negatron
       - 2) Positron
     - c. Fast neutrons
     - d. Protons
  3. Absorption and ionization
     - a. Direct
     - b. Indirect

II. Biophysical Events

- A. Molecular effects of radiation
  1. Direct mechanism
     - a. Target theory
       - 1) Target molecules
       - 2) Cell death
  2. Indirect mechanism
     - a. Radiolysis of water

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

III. Radiation Effects

A. Subcellular radiation effects
   1. Radiation effects on deoxyribonucleic acid (DNA)
      a. Types of damage
      b. Implications for humans
   2. Radiation effects of chromosomes
      a. Types of damage
      b. Implications for 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

C. Individual radiation effects
   1. Somatic effects
      a. Short term
      b. Long term
      c. Stochastic (probabilistic) effects
   2. Genetic effects
      a. Mutagenesis
   3. Embryonic and fetal effects

D. Factors influencing radiation response

IV. Radiosensitivity and Response

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

B. Cell survival and recovery
   1. Factors influencing survival
      a. LET
      b. Oxygen enhancement ratio (OER)
      c. Fractionation

d. Protraction

2. $LD_{50/60}$

C. Systemic response to radiation

1. Hemopoietic
2. Integumentary
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. GI
   c. Central nervous system
2. Stages of response and dose levels
3. Factors that influence response
4. Medical interventions of response

F. Late effects of radiation

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

G. Risk estimates

Radiation Production and Characteristics

Description
Content establishes a basic knowledge of atomic structure and terminology. Also presented are the nature and characteristics of radiation, x-ray production and the fundamentals of photon interactions with matter.

Objectives
1. Describe fundamental atomic structure.
2. Explain the processes of ionization and excitation.
3. Describe wavelength and frequency and how they are related to velocity.
4. Explain the relationships between energy, wavelength and frequency.
5. Explain the wave-particle duality phenomena.
6. Identify the properties of x-rays.
7. Describe the processes of ionization and excitation.
8. Differentiate between ionizing and nonionizing radiation.
9. Compare the production of bremsstrahlung and characteristic radiations.
10. Describe the conditions necessary to produce x-radiation.
11. Describe the x-ray emission spectra.
12. Identify the factors that affect the x-ray emission spectra.
13. Discuss various photon interactions with matter by describing the interaction, relation to atomic number, photon energy and part density, and their applications in diagnostic radiology.
14. Discuss the clinical significance of the photoelectric and modified scattering interactions in diagnostic imaging.

Content

I. Structure of the Atom

A. Composition
   1. Nucleus
   2. Structure – proton and electron balance
   3. Electron shells
      a. Binding energy
      b. Ionization

II. Nature of Radiation

A. Radiation
   1. Electromagnetic
      a. Spectrum
      b. Wave-particle duality
      c. Properties
   2. Particulate
      a. Types
      b. Characteristics
   3. Nonionizing (excitation) vs. ionization
      a. Energy
      b. Probability

B. Radioactivity
   1. Radioactive decay
   2. Half-life ($T_{½}$)

III. X-ray Production

A. Common terms related to the x-ray beam
   1. Primary beam
   2. Exit/remnant beam
   3. Leakage radiation
   4. Off-focus radiation

B. Conditions necessary for production
   1. Source of electrons
   2. Acceleration of electrons
   3. Focusing the electron stream
   4. Deceleration of electrons

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

IV. 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
      a. Atomic number
      b. Photon energy
      c. Part density
   5. Application

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

Radiation Protection

Description
Content presents an overview of the principles of radiation protection, including the responsibilities of the physician assistant for patients, personnel and the public. Radiation health and safety requirements of federal and state regulatory agencies, accreditation agencies and health care organizations are incorporated.

Objectives
1. Identify and justify the need to minimize unnecessary radiation exposure of humans.
2. Distinguish between somatic and genetic radiation effects.
3. Differentiate between the stochastic (probabilistic) and nonstochastic (deterministic) effects of radiation exposure.
4. Explain the objectives of a radiation protection program.
5. Define radiation and radioactivity units of measurement.
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 the negligible individual dose (NID).
10. Comply with legal and ethical radiation protection responsibilities of radiation workers.
11. Describe the relationship between irradiated area and effective dose.
12. Describe the theory and operation of radiation detection devices.
13. Discuss how iso-exposure curves are used for radiation protection.
14. Describe "Radiation Area" signs and identify appropriate placement sites.
15. Describe the function of federal, state and local regulations governing radiation protection practices.
16. Discuss personnel monitoring devices, including applications, advantages and limitations for each device.
17. Interpret personnel monitoring reports.
18. Identify dose equivalent limits for the embryo and fetus in occupationally exposed women.
19. Distinguish between primary and secondary radiation barriers.
20. Discuss the relationship between workload, energy, HVL, tenth-value layer (TVL), use factor and shielding design.
21. Demonstrate how time, distance and shielding can be manipulated to minimize radiation exposures.
22. Explain the relationship of beam-limiting devices to patient radiation protection.
23. Discuss added and inherent filtration in terms of the effect on patient dosage.
24. Explain the purpose and importance of patient shielding.
25. Use the appropriate method of shielding for a given fluoroscopic procedure.
26. Explain the relationship of exposure factors to patient dosage.
27. Explain how patient position affects dose to radiosensitive organs.
28. Describe the minimum source-to-tabletop distances for fixed and mobile fluoroscopic devices.
29. Apply safety factors for the patient and others in the room during mobile fluoroscopic procedures.

Content

I. Introduction

A. Justification for radiation protection
   1. Somatic effects
   2. Genetic effects

B. Potential biologic damage of ionizing radiation
   1. Stochastic (probabilistic) effects
   2. Nonstochastic (deterministic) effects

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

D. Sources of radiation
   1. Natural
   2. Man-made (artificial)

E. Legal and ethical responsibilities

II. Units, Detection and Measurement

A. Radiation units
   1. Exposure
      a. Coulomb/kilogram (C/kg)
      b. Roentgen (R)
   2. Absorbed dose
      a. Gray (Gy)
      b. Rad
   3. Dose equivalent
      a. Sievert (Sv)
      b. Rem
   4. Radioactivity
      a. Becquerel (Bq)
      b. Curie (Ci)

B. Dose reporting
   1. Code of Federal Regulations (CFR)
   2. National Council on Radiation Protection and Measurements (NCRP) Guidelines

III. Personnel Monitoring

A. Historical perspective
   1. Evolution of standards
   2. 10 CFR part 20
   3. NCRP recommendations
   4. ICRP recommendations

B. Requirements for personnel monitoring
    1. Deep dose equivalent (DDE)
    2. Shallow dose equivalent (SDE)
    3. Eye dose equivalent (EDE)
    4. Total effective dose equivalent (TEDE)

C. Methods and types of personnel monitors
    1. Film badge
    2. Thermoluminescent dosimeter (TLD)
    3. Optically stimulated luminescent dosimeter (OSLD)

D. Records of accumulated dose
    1. Purpose
    2. Content
    3. Length of record-keeping
    4. Retrieval from previous employers

E. Dose limits – 10 CFR part 20
    1. Occupational
    2. Nonoccupational limits
    3. Critical organ sites
    4. Embryo and fetus

F. Responsibilities for radiation protection
    1. Physician assistant
    2. Radiographer
    3. Radiation safety officer (RSO)
    4. Facility

IV. Application

A. Design
    1. Materials
    2. Primary barrier
    3. Secondary (scatter and leakage) barrier
    4. HVL and TVL
    5. Factors
        a. Use (U) controlled and uncontrolled
        b. Workload (W)
        c. Occupancy (T)
        d. Distance (D)
    6. X-ray and ancillary equipment
        a. Beam-limiting devices
        b. Exposure control devices
        c. On and off switches
        d. Interlocks
        e. Visual/audio monitors

f. Emergency controls
g. Quality control
1) Calibration
2) Standards

B. Regulations and recommendations
1. Current NRC recommendations and regulations
2. Current NCRP recommendations and regulations
3. Applicable state regulations
4. 42 U.S.C. 10001-10008 and 42 C.F.R, Part 75 (Patient Consumer Radiation Health and Safety Act of 1981)
5. Consistency, Accuracy, Responsibility and Excellence in Medical Imaging and Radiation Therapy (CARE) bill
6. Public awareness

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

D. Emergency procedures

V. Patient Protection

A. Beam-limiting devices

B. Filtration

C. Shielding

D. Exposure factors

E. Positioning

F. Immobilization

G. Fluoroscopic procedures

H. Special considerations
1. Pediatric patients
2. Pregnant patients

Clinical Component

Clinical Competency Requirements

Physician assistants wishing to perform select fluoroscopic examinations are required to document 40 hours of supervised clinical time in a fluoroscopic suite. Fluoroscopic procedures must be supervised by a radiologist, medical physicist or radiography educator.

Physician assistants must maintain a record of the performance and repetition of patient procedures. Documentation must include an operation check-off of each fluoroscopic room/portable fluoroscopy device prior to initial use. Documentation of patient exams must include the name of the procedure, date of procedure, time of day completed, facility where performed and the initials of the person verifying performance.

It is recognized that each clinical setting and patient population will determine the range and complexity of fluoroscopic examinations available to achieve clinical competence.

Fluoroscopic Device Orientation Check-off

Candidate Name: ________________________ Device ID: ____________________________

Prior to performing an initial patient exam, physician assistants are required to document they can manipulate the fluoroscopic device in a safe and proper manner. Evaluators are to date and initial each item when satisfactorily completed.

Date/Evaluator Initials

_____________1. Perform a visual equipment safety check.

_____________2. Confirm control panel exposure settings.

_____________3. Set a manual technique.

_____________4. Enter patient identification.

_____________5. Demonstrate the full range of fluoro tower movement.

_____________6. Demonstrate full range of fluoro table movement.

_____________7. Adjust position of the fluoro grid device.

_____________8. Apply patient footboard and shoulder restraints.

_____________9. Store and recall images.

_____________10. Produce hard copies and load cassettes.

_____________11. Operate exposure switch(es) (live fluoro or DR store).

_____________12. Collimate fluoro field.

_____________13. Change the field of view size.

_____________14. Reset the fluoro timer.

_____________15. Switch programs and dose settings.

_____________16. Rotate and flip images.

_____________17. Hook up and turn on the C-arm.

_____________18 Locate and manipulate locks, rotate the arm and steer the C-arm and monitor.

Clinical Experience Documentation Form

Procedures should be organized as presented in the sample table below. Like procedures must be grouped together.

Candidate Name: ____

Procedure	Date Performed	Time of Day	Facility Name	Verified by (Initials)
Example – Lumbar Puncture under Fluoroscopy	mm/dd/yy	10:00 a.m.	General Hospital	BTL
Example – Lumbar Puncture under Fluoroscopy	mm/dd/yy	10:00 a.m.	General Hospital	BTL
Example – Lumbar Puncture under Fluoroscopy	mm/dd/yy	10:00 a.m.	University Hospital	BTL
Example – Lumbar Puncture under Fluoroscopy	mm/dd/yy	10:00 a.m.	University Hospital	BTL
Example – Dialysis Catheter Placement under Fluoroscopy	mm/dd/yy	10:00 a.m.	General Hospital	BTL
Example – Dialysis Catheter Placement under Fluoroscopy	mm/dd/yy	10:00 a.m.	University Hospital	BTL
Example – PICC line placement	mm/dd/yy	10:00 a.m.	General Hospital	BTL
Example- Modified Barium Swallow	mm/dd/yy	9:30 a.m.	General Hospital	BTL

Signature of overall evaluator:____

This form may be duplicated

Candidate Name:____

Procedure	**Date Performed**	**Time of Day**	**Facility Name**	**Verified by (Initials)**

Signature of overall evaluator:____

This form may be duplicated

Resources

Textbooks

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Web sites

Harrison’s Online
www.accessmedicine.com/resourceTOC.aspx?resourceID=4

Lexi-Comp Online
www.lexi.com

Micromedex
www.micromedex.com

WebMD Scientific American Medicine
www.medscape.com