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# Content Specifications for the Registered Radiologist Assistant Examination



*Effective with the January 2011 Examination*

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The American Registry of Radiologic Technologists (ARRT) administers the national certifying examination for Registered Radiologist Assistants (R.R.A.s). To establish certification requirements for this area of advanced practice, the ARRT periodically sponsors a practice analysis project. The most recent study was completed in 2009 under the direction of the R.R.A. Advisory Committee, which included representatives from the American College of Radiologists (ACR) and the American Society of Radiologic Technologists (ASRT). Participants in the study included national samples of radiologists and radiologist extenders. The project culminated in the Entry-Level Clinical Activities (ELCA) document which identifies activities and clinical procedures performed by R.R.A.s.

The ELCA serves as the basis for the content specifications presented on the following pages. The content specifications identifies the knowledge and cognitive skills required to effectively perform the activities and clinical procedures included in the ELCA.

The table below presents the six major content categories, along with the number of questions appearing in each category. The examination consists primarily of selected response test questions (e.g., multiple choice). In addition, case studies are presented that require an essay response to several questions. Candidates are allowed 3½ hours to complete the selected response multiple-choice section, and 2½ hours to complete the case study section.

The pages that follow provide a detailed listing of topics within each major content category. Although this document covers many of the same topics included in curricula guides and related documentation, it is not intended to serve as a guide for educational programs. Educational programs are likely to be broader in scope.

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<b>Content Categories</b>	<b>Selected Response Points</b>	<b>Case Study Points<sup>1</sup></b>
A. Patient Communication, Assessment, and Management	45	
B. Drugs and Contrast Materials	30	
C. Anatomy, Physiology, and Pathophysiology <sup>2</sup>	55	
D. Radiologic Procedures <sup>2</sup>	40	
E. Radiation Safety, Radiation Biology, and Fluoroscopic Operation	15	
F. Medical-Legal, Professional, and Governmental Standards	<u>15</u>	
Total Number <sup>3</sup>	200	
Testing Time Allowed	3.5 hours	2.5 hours

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Notes: (1) The exam also contains two case studies. Each case is followed by four to six essay questions worth 3 or 6 points each. A case also includes a few selected response questions (e.g., multiple choice). Refer to *Overview of CBT* at [www.arrt.org](http://www.arrt.org) for additional details. (2) Test content in sections C or D may refer to appropriate imaging. (3) The exam also consists of an additional 20 unscored pilot questions.

## A. PATIENT COMMUNICATION, ASSESSMENT, AND MANAGEMENT (45)

### 1. PATIENT COMMUNICATION (5)

- A. Patient Education
  - 1. explanation of procedure
  - 2. alternatives to current procedure
  - 3. risk versus benefit
  - 4. radiation procedure exposure and cumulative dose education
- B. Psychosocial Support
  - 1. communication skills and issues
  - 2. cultural awareness
  - 3. social support structures
- C. Pre- and Post-Procedure Care Instructions

### 2. PATIENT ASSESSMENT: (20) Includes adaptations for pediatric, geriatric, and special needs populations

- A. Medical Data Review
  - 1. indications for procedure (ACR Appropriateness Criteria ®)
  - 2. contraindications for procedure
  - 3. laboratory values
  - 4. prior diagnostic studies
  - 5. current medications
  - 6. previous history (e.g., vital signs, nurses/physicians notes)
  - 7. assessment of vital signs, height, and weight
- B. Patient Interview
  - 1. verification
    - a. patient identification and correct procedure
    - b. patient preparation
    - c. pregnancy status
  - 2. medical history
    - a. chief complaint
    - b. present illness
    - c. past history
    - d. family history
    - e. personal and social history
    - f. review of systems

- 3. risk factors
  - a. medications
  - b. allergy history
  - c. medical or psychological indicators
  - d. alternative medicines
- C. Common Laboratory Tests, Analysis, and Significance
  - 1. complete blood count (CBC), RBC, WBC, hemoglobin, platelets
  - 2. electrolytes (sodium, potassium, bicarbonate, chloride)
  - 3. pancreatic and cardiac enzymes
  - 4. calcium
  - 5. albumin and total protein
  - 6. coagulation factors (e.g., prothrombin time (PT), partial thromboplastin time (PTT), International Normalized Ratio (INR), platelets)
  - 7. liver function
  - 8. renal function
  - 9. glucose
  - 10. culture and sensitivity
  - 11. cytology and histopathology
- D. Psychological Status
  - 1. cognitive abilities
  - 2. emotional stability
  - 3. speech and language skills
  - 4. disorders that affect communication
    - a. dementia
    - b. cognitive impairment
    - c. drug and/or alcohol impairment

(Section A continues on the following page)

#### E. Abdomen Assessment

1. assessment procedures
  - a. visual inspection
  - b. auscultation
  - c. percussion
  - d. palpation
  - e. pre-procedure rectal exam
2. signs and symptoms
  - a. tenderness on palpation
  - b. diarrhea
  - c. flatulence
  - d. dysuria
  - e. pain
  - f. constipation
  - g. reflux
  - h. nausea and vomiting

#### F. Thorax and Lung Assessment

1. assessment procedures
  - a. visual inspection
  - b. auscultation
  - c. percussion
  - d. palpation
  - e. chest wall excursion
  - f. oxygen saturation measurement
2. signs and symptoms
  - a. cough/sputum production
  - b. pain
  - c. breathing pattern
  - d. skin changes (e.g., cyanosis)
  - e. clubbing
  - f. exercise/activity tolerance

#### G. Cardiovascular Assessment

1. assessment procedures
  - a. visual inspection
  - b. auscultation
  - c. palpation
  - d. vital signs
  - e. electrocardiogram (ECG)
  - f. perfusion status
2. signs and symptoms
  - a. venous distention
  - b. heart rate and rhythm
  - c. peripheral pulse
  - d. edema
  - e. exercise/activity tolerance
  - f. pain
  - g. skin changes (e.g., ulceration)

#### H. Musculoskeletal Assessment

1. assessment procedures
  - a. visual inspection
  - b. palpation
  - c. range of motion analysis
  - d. mobility and strength testing
2. signs and symptoms
  - a. skin changes (e.g., redness, temperature)
  - b. swelling
  - c. crepitus
  - d. pain
  - e. change in function

#### I. Peripheral Vascular Assessment

1. assessment procedures
  - a. visual inspection
  - b. auscultation
  - c. palpation
  - d. pulse and edema scoring
  - e. ABI-Ankle Brachial Index
2. signs and symptoms of arterial occlusion and insufficiency
  - a. pain
  - b. skin changes
  - c. altered pulses
  - d. arterial bruits
  - e. claudication
  - f. thrills
3. signs and symptoms of venous obstruction and insufficiency
  - a. skin changes
  - b. generalized edema
  - c. varicose veins
  - d. venous hum

#### J. Neurological Assessment

1. assessment procedures
  - a. visual inspection (e.g., pupil size, symmetry, and reactivity)
  - b. sensory evaluation
  - c. motor evaluation
2. signs and symptoms
  - a. pain
  - b. weakness
  - c. sensory changes
  - d. motor changes

(Section A continues on the following page)

- K. Breast and Axillae Assessment
  1. assessment procedures
    - a. visual inspection
    - b. palpation
    - c. clinical breast examination
  2. signs and symptoms
    - a. mass
    - b. discharge
    - c. depression
    - d. skin changes
    - e. asymmetry
    - f. pain/tenderness
    - g. nipple changes

### 3. PATIENT MANAGEMENT (20)

- A. Standard Precautions (mechanism of disease transmission)
- B. Sterile Technique
- C. Patients with Disabilities
- D. Patient Monitoring and Assessment (pre-, during, and post-procedure)
  1. physical status
  2. emotional status
  3. cardiac monitoring
- E. Intravenous Therapy
  1. venipuncture
  2. flow rate monitoring
  3. complications
- F. Oxygen Therapy
  1. level (flow rate)
  2. indications and contraindications
- G. Urinary Catheterization
  1. technique
  2. complications
  3. contraindications
- H. Medical Emergencies
  1. cardiac arrest
  2. hypoglycemia
  3. seizure
  4. respiratory arrest
  5. shock

- I. Radiological Procedure Complications
  1. contrast related complications
    - a. nephrotoxicity
      1. contrast induced nephropathy
      2. NSF (nephrogenic systemic fibrosis)
    - b. neurotoxicity
    - c. extravasation
  2. infection
  3. hemorrhage
  4. pneumothorax
  5. perforation (GI or GU)
  6. respiratory distress
  7. aspiration
  8. vasovagal reaction
  9. pulmonary edema
  10. vascular injury or occlusion
  11. complications of catheterization
  12. seizures
  13. pain
  14. anaphylactoid shock
  15. neurologic deficit
  16. stroke
  17. cardiac arrest
  18. radiation injury
  19. physical injury
  20. death
- J. Medical Devices
  1. image appearance, indications, and purpose
    - a. drainage catheters
    - b. peritoneal dialysis catheters
    - c. CSF shunts
    - d. stents
    - e. IABP
    - f. pacers/AICD
    - g. urinary catheters
    - h. umbilical vascular catheters
    - i. cardiovascular valves
    - j. intrathecal catheters
    - k. bariatric devices
    - l. neuro stimulators
  2. image appearance, indications, purpose, appropriate location, and complications
    - a. Swan Ganz catheters
    - b. central venous catheters
    - c. IVC filter
    - d. chest tubes
    - e. tracheal tubes
    - f. gastroenteric tubes

## B. DRUGS AND CONTRAST MATERIALS (30)

### 1. TERMINOLOGY (5)

- A. Regulations
  - 1. Food and Drug Administration (FDA)
  - 2. Drug Enforcement Agency (DEA)
  - 3. controlled substances
- B. Identifying Names
  - 1. generic
  - 2. trade
  - 3. United States Pharmacopoeia (USP)
- C. Drug Characteristics
  - 1. actions
  - 2. synergisms
  - 3. indications
  - 4. contraindications
  - 5. side effects
  - 6. adverse actions
- D. Dosage
  - 1. loading
  - 2. maintenance
  - 3. therapeutic dose
  - 4. lethal dose
- E. Safe Dosage Calculation
  - 1. ratio
  - 2. proportion
  - 3. pediatric
  - 4. geriatric
- F. Administration
  - 1. oral
  - 2. rectal
  - 3. sublingual
  - 4. parenteral
  - 5. intravenous
  - 6. intramuscular
  - 7. intrathecal
  - 8. cutaneous
  - 9. nasal

### 2. ANESTHETICS (7)

- A. Local Anesthetics
  - 1. short acting
  - 2. long acting
  - 3. injectables
  - 4. cutaneous
- B. Moderate/Conscious Sedation - American Society of Anesthesiologists (ASA) Guidelines
  - 1. definitions
  - 2. guidelines
    - a. pre-procedure
      - 1. history and physical
      - 2. ASA guidelines
    - b. intra-procedure
    - c. post-procedure
    - d. discharge scoring system
      - 1. motor activity
      - 2. respirations
      - 3. standing blood pressure
      - 4. consciousness
      - 5. oxygen saturation
  - 3. equipment
  - 4. medications (indications, contraindications, dosing guidelines)
    - a. fentanyl
    - b. morphine
    - c. meperidine
    - d. diazepam
    - e. midazolam
    - f. lorazepam
    - g. pentobarbital
    - h. chloral hydrate
    - i. naloxone
    - j. flumazenil
    - k. epinephrine
    - l. atropine

(Section B continues on the following page)

**3. GENERAL MEDICATIONS: (9)**  
**classifications, indications,**  
**contraindications**

- A. Anti-Infective Drugs
  - 1. antibiotics
  - 2. antivirals
  - 3. antifungals
- B. Cardiac Drugs
  - 1. anti-hypertensive
    - a. calcium channel blockers
    - b. beta blockers
    - c. ACE inhibitors
  - 2. vasoconstrictors
  - 3. vasodilators
  - 4. anti-arrhythmics
- C. Gastrointestinal Drugs
  - 1. anti-reflux agents
  - 2. hypomotility (glucagon)
  - 3. cholecystokinetic (cholecystokinin)
  - 4. antiemetics
- D. Vascular Drugs
  - 1. coagulation modifiers
  - 2. tissue plasminogen activator (TPA)
- E. Anti-Inflammatory Drugs
  - 1. analgesics (aspirin)
  - 2. non steroidal anti-inflammatory drugs (NSAIDs)
  - 3. corticosteroids
- F. Endocrine Drugs
  - 1. diabetic medication
  - 2. anti-hypoglycemic (glucagon)
  - 3. insulin
  - 4. thyroid medications
- G. Diuretics

**4. CONTRAST MEDIA (9)**

- A. Agents (e.g., indications, contraindications, adverse reactions, dosage, routes of administration, excretion process)
  - 1. negative contrast agents
  - 2. positive contrast agents
  - 3. barium sulfate
  - 4. iodinated contrast media
    - a. osmolality (high versus low)
    - b. molecular structure
    - c. advantages
  - 5. MRI agents
  - 6. special considerations
    - a. hydration status
    - b. renal status (e.g., creatinine levels, GFR)
    - c. diseases of concern (e.g., multiple myeloma, diabetes)
    - d. incompatible medications (e.g., metformin/Glucophage)
- B. Allergies
  - 1. allergy history
  - 2. types of reactions (mild to severe)
  - 3. premedications
    - a. diphenhydramine
    - b. corticosteroids
- C. Resuscitation
  - 1. life support
    - a. basic life support (BLS)
    - b. advanced cardiac life support (ACLS)
  - 2. basic drugs
    - a. epinephrine
    - b. atropine
    - c. bronchodilator
    - d. nitroglycerine
    - e. lidocaine
    - f. intravenous fluid

## C. ANATOMY, PHYSIOLOGY, AND PATHOPHYSIOLOGY (55)

### 1. ANATOMY: (15) Includes gross and sectional anatomy, age-related changes, common surgical changes, congenital and developmental abnormalities/anomalies

- A. Abdominal Section
- B. Thoracic Section
- C. Musculoskeletal Section
- D. Neurological and Endocrine Section
- E. Vascular and Lymphatic Section
- F. Breast and Axilla Section

### 2. PHYSIOLOGY: (12) Includes age-related and surgery-related physiologic changes

- A. Abdominal Section
  - 1. gastrointestinal
  - 2. hepatobiliary
  - 3. urinary
  - 4. reproductive
- B. Thoracic Section
  - 1. cardiovascular
  - 2. pulmonary
- C. Musculoskeletal Section
  - 1. muscular
  - 2. skeletal
- D. Neurological and Endocrine Section
  - 1. neurological
  - 2. endocrine
- E. Vascular and Lymphatic Section
  - 1. vascular
  - 2. lymphatic
- F. Breast and Axilla Section

### 3. PATHOPHYSIOLOGY (28)

- A. Abdominal Section
  - 1. alteration in function related to disease/injury
  - 2. compensation mechanisms
  - 3. diseases/disorders/injuries (e.g., etiology, manifestations, physical examination, diagnostic studies, history and physical findings/clinical data)
    - a. general abdomen
      - 1. abdominal calcifications
      - 2. abdominal aortic aneurysm
      - 3. normal and abnormal gas patterns – (e.g., ileus, obstruction, volvulus)
      - 4. pneumatosis intestinalis
      - 5. portal venous gas
      - 6. peritonitis
      - 7. pneumoperitoneum
      - 8. abscess
      - 9. free fluid
    - b. gastrointestinal
      - 1. esophagus
        - a. dysphagia
        - b. achalasia
        - c. scleroderma
        - d. fistulae
        - e. esophagitis
        - f. varices
        - g. Crohn's disease
        - h. presbyesophagus
        - i. webs
        - j. diverticuli (Zenker's, Killian-Jameson, epiphrenic)
        - k. primary muscular and neural disorders
        - l. malignant and benign masses
        - m. Barrett's esophagus

(Section C continues on the following page)

2. stomach
  - a. hiatal hernias
  - b. gastric outlet obstruction
  - c. malignant and benign masses
  - d. gastroparesis
  - e. volvulus
  - f. pyloric stenosis
  - g. bezoar
  - h. ulcers
  - i. gastritis
  - j. gastroesophageal reflux disease (GERD)
  - k. surgical variation (Roux-en-Y, gastric band, Nissen fundoplication)
3. small intestine
  - a. diverticuli
  - b. non-rotation and malrotation
  - c. duodenitis
  - d. Crohn's disease
  - e. peptic ulcer disease
  - f. malignant and benign tumors
  - g. ischemia
  - h. adhesions
  - i. malabsorption
  - j. hernias
  - k. infections
  - l. fistulae
  - m. superior mesenteric artery (SMA) syndrome
  - n. intussusception
  - o. necrotizing enterocolitis
  - p. Meckel's diverticulum
4. large intestine
  - a. intussusception
  - b. Crohn's disease
  - c. polyps
  - d. malignant and benign masses
  - e. Hirschsprung's disease
  - f. fistulae
  - g. inflammatory diseases
  - h. adhesions
  - i. appendicitis
  - j. non-rotation and malrotation
  - k. colitis
  - l. diverticulosis/diverticulitis
  - m. volvulus
  - n. constipation
  - o. toxic megacolon
- c. hepatobiliary, pancreas, and spleen
  1. hepatitis
  2. cirrhosis
  3. pancreatitis
  4. cholecystitis
  5. biliary calculi
  6. liver failure
  7. portal hypertension
  8. malignant and benign masses
  9. inflammatory processes
  10. biliary dyskinesia
  11. fatty liver
  12. Gaucher's disease
  13. splenomegaly
  14. pancreatic insufficiency
  15. pancreatic pseudocyst
- d. urinary
  1. malignant and benign masses
  2. calculi
  3. inflammatory processes and abscesses
  4. acute and chronic renal failure
  5. glomerulonephritis and nephrotic syndrome
  6. infarcts, ischemia, thrombosis
  7. nephrocalcinosis
  8. renal papillary necrosis
  9. vesicoureteral reflux
  10. UPJ obstruction (congenital, adult)
  11. polycystic kidney disease
- e. reproductive
  1. female
    - a. endometriosis
    - b. malignant and benign masses
    - c. pelvic inflammatory disease
    - d. polycystic ovary disease
    - e. pregnancy
    - f. ectopic pregnancy
  2. male
    - a. benign prostatic hypertrophy
    - b. malignant and benign masses
    - c. inflammatory processes
    - d. testicular torsion
    - e. hydrocele

(Section C continues on the following page)

B. Thoracic Section

1. alteration in function related to disease/injury
2. compensation mechanisms
3. diseases/disorders/injuries (e.g., etiology, manifestations, physical examination, diagnostic studies, history and physical findings/clinical data)
  - a. inflammatory and infectious diseases
  - b. malignant and benign masses
  - c. adult respiratory distress syndrome (ARDS)
  - d. infant respiratory distress syndrome (IRDS)
  - e. hyaline membrane disease (HMD)
  - f. bronchopulmonary dysplasia (BPD)
  - g. chronic obstructive pulmonary disease (COPD)
  - h. pleural effusions
  - i. asthma
  - j. diaphragmatic paresis
  - k. pulmonary edema
  - l. pulmonary fibrosis
  - m. pulmonary emboli
  - n. atelectasis
  - o. pulmonary venous and arterial hypertension
  - p. calcification
  - q. pneumothorax
  - r. pneumomediastinum
  - s. congestive heart failure (CHF)
  - t. coronary artery disease
  - u. valvular heart disease
  - v. pericardial disease
  - w. cardiac dysrhythmias
  - x. pleural diseases

C. Musculoskeletal Section

1. alteration in function related to disease/injury
2. compensation mechanisms
3. diseases/disorders/injuries (e.g., etiology, manifestations, physical examination, diagnostic studies, history and physical findings/clinical data)
  - a. arthritis
    1. gout
    2. osteoarthritis
    3. rheumatoid arthritis
    4. ankylosing spondylitis
    5. psoriatic arthritis
  - b. trauma (fractures, dislocations, and associated soft tissue injuries)

- c. tumors
  1. osteochondroma
  2. Ewing's sarcoma
  3. osteosarcoma
  4. enchondroma
  5. chondrosarcoma
  6. osteoid osteoma
  7. metastatic disease
  8. multiple myeloma/plasmacytoma
- d. infections
  1. acute and chronic osteomyelitis
  2. soft tissue infection
- e. diseases
  1. osteomalacia
  2. osteoporosis
  3. Paget's disease
  4. fibrous dysplasia
  5. osteogenesis imperfecta
  6. renal osteodystrophy

D. Neurological and Endocrine Section

1. alteration in function related to disease/injury
2. compensation mechanisms
3. diseases/disorders/injuries (e.g., etiology, manifestations, physical examination, diagnostic studies, history and physical findings/clinical data)
  - a. neurological
    1. cerebrovascular accident (CVA)
    2. malignant and benign masses
    3. Parkinson's disease
    4. amyotrophic lateral sclerosis (ALS)
    5. multiple sclerosis (MS)
    6. hydrocephalus
    7. normal pressure hydrocephalus (NPH)
    8. increased cranial pressure
    9. pseudotumor cerebri
    10. infection/inflammation
    11. open and closed head injuries
    12. spinal cord injury
    13. syring
    14. seizures
    15. myasthenia gravis
    16. Alzheimer's disease
    17. dementia
    18. herniated disc

(Section C continues on the following page)

- b. endocrine
    - 1. osteoporosis
    - 2. hyperparathyroidism
    - 3. diabetes
    - 4. pituitary disorder
    - 5. thyroid disorders
      - a. malignant and benign masses
      - b. hypo and hyperthyroidism
    - 6. adrenal disorders
    - 7. renovascular hypertension
- E. Vascular and Lymphatic Section
- 1. alteration in function related to disease/injury
  - 2. compensation mechanisms
  - 3. diseases/disorders/injuries (e.g., etiology, manifestations, physical examination, diagnostic studies, history and physical findings/clinical data)
    - a. blood clotting disorders
    - b. anemias
    - c. leukemias
    - d. lymphomas
    - e. shock
    - f. hypertension
    - g. arterio and atherosclerosis
    - h. aneurysm
    - i. varicosities
    - j. arterial venous malformations (AVM)
    - k. lymphedema
    - l. coarctation of aorta
- F. Breast and Axilla
- 1. benign and malignant masses
    - a. cysts
    - b. fibroadenoma
    - c. invasive ductal carcinoma
    - d. invasive lobular carcinomas
    - e. phyllodes
    - f. inflammatory breast cancers
    - g. Paget's disease
    - h. ductal carcinoma in situ
  - 2. inflammatory diseases

## D. RADIOLOGIC PROCEDURES (40)

This section addresses radiographic procedures for the categories that follow (1-5). Questions will cover the following topics:

- Anatomy & Pathophysiology
- Indications for Procedure
- Contraindications for Procedure
- Patient Assessment and Preparation for the Procedure
- Alternative and/or Complementary Procedures
- Access Methods and Closure Devices
- Patient Management During Procedure
- Operation of Diagnostic Equipment to Reduce Patient Exposure
- Contrast and Drug Administration
- Image Enhancement and Post-Processing
- Evaluation of Images for Diagnostic Utility
- Complications and Response to Emergencies
- Post-Procedure Patient Care
- Outcomes Measurement

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### 1. GI AND CHEST STUDIES (10)

- A. Esophageal Study\*
- B. Swallowing Function Study\*
- C. Upper GI Study\*
- D. Small Bowel Study\*
- E. Small Bowel Study via Enteroclysis Tube
- F. Enema with Barium, Air, or Water Soluble Contrast\*
- G. Nasogastric/Enteric and Orogastric/Enteric Tube Placement\*
- H. T-Tube Cholangiogram
- I. Defecography
- J. Chest Fluoroscopy

### 2. GU STUDIES (8)

- A. Antegrade Urography (e.g., Pyelostography, Nephrostography)
- B. Cystography\*
- C. Retrograde Urethrography or Urethrocystography
- D. Voiding Cystourethrography
- E. Loopography
- F. Hysterosalpingography

### 3. INVASIVE NONVASCULAR PROCEDURES (10)

- A. Joint Injection and Aspiration
- B. Arthrogram (Radiography, CT, and MRI)\*
- C. Lumbar Puncture\*
- D. Cervical, Thoracic, or Lumbar Myelography
- E. Thoracentesis\*
- F. Placement of Tube for Pneumothorax
- G. Paracentesis\*
- H. Abscess, Fistula, or Sinus Tract Study

(Section D continues on the following page)

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\* Two of the 12 marked procedures (identified as mandatory on the clinical experience and competence assessments) will be included in the case study section of the exam.

- I. Injection for Sentinel Node Localization
- J. Breast Needle Localization
- K. Change of Percutaneous Tube or Drainage Catheter
- L. Thyroid Biopsy
- M. Liver Biopsy

#### **4. INVASIVE VASCULAR PROCEDURES (8)**

- A. Peripheral Insertion of Central Venous Catheter (PICC) placement\*
- B. Insertion of Non-Tunneled Central Venous Catheter
- C. Insertion of Tunneled Central Venous Catheter
- D. Port Injection
- E. Extremity Venography

#### **5. IMAGE POST-PROCESSING (4)**

- A. CT
  - 1. 3D reconstruction
  - 2. modifications to field of view (FOV)
  - 3. slice spacing
  - 4. algorithm
  - 5. maximum intensity projection (MIP)
  - 6. multiplanar reconstruction (MRP)
  - 7. quantitative measurements (volume, distance, diameter)
  - 8. cardiac analysis (calcium scoring and coronary artery mapping)
  - 9. shunt graft measurements
  - 10. volume rendering
- B. MRI
  - 1. 3D reconstructions
  - 2. maximum intensity projection (MIP)
  - 3. volume rendering
  - 4. multiplanar reconstruction
  - 5. quantitative measurements (volume, distance, diameter)
  - 6. subtraction

## E. RADIATION SAFETY, RADIATION BIOLOGY, AND FLUOROSCOPIC OPERATION (15)

### 1. RADIATION SAFETY (6)

- A. Exposure and Dose
  - 1. exposure
  - 2. absorbed dose, equivalent dose, effective dose
  - 3. measurement and calculation of quantities (e.g., CTDI, DAP)
  - 4. high dose exams and modalities
- B. Radiation Safety Standards
  - 1. organizations and their roles
    - a. Nuclear Regulatory Commission (NRC)
    - b. Occupational Safety and Health Administration (OSHA)
    - c. Environmental Protection Agency (EPA)
    - d. Food and Drug Administration (FDA)
    - e. state health departments
  - 2. principles of dose limitation (time, distance, shielding, ALARA)
  - 3. monitoring and measuring devices
  - 4. effective dose limits
    - a. National Council on Radiation Protection and Measurement (NCRP)
      - 1. role
      - 2. reports
    - b. ACR Appropriateness Criteria®
      - 1. role
      - 2. reports
- C. Methods to Reduce Patient Exposure
  - 1. intermittent fluoroscopy
  - 2. limitation of field size
  - 3. exposure factors (x-ray and CT)
  - 4. filtration of the x-ray beam
  - 5. protective shielding
  - 6. immobilization
  - 7. grid selection
  - 8. limitation of fluoroscopic time
  - 9. proper fluoroscope use
  - 10. pediatric considerations
- D. Methods to Reduce Occupational Exposure
  - 1. location in radiation area
  - 2. shielding devices in x-ray rooms
  - 3. personal shielding devices
  - 4. proper fluoroscope use

### 2. RADIATION BIOLOGY (4)

- A. Cell Growth and Division
- B. Radiosensitivity of Cells
  - 1. direct and indirect effects
  - 2. linear energy transfer (LET)
  - 3. relative biological effectiveness (RBE)
  - 4. oxygen enhancement ratio (OER)
  - 5. dose rate, fractionation, and protraction
- C. Radiation Effects
  - 1. deterministic effects verses stochastic effects
  - 2. background radiation
  - 3. dose-response relationships
  - 4. skin effects
  - 5. acute radiation syndromes
  - 6. local tissue damage
  - 7. hematological effects
  - 8. carcinogenesis
  - 9. fetal effects
  - 10. genetic effects

### 3. FLUOROSCOPIC OPERATION (5)

- A. Fluoroscopy
  - 1. components
    - a. x-ray tube
    - b. image intensifier
    - c. collimators
    - d. recording devices
      - 1. digital cameras
      - 2. cine
      - 3. spot films
      - 4. photo spot
    - e. generator
    - f. controls
    - g. display
    - h. recording
  - 2. static image storage
  - 3. dynamic image storage
  - 4. pulsed fluoroscopy
  - 5. high-level or boost mode
  - 6. exposure factors
  - 7. cumulative timer
- B. Dose Monitoring Equipment

## **F. MEDICAL-LEGAL, PROFESSIONAL, AND GOVERNMENTAL STANDARDS (15)**

### **1. MEDICAL RECORDS (3)**

- A. Components of Documentation
  - 1. types of documentation for patient chart
  - 2. electronic and paper records
  - 3. fluoroscopic and image documentation
- B. Techniques and Procedures for Documentation
- C. Document Development and Administration
  - 1. examination findings
  - 2. exceptions from established protocol or procedure
  - 3. patient's questions and concerns
  - 4. information regarding patient care, the procedure and final outcome
  - 5. diagnostic/therapeutic procedure and patient data
  - 6. radiologists report to referring physician
  - 7. direct communication with referring physician
  - 8. discharge summary
- D. Informed Consent
  - 1. patients competence
    - a. cognitive impairment
      - 1. competence-assessment
      - 2. mental status
      - 3. medication
    - b. surrogate consent
      - 1. health care power of attorney
      - 2. family
    - c. patient education
      - 1. explain procedure
      - 2. risk versus benefit
      - 3. alternatives and options
      - 4. refusal of procedure and implications

### **2. REGULATORY REQUIREMENTS (3)**

- A. Quality Assurance Management
  - 1. facility rules
  - 2. The Joint Commission requirements
- B. Credentialing
  - 1. local or hospital requirements
  - 2. state licensing/registration regulations
  - 3. continuing education requirements
  - 4. supervisory notification
  - 5. professional standards
- C. Government Regulations
  - 1. Medical Practice Act – supervisory requirements
  - 2. Health Insurance Portability and Accountability Act (HIPAA)

### **3. LEGAL CONSIDERATIONS (3)**

- A. Definitions
  - 1. negligence and malpractice
    - a. gross
    - b. contributing
  - 2. standard of care
  - 3. assault and battery
  - 4. false imprisonment
  - 5. slander and libel
  - 6. elements of tort
- B. Legal Doctrines
  - 1. respondeat superior
  - 2. res ipsa loquitur
  - 3. foreseeability
  - 4. personal liability
  - 5. good samaritan law

(Section F continues on the following page)

**4. ETHICS (3)**

- A. Patient Bill of Rights
- B. ASRT Practice Standards
- C. ARRT Standards of Ethics
- D. Definitions
  - 1. morals
  - 2. values
  - 3. ethics

**5. QUALITY IMPROVEMENT, DATA ANALYSIS, AND CLINICAL RESEARCH (3)**

- A. Definitions
  - 1. measures of frequency
  - 2. measures of central tendency
  - 3. measures of variance
- B. Assessment of Outcomes