



# Registered Radiologist Assistant

The purpose of the examination requirement is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of Registered Radiologist Assistants (R.R.A.s) for practice at entry level. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of radiologists and radiologist extenders.<sup>1</sup> The *Registered Radiologist Assistant Entry-Level Clinical Activities (ELCA)* inventory may be found on the ARRT’s website ([www.arrt.org](http://www.arrt.org)).

The *Examination Content Specifications for the Registered Radiologist Assistant* identifies the knowledge areas underlying performance of the tasks on the *Registered Radiologist Assistant Entry-Level Clinical Activities (ELCA)* inventory. Every content category can be linked to one or more activities on the ELCA inventory.

The ARRT avoids content when there are multiple resources with conflicting perspectives. Educational programs accredited by a mechanism acceptable to ARRT offer education and experience beyond the minimum requirements specified in the content specifications and clinical competency requirements documents.

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address the subject matter that is included in these content specifications, but do not limit themselves to only this content.

The table below presents the major content categories and subcategories covered in the Selected Response section of the examination. The number of test questions in each category are listed in bold and number of test questions in each subcategory in parentheses. Specific topics within each category are addressed in the content outline, starting on page three of this document.

<b>Content Categories</b>	<b>Selected Response Section</b>	<b>Case Study Section</b>
Patient Care	<b>56</b>	
<i>Patient Management (38)</i>		
<i>Pharmacology (18)</i>		
Safety	<b>28</b>	
<i>Patient Safety, Radiation Protection and Equipment Operation<sup>2</sup> (28)</i>		
Procedures <sup>3</sup>	<b>116</b>	See page 2
<i>Abdominal Section (41)</i>		
<i>Thoracic Section (25)</i>		
<i>Musculoskeletal and Endocrine Sections (25)</i>		
<i>Neurological, Vascular, and Lymphatic Sections (25)</i>		
Total Number	<b>200<sup>4</sup></b>	
<b>Percent of Total Exam Points</b>	<b>75%</b>	<b>25%</b>
<b>Testing Time Allowed</b>	<b>3.5 hours</b>	<b>2.5 hours</b>

<sup>1</sup> A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.

<sup>2</sup> SI units are the primary (principle) units of radiation measurement used on the R.R.A. examination.

<sup>3</sup> The Procedures section includes patient assessment and pathophysiology. Procedures may also refer to appropriate imaging.

<sup>4</sup> The selected response section includes an additional 30 unscored (pilot) questions.

\*\*R.R.A.s function as part of a radiologist-led team



A varied selection of the following 13 procedures (identified as mandatory on *Form CR-1 Summary of Clinical Experience and Competence Assessments*) will be included in the Case Study section of the examination. The number of items per case may vary, so this section will consist of at least 30 scored questions and 20 unscored (pilot) questions.

Abdominal Procedures

*General Abdomen*

1. Paracentesis

*Gastrointestinal*

2. Esophageal study
3. Swallowing function study
4. Upper GI study
5. Small bowel study
6. Enema with barium, air, or water-soluble contrast
7. Nasogastric/enteric or orogastric/enteric tube placement

*Urinary*

8. Cystography, voiding cystography or voiding cystourethrography

Thoracic Procedures

*Pulmonary*

9. Thoracentesis

Musculoskeletal and Endocrine Procedures

*Musculoskeletal*

10. Arthrogram (shoulder or hip)

Neurological, Vascular, and Lymphatic Procedures

*Neurological*

11. Lumbar puncture with or without contrast
12. Cervical, thoracic, or lumbar myelography – imaging only

*Vascular and Lymphatic*

13. Peripherally inserted central catheter (PICC) placement



## Patient Care

### 1. Patient Management<sup>1</sup>

#### A. Ethics

1. American Hospital Association (AHA) Patient Care Partnership (Patients' Bill of Rights)
2. consent and patient education (e.g., informed, oral, implied)
  - a. patient competence
    1. cognitive impairment
    2. competence assessment
    3. mental status
    4. medication
  - b. surrogate consent
    1. health care power of attorney
    2. family
  - c. informed consent components
    1. explanation of procedure
    2. risk versus benefit
    3. alternatives and options to current procedure
    4. refusal of procedure and implications
    5. radiation exposure and cumulative dose education
  - d. pre- and post-procedure care instructions
3. ASRT Practice Standards
4. ARRT Standards of Ethics

#### B. Medical Law

1. definitions
  - a. negligence and malpractice
    1. gross
    2. contributing
  - b. standard of care
  - c. assault and battery
  - d. false imprisonment
  - e. slander and libel
  - f. elements of tort law
2. legal doctrines
  - a. respondeat superior
  - b. res ipsa loquitur
  - c. foreseeability
  - d. personal liability
  - e. Good Samaritan Law
  - f. burden of proof
  - g. borrowed servant

#### C. Patient Communication

1. psychosocial support
  - a. communication skills and issues
  - b. cultural awareness
  - c. social support structures
2. patient interview
  - a. verification
    1. patient identification and correct procedure
    2. patient preparation
    3. pregnancy status
  - b. medical history
    1. chief complaint
    2. present illness
    3. past medical/surgical/psychological history
    4. family history
    5. personal and social history
    6. review of systems
    7. medications (\*e.g., prescribed, OTC, natural)
    8. allergy history
3. factors affecting communication
  - a. speech, hearing, and language ability
  - b. cognitive disorders
  - c. drug and/or alcohol effects

#### D. Medical Data Review

1. indications for procedure (e.g., ACR Appropriateness Criteria®)
2. contraindications for procedure
3. laboratory values
4. prior diagnostic studies
5. current medications
6. previous history (e.g., vital signs, practitioner notes)
7. assessment of vital signs, height, and weight
8. physical and/or mental limitations

#### E. Psychological and Cognitive Status

1. cognitive abilities
2. emotional stability

\* The abbreviation "e.g.," is used to indicate that examples are listed in parenthesis, but that it is not a complete list of all possibilities.

(Patient Care continues on the following page.)

<sup>1</sup> Includes adaptations for pediatric, geriatric, and special needs populations.



## Patient Care (continued)

- F. Patient Monitoring and Assessment (prior to, during, and post-procedure)
  - 1. physical status
  - 2. emotional status
  - 3. cardiac and pulmonary monitoring
  - 4. sedation and/or pain control
  - 5. medical emergencies
    - a. cardiac arrest
    - b. hyper/hypoglycemia
    - c. seizure
    - d. respiratory arrest
    - e. shock
    - f. stroke
- G. Common Laboratory Tests, Analysis, and Significance
  - 1. CBC
  - 2. electrolytes (sodium, potassium, bicarbonate, chloride, calcium)
  - 3. pancreatic and cardiac enzymes
  - 4. albumin and total protein
  - 5. coagulation profile
  - 6. liver function
  - 7. renal function
  - 8. glucose
  - 9. culture and sensitivity
  - 10. cytology and histopathology
- H. Infection Control
  - 1. asepsis and sterile technique
    - a. medical asepsis
    - b. sterile technique (e.g., patient preparation, procedural tray, maintenance of sterile fields)
  - 2. Centers for Disease Control (CDC) standard precautions (including mechanisms of disease transmission)
- I. Intravenous Therapy
  - 1. venipuncture
  - 2. flow rate monitoring
  - 3. complications
- J. Oxygen Therapy
  - 1. level (flow rate)
  - 2. devices
  - 3. indications and contraindications
- K. Urinary Catheterization
  - 1. technique
  - 2. complications
  - 3. contraindications
- L. Procedure Complications (Non-Contrast)
  - 1. infection
  - 2. hemorrhage
  - 3. pneumothorax
  - 4. perforation (GI or GU)
  - 5. respiratory distress
  - 6. aspiration
  - 7. vasovagal reaction
  - 8. pulmonary edema
  - 9. vascular injury or occlusion
  - 10. seizures
  - 11. pain
  - 12. neurologic deficit
  - 13. stroke
  - 14. cardiac arrest
  - 15. radiation injury
  - 16. physical injury
  - 17. death
- M. Medical Records
  - 1. components of documentation
    - a. types of documentation for patient chart
    - b. electronic and paper records
    - c. fluoroscopic and image documentation
  - 2. techniques and procedures for documentation
  - 3. document development and administration
    - a. examination findings
    - b. exceptions from established protocol or procedure
    - c. patient's questions and concerns
    - d. information regarding patient care, the procedure, and final outcome
    - e. diagnostic/therapeutic procedure and patient data
    - f. radiologists' reports to referring physician
    - g. direct communication with referring physician
    - h. discharge summary
    - i. incident reports

(Patient Care continues on the following page.)



## Patient Care (continued)

### 2. Pharmacology

#### A. Terminology

1. regulations
  - a. Food and Drug Administration (FDA)
  - b. Drug Enforcement Agency (DEA)
  - c. controlled substances
2. identifying names
  - a. generic
  - b. trade
  - c. United States Pharmacopoeia (USP)
3. drug characteristics
  - a. actions
  - b. synergisms
  - c. side effects
  - d. adverse reactions
4. dosage
  - a. loading
  - b. maintenance
  - c. therapeutic dose
  - d. lethal dose
5. safe dosage calculation
  - a. ratio
  - b. proportion
  - c. pediatric
  - d. geriatric
6. administration (e.g., oral, rectal, intravenous)
7. adverse event

#### B. General Medications: Classifications, Indications, and Contraindications<sup>2</sup>

1. anti-infective drugs
  - a. antibiotics
  - b. antivirals
  - c. antifungals
2. cardiovascular drugs
  - a. antihypertensive
    1. calcium channel blockers
    2. beta blockers
    3. ACE inhibitors
  - b. vasoconstrictors
  - c. vasodilators
  - d. anti-arrhythmics
  - e. vascular drugs
    1. coagulation modifiers
    2. thrombolytics
3. gastrointestinal drugs
  - a. anti-reflux agents
  - b. hypomotility (glucagon)
  - c. cholecystokinetic (sincalide)
  - d. antiemetics
4. anti-inflammatory drugs
  - a. analgesics
  - b. nonsteroidal anti-inflammatory drugs (NSAIDs)
  - c. corticosteroids
5. endocrine drugs
  - a. diabetic medication
  - b. anti-hypoglycemic (glucagon)
  - c. insulin
  - d. thyroid medications
6. diuretics
7. neurologic and psychotropic drugs
  - a. anticonvulsants
  - b. antiparkinsonians

<sup>2</sup> Includes indications, contraindications, adverse reactions, dosage, routes of administration, and excretion process.

(Patient Care continues on the following page.)



## Patient Care (continued)

### C. Anesthetics and Sedation

1. local anesthetics<sup>2</sup>
  - a. short acting
  - b. long acting
2. moderate/conscious sedation
  - a. American Society of Anesthesiologists (ASA) definitions
  - b. ASA guidelines
    1. history and physical
    2. intra-procedure
    3. post-procedure
    4. discharge scoring system
      - a. motor activity
      - b. respirations
      - c. standing blood pressure
      - d. consciousness
      - e. oxygen saturation
  - c. medications<sup>2</sup>
    1. fentanyl
    2. morphine
    3. meperidine
    4. diazepam
    5. midazolam
    6. lorazepam
    7. naloxone
    8. flumazenil

### D. Contrast Media (ACR Manual on Contrast Media)

1. agents<sup>2</sup>
  - a. negative contrast agents (e.g., air, CO<sub>2</sub>, water)
  - b. positive contrast agents
    1. barium sulfate
    2. iodinated contrast media
      - a. osmolality
      - b. molecular structure
  - c. MRI agents
2. contrast related complications
  - a. nephrotoxicity
  - b. NSF (nephrogenic systemic fibrosis)
  - c. extravasation
  - d. allergies
    1. allergy history
    2. types of reactions (mild to severe)
    3. premedications
      - a. diphenhydramine
      - b. corticosteroids
    4. anaphylaxis
3. resuscitation
  - a. life support
    1. basic life support (BLS)
    2. advanced cardiac life support (ACLS)
  - b. basic drugs<sup>2</sup>
    1. epinephrine
    2. atropine
    3. bronchodilator
    4. nitroglycerine
    5. intravenous fluid

<sup>2</sup> Includes indications, contraindications, adverse reactions, dosage, routes of administration, and excretion process.



## Safety

### 1. Patient Safety, Radiation Protection, and Equipment Operation

- A. Exposure and Dose
  - 1. exposure
  - 2. absorbed dose, equivalent dose, and effective dose
  - 3. measurement and calculation of quantities (e.g., CTDI, DAP, kerma area product)
  - 4. high dose exams and modalities
- B. Safety Standards
  - 1. organizations and their roles
    - a. American College of Radiology (ACR)
      - 1. Practice Parameters and Technical Standards
      - 2. Appropriateness Criteria®
      - 3. Contrast Manual
    - b. Nuclear Regulatory Commission (NRC)
    - c. Occupational Safety and Health Administration (OSHA)
    - d. Environmental Protection Agency (EPA)
    - e. Food and Drug Administration (FDA)
    - f. International Commission on Radiological Protection (ICRP)
    - g. National Council on Radiation Protection and Measurements (NCRP)
    - h. state health departments
  - 2. monitoring and measuring
    - a. personnel dosimetry
    - b. environment
    - c. devices
  - 3. benchmarking patient radiation dose
    - a. NCRP reports
    - b. ACR Appropriateness Criteria®
    - c. diagnostic reference levels
    - d. radiation safety resources (e.g., Image Wisely®, Image Gently®, radiologyinfo.org)
- C. Methods to Reduce Patient Exposure
  - 1. intermittent fluoroscopy
  - 2. limitation of field size
  - 3. exposure factors (x ray and CT)
  - 4. geometry (e.g., SID, SSD, angulation, table height)
  - 5. filtration of the x-ray beam
  - 6. vary beam angulation
  - 7. immobilization
  - 8. grid selection and/or removal
  - 9. limitation of fluoroscopic time
  - 10. proper fluoroscope use
    - a. last image hold
    - b. cumulative timer
    - c. magnification mode
    - d. dose mode
      - 1. low dose
      - 2. cine
      - 3. high-level control
      - 4. pulsed
  - 11. pediatric considerations
- D. Methods to Reduce Occupational Exposure (e.g., ALARA)
  - 1. time and location in radiation area
  - 2. shielding devices in x-ray rooms
  - 3. personal shielding devices
  - 4. proper fluoroscope use
- E. Radiation Biology
  - 1. cell growth and division
  - 2. radiosensitivity of cells
    - a. direct and indirect effects
    - b. linear energy transfer (LET)
    - c. relative biological effectiveness (RBE)
    - d. oxygen enhancement ratio (OER)
    - e. dose rate, fractionation, and protraction
  - 3. radiation effects
    - a. deterministic (tissue reactions) and stochastic effects
    - b. background radiation
    - c. dose-response relationships
    - d. skin effects
    - e. acute radiation syndromes
    - f. local tissue damage
    - g. hematological effects
    - h. carcinogenesis
    - i. fetal effects
    - j. genetic effects

(Safety continues on the following page.)



## Safety (continued)

### F. Regulations

1. quality assurance management
  - a. facility rules
  - b. The Joint Commission requirements
2. credentialing
  - a. institutional requirements
  - b. state licensing/registration regulations
  - c. supervisory requirements
  - d. professional standards
3. government regulations
  - a. Medical Practice Act – supervisory requirements
  - b. Health Insurance Portability and Accountability Act (HIPAA)
  - c. MQSA Act
    1. personnel requirements
    2. reporting and data system (BI-RADS)

### G. Equipment Operation

1. fluoroscopy
  - a. components
    1. x-ray tube
    2. image receptors
    3. collimators
    4. recording devices
    5. generator
    6. controls
    7. display
    8. automatic exposure rate control (AERC)
  - b. static image storage
  - c. dynamic image storage
  - d. pulsed fluoroscopy
  - e. high-level or boost mode
  - f. exposure factors
  - g. cumulative timer
  - h. common artifacts (e.g., recursive filtration, DSA)
2. dose monitoring equipment:  
cumulative air kerma and dose rate display

### H. MRI Safety

1. screening and education (patients, personnel, non-personnel)
  - a. biomedical implants
  - b. ferromagnetic foreign bodies
  - c. medical conditions (e.g., renal function, pregnancy)
  - d. prior diagnostic or surgical procedures
  - e. topical or externally applied items (e.g., tattoos, medication patches, body piercing jewelry, monitoring devices, handcuffs)
2. equipment safety
  - a. ancillary equipment in proximity
  - b. designated safety zones
  - c. emergency response (e.g., fire fighters, rapid response team, other emergency services)
  - d. FDA labeling criteria
    1. Safe
    2. Conditional
    3. Unsafe

### I. Quality Improvement and Research

1. continuous quality improvement (CQI)
2. statistics
  - a. measures of frequency
  - b. measures of central tendency
  - c. measures of variation
3. clinical study design
4. clinical trial phases





## Procedures

Each section may include questions related to the following topics:

- Anatomy and Physiology: normal, age-related changes, and common surgical changes.
- Patient Assessment (prior to, during, and post-procedure): review medical history, perform a physical examination, evaluate test results, vital signs, signs, and symptoms.
- Procedures: patient and procedure preparation, consent (indications, contraindications, alternatives), performance, image evaluation and post-processing\*, and post procedure outcomes assessment.
- Medical Devices: image appearance, indications, purpose, appropriate location, and complications.
- Pathophysiology: alteration in function and structure related to disease/injury, compensation mechanisms, and congenital and developmental abnormalities.

\*Post processing includes:

CT and MRI Image Post-Processing

- 3D reconstruction
- maximum intensity projection (MIP)
- multiplanar reconstruction (MPR)
- quantitative measurements (volume, distance, diameter)
- volume rendering

CT Post-Processing

- modifications to field of view (FOV)
- slice spacing
- algorithm
- cardiac analysis (e.g., calcium scoring, coronary artery mapping, TAVR)

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## 1. Abdominal Section

### A. General Abdomen

1. anatomy and physiology
2. patient assessment
3. related procedures
  - a. paracentesis
  - b. abscess, fistula, or sinus tract study
  - c. percutaneous drainage with or without placement of catheter
  - d. change of percutaneous tube or drainage catheter
  - e. removal of percutaneous drainage catheter
4. medical devices
  - a. drainage catheters
  - b. peritoneal dialysis catheters
5. pathophysiology
  - a. abdominal aortic aneurysm
  - b. abdominal calcifications
  - c. abscess
  - d. free fluid/ascites
  - e. hemoperitoneum
  - f. normal and abnormal gas patterns
  - g. peritonitis
  - h. pneumatosis intestinalis
  - i. pneumoperitoneum
  - j. portal venous gas

c. upper GI study

d. small bowel study

e. enema with barium, air, or water-soluble contrast

f. postoperative GI study

g. percutaneous, nasogastric/enteric, and orogastric/enteric tube evaluation

h. nasogastric/enteric or orogastric/enteric tube placement

4. medical devices

a. bariatric devices

b. gastroenteric tubes

c. gastrointestinal tract stents

(Procedures continues on the following page.)

### B. Gastrointestinal

1. anatomy and physiology
2. patient assessment
3. related procedures
  - a. esophageal study
  - b. swallowing function study



## Procedures (continued)

5. pathophysiology – esophagus and stomach
    - a. achalasia
    - b. Barrett esophagus
    - c. bezoar
    - d. Crohn disease
    - e. diverticula (Zenker, Killian-Jameson, epiphrenic)
    - f. dysphagia
    - g. esophagitis
    - h. fistulae
    - i. gastric outlet obstruction
    - j. gastritis
    - k. gastroesophageal reflux disease (GERD)
    - l. gastroparesis
    - m. hiatal hernias
    - n. malignant and benign masses
    - o. presbyesophagus
    - p. primary muscular and neural disorders
    - q. pyloric stenosis
    - r. scleroderma
    - s. surgical variation (e.g., Roux-en-Y, gastric band, fundoplication, gastric sleeve)
    - t. ulcers
    - u. varices
    - v. volvulus
    - w. webs
  6. pathophysiology – small and large intestine
    - a. adhesions
    - b. appendicitis
    - c. colitis
    - d. constipation
    - e. Crohn disease
    - f. diverticulosis/diverticulitis
    - g. duodenitis
    - h. fistulae
    - i. hernias
    - j. Hirschsprung disease
    - k. ileus
    - l. infections
    - m. inflammatory bowel syndrome
    - n. inflammatory diseases
    - o. intussusception
    - p. ischemia
    - q. malabsorption
    - r. malignant and benign tumors (masses)
    - s. malrotation
    - t. Meckel diverticulum
    - u. necrotizing enterocolitis
    - w. obstruction
    - x. peptic ulcer disease
    - y. polyps
    - z. superior mesenteric artery (SMA) syndrome
      - aa. surgical variation
      - bb. toxic megacolon
      - cc. volvulus
- C. Hepatobiliary, Pancreas, and Spleen
    1. anatomy and physiology
    2. patient assessment
    3. related procedure
      - a. liver biopsy (non-targeted)
      - b. t-tube cholangiogram
    4. medical devices
      - a. stents
      - b. cholecystostomy tubes
      - c. biliary drainage tubes
    5. pathophysiology
      - a. biliary calculi
      - b. biliary dyskinesia
      - c. cholangitis
      - d. cholecystitis
      - e. cirrhosis
      - f. hepatic steatosis
      - g. hepatitis
      - h. liver failure
      - i. malignant and benign masses
      - j. pancreatic insufficiency
      - k. pancreatic pseudocyst
      - l. pancreatitis
      - m. portal hypertension
      - n. splenomegaly
  - D. Urinary
    1. anatomy and physiology
    2. patient assessment
    3. related procedures
      - a. antegrade urography (e.g., nephrostography)
      - b. loopography (urinary diversion study)
      - c. retrograde urethrography or urethrocytography
      - d. cystography/cystourethrography
    4. medical devices
      - a. urinary catheters
      - b. nephrostomy tubes
      - c. ureteral stents
      - d. artificial urinary sphincter
    5. pathophysiology
      - a. acute and chronic renal failure
      - b. calculi
      - c. glomerulonephritis and nephrotic syndrome

(Procedures continues on the following page.)



## Procedures (continued)

- d. infarcts, ischemia, thrombosis
  - e. infectious and inflammatory processes
  - f. malignant and benign masses
  - g. nephrocalcinosis
  - h. polycystic kidney disease
  - i. renal papillary necrosis
  - j. UPJ obstruction (congenital, adult)
  - k. vesicoureteral reflux
- E. Reproductive
- 1. anatomy and physiology
  - 2. patient assessment
  - 3. related procedure: hysterosalpingography
  - 4. medical devices
    - a. penile implants
    - b. pessary
    - c. contraceptive devices
  - 5. pathophysiology
    - a. female
      - 1. ectopic pregnancy
      - 2. endometriosis
      - 3. infertility
      - 4. malignant and benign masses
      - 5. pelvic inflammatory disease
      - 6. polycystic ovary disease
      - 7. pregnancy
    - b. male
      - 1. benign prostatic hypertrophy
      - 2. hydrocele
      - 3. inflammatory processes
      - 4. malignant and benign masses
      - 5. testicular torsion
- ## 2. Thoracic Section
- A. General Thoracic
- 1. anatomy and physiology
  - 2. patient assessment
  - 3. related procedures: chest fluoroscopy
  - 4. pathophysiology
    - a. calcification
    - b. diaphragmatic paresis
    - c. inflammatory and infectious diseases
    - d. malignant and benign masses
    - e. pneumomediastinum
- B. Cardiac
- 1. anatomy and physiology
  - 2. patient assessment
  - 3. medical devices
    - a. IABP/heart assist device
    - b. pacers/AICD
    - c. cardiovascular valves
    - d. Swan-Ganz catheters
    - e. central venous catheters
    - f. stents
- 4. pathophysiology
    - a. cardiac dysrhythmias
    - b. congestive heart failure (CHF)
    - c. coronary artery disease
    - d. endocarditis
    - e. pericardial disease
    - f. valvular heart disease
- C. Pulmonary
- 1. anatomy and physiology
  - 2. patient assessment
  - 3. related procedures
    - a. thoracentesis
    - b. placement of catheter for pneumothorax
  - 4. medical devices
    - a. chest tubes
    - b. tracheal tubes
    - c. vascular coils
  - 5. pathophysiology
    - a. adult respiratory distress syndrome (ARDS)
    - b. asthma
    - c. atelectasis
    - d. bronchopulmonary dysplasia (BPD)
    - e. chronic obstructive pulmonary disease (COPD)
    - f. malignant and benign masses
    - g. neonatal respiratory distress syndrome
    - h. pleural diseases
    - i. pleural effusions
    - j. pneumothorax
    - k. pulmonary edema
    - l. pulmonary emboli
    - m. pulmonary fibrosis
    - n. pulmonary venous and arterial hypertension

(Procedures continues on the following page.)



## Procedures (continued)

### D. Breast and Axilla

1. anatomy and physiology
2. patient assessment
3. related procedures: injection for sentinel node localization
4. medical devices
  - a. breast implants
  - b. tissue expander
  - c. radiofrequency devices
5. pathophysiology
  - a. benign and malignant masses
    1. cysts
    2. ductal carcinoma in situ
    3. fibroadenoma
    4. inflammatory breast cancer
    5. invasive ductal carcinoma
    6. invasive lobular carcinoma
    7. Paget disease
    8. phyllodes
  - b. inflammatory diseases

## 3. Musculoskeletal and Endocrine Sections

### A. Musculoskeletal

1. anatomy and physiology
2. patient assessment
3. related procedures
  - a. therapeutic bursa aspiration and/or injection
  - b. diagnostic joint aspiration
  - c. therapeutic joint injection
  - d. superficial soft tissue mass biopsy
  - e. arthrogram (radiography, CT, MRI)
    1. shoulder
    2. elbow
    3. wrist
    4. hip
    5. knee
    6. ankle
4. medical devices: orthopedic hardware

### 5. pathophysiology

- a. arthritis
  1. gout
  2. osteoarthritis
  3. rheumatoid arthritis
  4. ankylosing spondylitis
  5. psoriatic arthritis
  6. septic arthritis
- b. bursitis
- c. trauma
  1. fractures
  2. dislocations
  3. associated soft tissue injuries (e.g., labral tears, meniscus tears, tendon tears, effusions)
- d. tumors
  1. chondrosarcoma
  2. enchondroma
  3. Ewing sarcoma
  4. metastatic disease
  5. multiple myeloma/plasmacytoma
  6. osteochondroma
  7. osteoid osteoma
  8. osteosarcoma
- e. infections
  1. osteomyelitis
  2. soft tissue infection
- f. diseases
  1. fibrous dysplasia
  2. osteogenesis imperfecta
  3. osteomalacia
  4. osteoporosis
  5. Paget disease
  6. renal osteodystrophy

### B. Endocrine

1. anatomy and physiology
2. patient assessment
3. related procedure: thyroid biopsy
4. medical devices: insulin pumps
5. pathophysiology
  - a. adrenal disorders
  - b. diabetes mellitus
  - c. hyperparathyroidism
  - d. pituitary disorders
  - e. renovascular hypertension
  - f. thyroid disorders
    1. malignant and benign masses
    2. hypo and hyperthyroidism
    3. inflammatory

(Procedures continues on the following page.)



## Procedures (continued)

### 4. Neurological, Vascular, and Lymphatic Sections

#### A. Neurological

1. anatomy and physiology
2. patient assessment
3. related procedures
  - a. lumbar puncture
  - b. myelogram
    1. cervical
    2. thoracic
    3. lumbar
4. medical devices
  - a. CSF shunts
  - b. intrathecal catheters
  - c. neuro stimulators
  - d. embolization devices
  - e. orthopedic hardware (e.g., spine hardware)
5. pathophysiology
  - a. amyotrophic lateral sclerosis (ALS)
  - b. cerebrovascular accident (CVA)
  - c. Chiari malformation
  - d. dementia (e.g., Alzheimer disease)
  - e. herniated disc
  - f. hydrocephalus
  - g. increased intracranial pressure
  - h. infection/inflammation
  - i. intracranial hemorrhage
  - j. malignant and benign masses
  - k. multiple sclerosis (MS)
  - l. myasthenia gravis
  - m. normal pressure hydrocephalus (NPH)
  - n. open and closed head injuries
  - o. Parkinson disease
  - p. pseudotumor cerebri
  - q. seizures
  - r. spinal cord injury
  - s. syrinx
  - t. tethered cord

#### B. Vascular and Lymphatic

1. anatomy and physiology
2. patient assessment
3. signs and symptoms of vessel disease
4. related procedures
  - a. extremity venography
  - b. superficial lymph node biopsy
  - c. insertion of non-tunneled central venous catheter
  - d. central venous catheter or port injection
  - e. peripherally inserted central catheter (PICC) placement
  - f. tunneled venous catheter removal
5. medical devices
  - a. catheters
  - b. stents
  - c. embolization devices
  - d. IVC filters
  - e. umbilical vascular catheters
6. pathophysiology
  - a. anemias
  - b. aneurysm
  - c. arterial venous malformations (AVM)
  - d. arteriosclerosis/atherosclerosis
  - e. blood clotting disorders
  - f. coarctation of aorta
  - g. deep vein thrombosis
  - h. dissection
  - i. hemorrhage
  - j. hypertension
  - k. infectious or inflammatory lymphadenopathy (e.g., cat scratch disease)
  - l. leukemias
  - m. lymphedema
  - n. lymphomas
  - o. shock
  - p. venous insufficiency