



Registered Radiologist Assistant

The purpose of the *Registered Radiologist Assistant (R.R.A.)* examination is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of Registered Radiologist Assistants at entry into the profession. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of radiologists and radiologist extenders. The *Registered Radiologist Assistant Entry-Level Clinical Activities (ELCA)* inventory may be found on the ARRT's website (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 following table presents the major content categories and subcategories covered on the examination. The number of selected response 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, which makes up the remaining pages of this document. In addition, the case study essay section of the examination requires candidates to respond to essay questions concerning the procedures listed in *Attachment A*, which can be found at the end of this document.

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.

Content Categories	Selected Response Points	Case Study Points ¹
Patient Care	60	
<i>Patient Management (34)</i>		
<i>Pharmacology (26)</i>		
Safety	25	
<i>Patient Safety, Radiation Protection and Equipment Operation² (25)</i>		
Procedures ³	115	
<i>Abdominal Section (43)</i>		
<i>Thoracic Section (29)</i>		
<i>Musculoskeletal and Endocrine Sections (20)</i>		
<i>Neurological, Vascular, and Lymphatic Sections (23)</i>		
Total Number⁴	200	
Testing Time Allowed	3.5 hours	2.5 hours

¹ The examination contains two case studies from the list of procedures on *Attachment A*. Each case is followed by four to six essay questions worth 3 or 6 points each. A case may also include a few selected response questions (e.g., multiple choice). Refer to *Overview of CBT* at www.arrt.org for additional details.

² SI units will become the primary (principle) units of radiation measurement used on the R.R.A. examination in July, 2018.

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

⁴ The exam includes an additional 20 unscored (pilot) questions.



Patient Care

1. Patient Management¹

A. Ethics

1. AHA Patient Care Partnership (Patient's Bill of Rights)
2. informed consent and patient education
 - 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. definitions
 - a. morals
 - b. values
 - c. ethics
4. ASRT Practice Standards
5. 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

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, nurses/physicians notes)
7. assessment of vital signs, height, and weight
8. disabilities

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.)

¹ 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. 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. sterile technique
 - 2. 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

1. anti-infective drugs
 - a. antibiotics
 - b. antiviral
 - 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 (cholecystokinin)
 - 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

(Patient Care continues on the following page.)



Patient Care (continued)

C. Anesthetics and Sedation

1. local anesthetics²
 - a. short acting
 - b. long acting
2. moderate 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. equipment
 - d. medications²
 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. agents²
 - a. negative contrast agents
 - 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 drugs²
 1. epinephrine
 2. atropine
 3. bronchodilator
 4. nitroglycerine
 5. intravenous fluid

² 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, effective dose
3. measurement and calculation of quantities (e.g., CTDI, DAP)
4. high dose exams and modalities

B. 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. International Commission on Radiological Protection (ICRP)
 - f. National Council on Radiation Protection and Measurements (NCRP)
 - g. state health departments
2. monitoring and measuring
 - a. personnel dosimetry
 - b. environment
 - c. devices
3. effective dose limits
 - a. NCRP reports
 - b. ACR Appropriateness Criteria®

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)
5. filtration of the x-ray beam
6. protective shielding
7. immobilization
8. grid selection
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 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. local or hospital 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 – personnel requirements

G. Equipment Operation

1. fluoroscopy
 - a. components
 1. x-ray tube
 2. image receptors
 3. collimators
 4. recording devices (e.g., digital cameras, cine)
 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
2. dose monitoring equipment

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)
2. equipment safety
 - a. ancillary equipment in proximity
 - b. designated safety zones

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.
 - Pathophysiology: alteration in function and structure related to disease/injury, compensation mechanisms, and congenital and developmental abnormalities.
 - Patient Assessment.
 - Procedures: patient and procedure preparation, consent (indications, contraindications, alternatives), performance, image evaluation and post-processing*, and post procedure outcomes assessment.
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1. Abdominal Section

A. General Abdomen

1. anatomy and physiology
2. assessment
 - a. pre-procedure rectal exam
 - b. signs and symptoms
3. related procedures
 - a. paracentesis
 - b. abscess, fistula, or sinus tract study
 - c. percutaneous drainage
 - d. change of percutaneous tube or drainage catheter
 - e. liver biopsy
4. medical devices (image appearance, indications, purpose, appropriate location, and complications)
 - a. drainage catheters
 - b. peritoneal dialysis catheters
 - c. stents
 - d. umbilical vascular catheters
 - e. IVC filter
5. pathophysiology
 - a. abdominal calcifications
 - b. abdominal aortic aneurysm
 - c. normal and abnormal gas patterns
 - d. pneumatosis intestinalis
 - e. portal venous gas
 - f. peritonitis
 - g. pneumoperitoneum
 - h. abscess
 - i. free fluid

B. Gastrointestinal

1. anatomy and physiology
2. related procedures
 - a. esophageal study
 - b. swallowing function study
 - c. upper GI study
 - d. small bowel study
 - e. enema with barium, air, or water soluble contrast
 - f. postoperative GI study
 - g. CT colonography
 - h. nasogastric/enteric and orogastric/enteric tube placement
3. medical devices (image appearance, indications, purpose, appropriate location, and complications)
 - a. bariatric devices
 - b. gastroenteric tubes

(Procedures continues on the following page.)

*post-processing includes:

CT & 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 (calcium scoring and coronary artery mapping)



Procedures (continued)

4. 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 (Roux-en-Y, gastric band, Nissen fundoplication)
 - t. ulcers
 - u. varices
 - v. volvulus
 - w. webs
 5. 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. Meckel diverticulum
 - t. necrotizing enterocolitis
 - u. malrotation
 - v. obstruction
 - w. peptic ulcer disease
 - x. polyps
 - y. superior mesenteric artery (SMA) syndrome
 - z. toxic megacolon
 - aa. volvulus
- C. Hepatobiliary, Pancreas, and Spleen
1. anatomy and physiology
 2. related procedure: t-tube cholangiogram
 3. 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. related procedures
 - a. antegrade urography (e.g., nephrostography)
 - b. loopography (neobladder study)
 - c. retrograde urethrography or urethrocytography
 - d. voiding cystography/cystourethrography
 3. medical devices (image appearance, indications, and purpose)
 - a. urinary catheters
 - b. nephrostomy tubes
 - c. ureteral stents
 4. pathophysiology
 - a. acute and chronic renal failure
 - b. calculi
 - c. glomerulonephritis and nephrotic syndrome
 - 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

(Procedures continues on the following page.)



Procedures (continued)

E. Reproductive

1. anatomy and physiology
2. related procedure: hysterosalpingography
3. 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
4. medical devices (image appearance, indications, and purpose)
 - a. penile implants
 - b. pessary
 - c. contraceptive devices

2. Thoracic Section

A. General Thoracic

1. anatomy and physiology
2. related procedures: chest fluoroscopy
3. 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. assessment
 - a. perfusion status
 - b. electrocardiogram (ECG)
3. signs and symptoms
4. medical devices (image appearance, indications, purpose, appropriate location, and complications)
 - a. IABP/heart assist device
 - b. pacers/AICD
 - c. cardiovascular valves
 - d. Swan-Ganz catheters
 - e. central venous catheters
5. pathophysiology
 - a. cardiac dysrhythmias
 - b. congestive heart failure (CHF)
 - c. coronary artery disease
 - d. pericardial disease
 - e. valvular heart disease
 - f. endocarditis

C. Pulmonary

1. anatomy and physiology
2. assessment:
 - oxygen saturation measurement
3. signs and symptoms
4. related procedures
 - a. thoracentesis
 - b. placement of catheter for pneumothorax
5. medical devices (image appearance, indications, purpose, appropriate location, and complications)
 - a. chest tubes
 - b. tracheal tubes
6. pathophysiology
 - a. adult respiratory distress syndrome (ARDS)
 - b. asthma
 - c. atelectasis
 - d. bronchopulmonary dysplasia (BPD)
 - e. chronic obstructive pulmonary disease (COPD)
 - f. neonatal respiratory distress syndrome
 - g. pleural diseases
 - h. pleural effusions
 - i. pneumothorax
 - j. pulmonary edema
 - k. pulmonary emboli
 - l. pulmonary fibrosis
 - m. pulmonary venous and arterial hypertension

(Procedures continues on the following page.)



Procedures (continued)

D. Breast and Axilla

1. anatomy and physiology
2. assessment
3. signs and symptoms
4. related procedures
 - a. injection for sentinel node localization
 - b. breast needle localization
 - c. breast imaging - reporting and data system (BI-RADS)
5. medical devices (image appearance, indications, purpose, appropriate location, and complications): breast implants
6. pathophysiology
 - a. benign and malignant masses
 1. cysts
 2. ductal carcinoma in situ
 3. fibroadenoma
 4. inflammatory breast cancers
 5. invasive ductal carcinoma
 6. invasive lobular carcinomas
 7. Paget disease
 8. phyllodes
 - b. inflammatory diseases

3. Musculoskeletal and Endocrine Sections

A. Musculoskeletal

1. anatomy and physiology
2. assessment
3. signs and symptoms
4. related procedures
 - a. therapeutic bursa aspiration and/or injection
 - b. diagnostic joint aspiration
 - c. therapeutic joint injection
 - d. arthrogram (radiography, CT, MRI)
 1. shoulder
 2. elbow
 3. wrist
 4. hip
 5. knee
 6. ankle
5. medical devices (image appearance, indications, purpose): orthopedic hardware

6. 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
- 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. related study: thyroid biopsy
3. 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. assessment
3. signs and symptoms
4. related procedures
 - a. lumbar puncture
 - b. myelogram
 1. cervical
 2. thoracic
 3. lumbar
5. medical devices
 - a. image appearance, indications, and purpose
 1. CSF shunts
 2. intrathecal catheters
 3. neuro stimulators
 4. embolization devices
6. pathophysiology
 - a. amyotrophic lateral sclerosis (ALS)
 - b. cerebrovascular accident (CVA)
 - c. dementia (e.g., Alzheimer disease)
 - d. herniated disc
 - e. hydrocephalus
 - f. increased intracranial pressure
 - g. infection/inflammation
 - h. malignant and benign masses
 - i. multiple sclerosis (MS)
 - j. myasthenia gravis
 - k. normal pressure hydrocephalus (NPH)
 - l. open and closed head injuries
 - m. Parkinson disease
 - n. pseudotumor cerebri
 - o. seizures
 - p. spinal cord injury
 - q. syrinx
 - r. tethered cord
 - s. Chiari malformation

B. Vascular and Lymphatic

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



Attachment A

Two 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 Essay Section of the Examination**

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