



# Vascular Sonography

The purpose of the ~~vascular sonography~~ examination requirement is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required ~~of vascular sonographers at in vascular sonography at entry level into the profession~~. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of vascular sonographers<sup>1</sup>. An advisory committee then determined the knowledge and cognitive skills needed to perform the tasks on the task inventory and these are organized into the content categories within this document. Every content category can be linked to one or more tasks on the task inventory. The document is used to develop the examination, The *Task Inventory for Vascular Sonography* may be found on the ARRT's website ([www.arrt.org](http://www.arrt.org)).

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 Examination Content Specifications for Vascular Sonography identifies the knowledge areas underlying performance of the tasks on the Task Inventory for Vascular Sonography. Every content category can be linked to one or more tasks on the task inventory~~

The table below presents the major content categories and subcategories covered on the examination. The number of test questions in each category are listed in bold and the 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.

Content Category	Number of Scored Questions <sup>2</sup>
Patient Care	<b>20</b>
<i>Patient Interactions and Management (20)</i>	
Image Production	<b>7570</b>
<i>Basic Principles of Ultrasound (2623)</i>	
<i>Image Formation (4412)</i>	
<i>Evaluation and Selection of Representative Images (35)</i>	
Procedures	<b>8085</b>
<i>Abdominal/Pelvic Vasculature (2319)</i>	
<i>Arterial Peripheral Vasculature (254)</i>	
<i>Venous Peripheral Vasculature (2518)</i>	
<i>Extracranial Cerebral Vasculature and Other Sonographic Procedures (168)</i>	
<b>Total</b>	<b>175</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> The exam includes an additional ~~40~~ 50 unscored (pilot) questions.



## Patient Care

### 1. Patient Interactions and Management

#### A. Ethical and Legal Aspects

1. patient's rights
  - a. ~~informed~~-consent  
(\*e.g., ~~written~~informed, oral, implied)
  - b. confidentiality (HIPAA)
  - c. American Hospital Association (AHA) Patient Care Partnership (Patients' Bill of Rights)
    1. privacy
    2. extent of care (e.g., DNR)
    3. access to information
    4. living will, health care proxy, advance directive
    5. research participation
2. legal issues
  - a. verification (e.g., patient identification, compare order to clinical indication, exam coding)
  - b. common terminology (e.g., battery, negligence, malpractice, beneficence)
  - c. legal doctrines (e.g., respondeat superior, res ipsa loquitur)
  - d. restraints versus ~~immobilization~~positioning aids used to eliminate motion artifact
  - e. documentation (e.g., changes to order, medical event)
3. ARRT Standards of Ethics

#### B. Interpersonal Communication

1. modes of communication
  - a. verbal/written
  - b. nonverbal (e.g., eye contact, touching)
2. challenges in communication
  - a. interactions with others
    1. language barriers
    2. cultural and social factors
    3. physical, ~~and~~-sensory, or cognitive impairments
    4. age
    5. emotional status, acceptance of condition (e.g., stages of grief, mental health concerns)
  - b. explanation of medical terms
  - c. strategies to improve understanding

3. patient education
  - a. explanation of current procedure (e.g., ~~purpose~~, ~~breathing instructions~~, risks, benefits)
  - b. pre- and post-examination instructions (e.g., preparations, diet, medications, discharge instructions)
  - c. respond to inquiries about other imaging modalities (e.g., ~~CT~~, ~~MRI~~, ~~mammography~~, ~~radiography~~, ~~bone densitometry dose~~discipline differences, patient preparations)

#### C. Physical Assistance and Monitoring

- ~~1. patient transfer and movement~~
  - ~~1a.~~body mechanics (e.g., balance, alignment, movement)
  - ~~a.~~ patient transfer techniques
  - ~~b.~~ safe patient handling devices (e.g., transfer board)
2. assisting patients with medical equipment
  - a. infusion catheters and pumps
  - b. oxygen delivery systems
  - c. other (e.g., nasogastric tubes, urinary catheters)
3. ~~routine~~patient monitoring and documentation
  - a. vital signs
  - b. physical signs and symptoms (e.g., motor control, severity of injury)
  - c. fall prevention
  - ~~d. documentation~~
4. ~~operator-sonographer~~ ergonomics<sup>1</sup>
  - a. equipment
  - b. work environment
  - c. ~~sonograph~~-body mechanics

#### D. Medical Emergencies

1. allergic reactions (e.g., contrast, latex)
2. cardiac/respiratory arrest (e.g., CPR, AED)
3. physical injury or trauma
4. mental health crisis
- ~~4~~5.other medical disorders (e.g., seizures, diabetic reactions)

\* 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.

<sup>1</sup> Operator ergonomics is referenced in the "[Industry Standards for the Prevention of Work Related Musculoskeletal Disorders in Sonography.](#)" (Patient Care continues on the following page)



## Patient Care (continued)

### E. Infection Control

1. chain of infection (~~cycle of infection~~)
  - a. pathogen
  - b. reservoir
  - c. portal of exit
  - d. mode of transmission
    1. direct
      - a. droplet
      - b. direct contact
    2. indirect
      - a. airborne
      - b. vehicle -borne (fomite)
      - c. vector -borne (mechanical or biological)
  - e. portal of entry
  - f. susceptible host
2. asepsis
  - a. equipment disinfection
  - b. equipment sterilization
  - c. medical aseptic technique
  - d. sterile technique
  - e. proper gel handling
3. CDC Standard Precautions
  - a. hand hygiene
  - b. use of personal protective equipment (e.g., gloves, gowns, masks)
  - c. safe handling of contaminated equipment and surfaces
  - d. disposal of contaminated materials
    1. linens
    2. needles
    3. patient supplies
    4. blood and body fluids

### 4. transmission-based precautions

- a. contact
- b. droplet
- c. airborne

### 5. additional precautions

- a. neutropenic precautions (reverse isolation)
- b. healthcare associated (nosocomial) infections

### F. Handling and Disposal of Toxic and Hazardous Material

1. chemical (e.g., disinfectants)
2. safety data sheet

### FG. Patient Monitoring and Safety

1. ultrasound bioeffects and safety
2. pressure and intensity measurement
  - a. thermal index (e.g., soft tissue, bone)
  - b. mechanical index
3. research on biological effects
4. AIUM recommendations
5. health care team communication

### GH. Interventional Procedures

1. patient preparation
2. time-out
3. informed consent
4. sterile technique
5. fluid/tissue sample handling
6. follow-up instructions



## Image Production

### 1. Basic Principles of Ultrasound

#### A. Generation of Signal

1. transducers
  - a. construction and properties
    1. crystal thickness, wavelength
    2. frequency spectrum, resonance
    3. damping
  - b. operation
    1. focusing
    2. beam diameter
    3. piezoelectric effect
  - c. types
2. beam configuration
  - a. near and far field
  - b. focal zone
  - c. beam profile
3. pulse characteristics
  - a. pulse repetition frequency
  - b. pulse repetition period
  - c. spatial pulse length
  - d. duty factor
  - e. frequency
  - f. resolution
    1. axial
    2. lateral
    3. temporal
    4. elevational
    5. contrast

#### 4. technical factors

- a. frequency, bandwidth, Q factor
- b. power
- c. pressure
- d. intensity
- e. amplitude

#### 5. modes

- a. B-mode
- b. Doppler
  1. color
  2. spectral
    - a. pulse wave Doppler
    - b. continuous wave Doppler
  3. power/energy

#### B. Machine and Transducer Use

1. selection
2. care
3. malfunctions

#### C. ABI/Pulse Volume Recording Equipment

1. cuff selection
2. treadmill

(Image Production continues on the following page)



## Image Production (continued)

### 2. Image Formation

#### A. Technical Factors for Diagnostic Quality

##### Images

1. power
2. focal zone
3. depth
4. compensation/TGC
5. gain
6. frame rate
7. Doppler gain
8. Doppler angle
9. gate (sample volume) size/placement
10. wall filter
11. scale
12. color box (size and steering)
13. dynamic range
14. line density
15. spectral baseline
16. harmonics
17. spatial compounding

#### B. Beam Interactions

1. speed of sound in soft tissue
  - a. density
  - b. stiffness
2. time and distance (range equation)
3. acoustic impedance
4. normal and oblique incidence
5. reflection
6. transmitted/refracted waves
7. intensity
8. scattering
9. absorption and attenuation

#### C. Detection and Display of Echoes

1. receiver
2. amplitude
3. dynamic range and compression
4. analog-to-digital converter (ADC)
5. digital-to-analog converter (DAC)
6. brightness
7. contrast
8. post-processing (e.g., smoothing, edge enhancement, filtering, read magnification)
9. panoramic imaging
10. write magnification

#### D. Bioeffects

1. thermal
2. mechanical (e.g., cavitation)
3. output measures (e.g., MI, TIS, TIC, TIB, SPTA)
4. ALARA

#### E. Measurements from Spectral Analysis

1. peak systolic velocity (PSV)
2. end diastolic velocity (EDV)
3. resistive index (RI)/pulsatility index (PI)
4. measure of systolic acceleration
  - a. acceleration time (AT)
  - b. acceleration index (AI)
  - c. tardus parvus waveform
5. volume flow (e.g., hemodialysis fistulas)

(Image Production continues on the following page)



## Image Production (continued)

### 3. Evaluation and Selection of Representative Images

- A. Criteria for Diagnostic Quality
  - 1. proper demonstration of anatomical structures
  - 2. proper demonstration of pathological conditions
  - 3. artifacts
    - a. gray scale (e.g., reverberation, mirror image, shadowing, posterior enhancement, comet tail)
    - b. Doppler (e.g., aliasing, twinkling, mirror image)
  - 4. annotation (e.g., plane, position)
  - 5. improvement of suboptimal images
- B. Real Time Imaging
  - 1. effect on image quality
  - 2. echogenicity of reflectors
  - 3. echotextures
- C. Color and Spectral Analysis
  - 1. direction of flow
  - 2. presence or absence of flow
  - 3. differentiation of normal and abnormal spectral waveforms
- D. Arterial and Venous Hemodynamics
  - 1. flow patterns (e.g., turbulence, phasicity)
  - 2. pressure
  - 3. velocity
  - 4. peripheral vascular resistance
  - 5. wall compliance
- E. ~~Image Archiving~~ Imaging Informatics
  - 1. information systems (e.g., HIS, RIS, EMR, EHR)
  - 2. networking
    - a. PACS
    - b. DICOM
  - c. teleradiology (e.g., off site reading, third party coverage)



## Procedures

### TYPE OF EXAM

#### 1. Abdominal/Pelvic Vasculature

##### A. Arterial

1. aorta
2. celiac
3. hepatic
4. splenic
5. superior mesenteric/inferior mesenteric
6. renal
7. common iliac
8. internal iliac
- ~~9. external iliac~~

##### B. Venous

1. inferior vena cava
2. hepatic
3. portal
4. splenic
5. superior mesenteric
6. renal
- ~~7. pelvic varices~~
- ~~8. common iliac~~
- ~~9. internal iliac~~
- ~~10. external iliac~~

##### C. Transplant

1. liver
2. kidney(s)

### FOCUS OF QUESTIONS

#### Practice Parameters (e.g., AIUM, ACR, IAC)

- clinical indications
- patient preparation
- patient positioning
- instrumentation (e.g., transducer, stand-off pads)
- technical factors
- evaluation and documentation of visualized anatomy
- optimizing image quality
- image annotation

#### Anatomy and Physiology

- normal
- normal variant
- abnormal
- measurements

#### Abnormalities

- pathology
- congenital anomalies
- lab values
- differential diagnosis

#### Doppler Applications/Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements

(Procedures continues on the following page.)



## Procedures (continued)

### TYPE OF EXAM

#### 2. Arterial Peripheral Vasculature

- A. Upper Extremity
  - 1. brachiocephalic
  - 2. subclavian
  - 3. axillary
  - 4. brachial
  - 5. radial
  - 6. ulnar
  - ~~7. palmar arch (including Allen test)~~
  - ~~8. digital~~
  - 7. radial artery mapping
- B. Lower Extremity
  - 1. external iliac
  - 2. common femoral
  - 3. superficial femoral
  - 4. deep femoral
  - 5. popliteal
  - 6. tibioperoneal trunk
  - 7. posterior tibial
  - 8. anterior tibial
  - 9. peroneal
  - 10. dorsalis pedis
- C. Stress/Pressure Testing
  - 1. PVR (pulse volume recording)
  - 2. segmental pressures (upper extremities)
  - 3. segmental pressures (lower extremities)
  - 4. ABI (ankle brachial index)
  - ~~5. post-exercise testing~~
  - ~~6. photoplethysmography (PPG)~~
  - ~~7. toe brachial index (TBI)~~

### FOCUS OF QUESTIONS

#### Practice Parameters (e.g., AIUM, ACR, IAC)

- clinical indications
- patient preparation
- patient positioning
- instrumentation (e.g., transducer, stand-off pads)
- technical factors
- evaluation and documentation of visualized anatomy
- optimizing image quality
- image annotation

#### Anatomy and Physiology

- normal
- normal variant
- abnormal
- measurements

#### Abnormalities

- pathology
- congenital anomalies
- lab values
- differential diagnosis

#### Doppler Applications/Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements

(Procedures continues on the following page.)





## Procedures (continued)

### TYPE OF EXAM

#### 3. Venous Peripheral Vasculature

- A. Upper Extremity Venous
  - 1. internal jugular
  - 2. brachiocephalic
  - 3. subclavian
  - 4. axillary
  - 5. brachial
  - 6. cephalic
  - 7. basilic
  - 8. radial
  - 9. ulnar
- B. Lower Extremity Venous
  - 1. external iliac
  - 2. common femoral
  - 3. femoral
  - 4. deep femoral
  - 5. popliteal
  - 6. great saphenous
  - 7. small saphenous
  - 8. calf veins
- C. Venous Testing
  - 1. vein mapping (upper and lower)
  - 2. reflux assessment (e.g., venous insufficiency, perforators, varicose veins, valve competency)

### FOCUS OF QUESTIONS

#### Practice Parameters (e.g., AIUM, ACR, IAC)

- clinical indications
- patient preparation
- patient positioning
- instrumentation (e.g., transducer, stand-off pads)
- technical factors
- evaluation and documentation of visualized anatomy
- optimizing image quality
- image annotation

#### Anatomy and Physiology

- normal
- normal variant
- abnormal
- measurements

#### Abnormalities

- pathology
- congenital anomalies
- lab values
- differential diagnosis

#### Doppler Applications/Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements

(Procedures continues on the following page.)



## Procedures (continued)

### TYPE OF EXAM

#### 4. Extracranial Cerebral Vasculature and Other Sonographic Procedures

##### A. Carotid Artery (~~GCA, ICA, ECA~~)

1. CCA
2. ICA
  - a. post endarterectomy
3. ECA
4. vertebral

##### ~~B. Vertebral Artery~~

##### ~~B. Other Sonographic Procedures~~

1. bypass grafts
2. endografts
3. dialysis access grafts/fistulae
4. stents
5. post catheterization complications
6. IVC filters
7. TIPS
- ~~8. line position (e.g., PICC)~~
- ~~9. post endarterectomy~~
- ~~10. vein ablations~~
- ~~11. pseudoaneurysm treatment (compression or guided thrombin injection)~~

### FOCUS OF QUESTIONS

#### Practice Parameters (e.g., AIUM, ACR, IAC)

- clinical indications
- patient preparation
- patient positioning
- instrumentation (e.g., transducer, stand-off pads)
- technical factors
- evaluation and documentation of visualized anatomy
- optimizing image quality
- image annotation

#### Anatomy and Physiology

- normal
- normal variant
- abnormal
- measurements

#### Abnormalities

- pathology
- congenital anomalies
- lab values
- differential diagnosis

#### Doppler Applications/Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements