



Vascular Sonography

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 in vascular sonography for practice at entry level.

ARRT determined the tasks that entry-level vascular sonographers typically perform by administering a comprehensive practice analysis survey to a nationwide sample of vascular sonographers.¹ The *Task Inventory for Vascular Sonography* is on ARRT's website (www.arrt.org).

The *Examination Content Specifications for Vascular Sonography* and attached content outline identify the knowledge areas underlying performance of the tasks on the *Task Inventory for Vascular Sonography*. Every content category links to one or more tasks on the [task inventory](#).

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 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 the content outline, but do not limit themselves to only this content. ARRT administers this examination on a computer at a standardized testing center.

The table below presents the major content categories and subcategories that the examination covers. The table lists the number of test questions in each category in bold and the number of test questions in each subcategory in parentheses. The content outline, which makes up the remaining pages of this document, addresses specific topics within each category.

Content Category	Number of Scored Questions ²
Patient Care	20
<i>Patient Interactions and Management (20)</i>	
Image Production	70 67
<i>Basic Principles of Ultrasound (23)</i>	
<i>Image Formation (4215)</i>	
<i>Evaluation and Selection of Representative Images (3529)</i>	
Procedures	85 88
<i>Abdominal and Pelvic Vasculature (4921)</i>	
<i>Arterial Peripheral Vasculature (25)</i>	
<i>Venous Peripheral Vasculature (25)</i>	
<i>Extracranial Cerebral Vasculature and Other Sonographic Procedures (4617)</i>	
Total	175

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

² The exam includes an additional 50 unscored (pilot) questions.



Patient Care

1. Patient Interactions and Management

A. Ethical and Legal Aspects

1. patients' rights
 - a. consent (e.g., * 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 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 ~~and written~~
 - b. nonverbal (e.g., eye contact, touching)
 - [c. written](#)
2. challenges in communication
 - a. interactions with others
 1. language barriers
 2. cultural and social factors
 3. physical, 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
 - [d. scheduling and sequencing examinations](#)

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. ~~review~~ pertinent medical history [review](#)
- [d. symptomatic areas \(pain, swelling\) identification](#)
- ~~ed.~~ respond to inquiries about other imaging modalities (e.g., discipline differences, patient preparations)

C. Physical Assistance and Monitoring

1. 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. patient monitoring and documentation
 - a. vital signs
 - b. physical signs and symptoms (e.g., motor control, severity of injury)
 - c. fall prevention
 - d. patient comfort and modesty
4. sonographer ergonomics¹
 - a. equipment
 - b. work environment
 - ~~c. body mechanics~~

D. Medical Emergencies

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

*"e.g." indicates examples of the topics covered, but is not a complete list.

¹ Operator ergonomics is referenced in the "[Industry Standards for the Prevention of Work Related Musculoskeletal Disorders in Sonography.](#)"



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. chemicals (e.g., disinfectants)
2. safety data sheet

G. 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

H. Interventional Procedures

1. patient preparation
2. time-out
3. informed consent
4. sterile technique
5. fluid [and](#) 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 ~~or~~ energy
- c. [microvascular flow imaging and B-flow](#)

B. Machine and Transducer Use

1. selection
2. care
3. malfunctions

C. ABL ~~and~~ Pulse Volume Recording Equipment (e.g., cuff selection)



Image Production (continued)

2. Image Formation

A. Technical Factors for Diagnostic Quality Images

1. power
2. focal zone
3. depth
4. compensation and/ TGC
5. gain
6. frame rate
7. Doppler gain
8. Doppler angle
9. gate (sample volume) size and/ 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 and/ 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. postprocessing
(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)~~

This section moved
to the next section



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)
4. annotation (e.g., plane, position)
5. improvement of suboptimal images

B. Real-Time Imaging

1. effect on image quality ([e.g., changes in depth, sample size, scale, gain](#))
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
 - a. [tardus parvus](#)
 - b. [monophasic venous](#)
 - c. [to and fro arterial](#)
 - d. [cardiac devices](#)
 - e. [arrhythmia](#)

4. measurements from spectral analysis
 - a. peak systolic velocity (PSV)
 - b. end diastolic velocity (EDV)
 - c. resistive index (RI) [and](#) ~~4~~pulsatility index (PI)
 - d. [renal-aortic ratio \(RAR\)](#)

~~4e.~~ measure of systolic acceleration

1. acceleration time (AT)
2. acceleration index (AI)

~~c. tardus parvus waveform~~

5. volume flow (e.g., hemodialysis fistulas)

Moved to differentiation of normal and abnormal spectral waveforms

D. Arterial and Venous Hemodynamics

1. flow patterns (e.g., turbulence, phasicity, [direction](#))
2. pressure
3. velocity
4. peripheral vascular resistance
5. wall compliance ([e.g., stiffness, elasticity](#))

E. Imaging Informatics

1. information systems (e.g., HIS, RIS, EMR, EHR)

[2. previous procedures and reports](#)

3. networking

- a. PACS
- b. DICOM
- c. teleradiology (e.g., off-site reading, third-party coverage)



Procedures

TYPE OF EXAM

1. Abdominal and /Pelvic Vasculature

A. Arterial

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

B. Venous

1. inferior vena cava
2. hepatic
3. portal
4. splenic
5. superior mesenteric
6. renal
7. common iliac
8. internal iliac

C. Transplant

1. liver
2. kidney

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
- incidental abnormal findings

Doppler Applications and Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements



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. ~~radial~~ predialysis artery mapping
 - 8. digital
 - 9. thoracic outlet syndrome (TOS)
- B. Lower Extremity
 - 1. external iliac
 - 2. common femoral
 - 3. superficial femoral
 - 4. profunda femoris
 - 5. popliteal
 - 6. tibioperoneal trunk
 - 7. posterior tibial
 - 8. anterior tibial
 - 9. peroneal
 - 10. dorsalis pedis
- C. Pressure Testing
 - 1. ~~PVR~~ (pulse volume recording) (PVR)
 - 2. segmental pressures (upper extremities)
 - 3. segmental pressures (lower extremities)
 - 4. ~~ABI~~ (ankle-brachial index) (ABI)
 - 5. toe-brachial index (TBI)
 - 6. photoplethysmography (PPG)

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
- incidental abnormal findings

Doppler Applications and Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements



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
 - [10. thoracic outlet syndrome \(TOS\)](#)
- B. Lower Extremity Venous
 - 1. external iliac
 - 2. common femoral
 - 3. femoral
 - 4. profunda femoris
 - 5. popliteal
 - 6. great saphenous
 - 7. small saphenous
 - 8. ~~calf veins~~ [posterior tibial](#)
 - [9. gastrocnemius](#)
 - [10. anterior tibial](#)
 - [11. peroneal](#)
- C. Venous Testing
 - 1. vein mapping (upper and lower, [predialysis or graft harvesting](#))
 - 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
- incidental abnormal findings

Doppler Applications and Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements



Procedures (continued)

TYPE OF EXAM

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

A. ~~Cranial Vasculature~~ Carotid Artery

1. common carotid artery (CCA)
2. internal carotid artery (ICA)
3. external carotid artery (ECA)

B. ~~4. V~~ vertebral Artery

C. Post Interventional ~~Other Sonographic Procedures~~ Studies

1. bypass grafts
2. endografts
3. dialysis access grafts or /fistulae
4. stents
5. post-procedure ~~catheterization~~ complications and treatments (e.g., arteriovenous fistula (AVF), pseudoaneurysm)
6. IVC filters
7. TIPS
8. post endarterectomy
9. ~~pseudoaneurysm treatment (compression or guided thrombin injection)~~
9. venous ablation

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
- incidental abnormal findings

Doppler Applications and Blood Flow Characteristics

- normal
- normal variant
- abnormal
- measurements