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 sonography for practice at entry level.

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

The *Examination Content Specifications for Sonography* and attached content outline identify the knowledge areas underlying performance of the tasks on the *Task Inventory for 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 below presents 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	**26**
Patient Interactions and Management (26)	
Image Production	**115~~118~~**
Basic Principles of Ultrasound (30~~45~~)	
Image Formation (40~~47~~)	
Evaluation and Selection of Representative Images (45~~26~~)	
Procedures	**219~~216~~**
Abdomen (70~~75~~)	
First Trimester Obstetrics (40~~20~~)	
Second~~/~~ and Third Trimester and High-Risk Obstetrics (40~~57~~)	
Gynecology (35~~32~~)	
Superficial Structures and Other Sonographic Procedures (34~~32~~)	
Total	**360**

[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 40 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 Communications
   1. modes of communication
      a. verbal~~/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 (e.g., pain, swelling) identification
      e. 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 ergonomics[1]
      a. equipment
      b. work environment
      ~~c. body mechanics~~

*"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)

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. 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 or 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, cranium, 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. M-mode
      c. Doppler
         1. color
         2. spectral
            a. pulse wave Doppler
            b. continuous wave Doppler
         3. power or ~~/and~~ energy

      d. microvascular flow imaging

B. Machine and Transducer Use
   1. selection
   2. care
   3. malfunctions

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
   11. 3D and ~~/~~ 4D imaging

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) and /pulsatility index (PI)~~
   ~~4. tardus parvus waveform~~

Moved to the next section for #1-3

E. Sonographic techniques
   a. augmentation for DVT
   b. provocative maneuvers (e.g., extremity movement, Valsalva, sniff test) for DVT

D. 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)

3. Evaluation and Selection of Representative Images

A. Criteria for Diagnostic Quality
   1. proper demonstration of anatomic~~al~~ structures
   2. proper demonstration of pathologic~~al~~ 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 (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. peak systolic velocity (PSV)
      b. end diastolic velocity (EDV)
      c. resistive index (RI) and pulsatility index (PI)

Moved from the last section

Procedures

TYPE OF EXAM

1. Abdomen

A. Abdominal and Transplant Vasculature
   1. aorta and branches (e.g., celiac, renal)
   2. inferior vena cava (IVC) and ~~confluences~~ tributaries (e.g., confluence)
   3. portal venous system~~veins and confluences~~ (e.g., portal venous gas, flow direction, TIPS)
   4. kidney transplant(s)
   5. liver transplant

B. Abdominal Organs
   1. biliary system
      a. gallbladder
      b. bile ducts (e.g., CBD, extra-hepatic)
   2. urinary tract
      a. kidneys
      b. ureters
      c. bladder
   3. spleen
   4. pancreas
   5. liver
   6. other
      a. lymph nodes
      b. adrenal glands
      c. bowel~~gastrointestinal tract~~ (e.g., appendix, obstruction, intussusception)
      d. hernia
      e. prostate
      f. peritoneal cavity

FOCUS OF QUESTIONS

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

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. First Trimester Obstetrics

A. Standard Measurements (e.g., heart rate, CRL, MSD)
B. Maternal Anatomy
   1. uterus
   2. cervix
   3. adnexa
   4. ovaries
C. Embryonic Anatomy and Physiology
   1. fetal number
   2. gestational age
   3. gestational sac
   4. decidual layer
   5. amnion
   6. chorion
   7. yolk sac
   8. embryonic pole
   9. cardiac activity
D. Key Abnormalities (e.g., anembryonic pregnancy, spontaneous abortion, ectopic pregnancy, embryonic demise)

3. Second and ~~/~~Third Trimester and High-Risk Obstetrics

A. Standard Measurements (e.g., BPD, HC, AC, FL)
B. Maternal Anatomy
   1. uterus
   2. cervix
   3. adnexa
   4~~3~~. ovaries
C. Fetal Anatomy and Physiology
   1. fetal number
   2. position, presentation and lie
   3. gestational age and weight
   4. amniotic fluid volume
   5. umbilical cord
   6. placenta
   7. cardiac activity (e.g., FHR)
   8. anatomic systems visualized (e.g., GI, CNS, cardiovascular)
   9. nuchal fold
   10. middle cerebral artery (MCA)
D. Chromosomal Abnormalities (e.g., trisomies, triploidy)
E. Genetic Abnormalities (e.g., polycystic kidney disease, skeletal dysplasias)
F. Infection (e.g., TORCH)

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Procedures (continued)

TYPE OF EXAM

3. Second and ~~/~~Third Trimester and High Risk Obstetrics (continued)

G. Abnormal Growth and Development (e.g., club foot, esophageal atresia, anencephaly, macrocephaly, renal agenesis, gastroschisis, VSD)
H. Neoplasm (e.g., blastoma, teratoma)
I. Multiple Gestations (e.g., chorionicity, amnionicity, twin-to-twin transfusion syndrome, conjoined)
J. Assisted Reproduction and Implantation
K. Fetal Biophysical Profile (BPP)
L. Placenta (e.g., trophoblastic disease, previa, accreta, insufficiency, abruption)
M. Amniotic Fluid (e.g., polyhydramnios, oligohydramnios, PROM, AFI)
N. Hydrops (immune and non-immune)
O. Intrauterine Growth Restriction (symmetric and asymmetric)
P. Umbilical Cord (e.g., 2-vessel cord, knots, vasa previa, prolapse, Doppler)
Q. Cervical Incompetence
R. Maternal Disease and Abnormality (e.g., diabetes, uterine anomaly)

4. Gynecology

A. Uterus
   1. myometrium
   2. endometrium
   3. cervix
B. Adnexa
   1. ovaries
   2. fallopian tubes
   3. para-ovarian structures
   4. pelvic varices
C. Cul-de-Sac
D. Vagina
E. Pelvic Floor

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Doppler Applications and Blood Flow Characteristics

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- normal variant
- abnormal
- measurements

Procedures (continued)

TYPE OF EXAM

5. Superficial Structures and Other Sonographic Procedures

A. Neck
   1. thyroid
   2. parathyroid
   3. salivary glands (e.g., parotid)
   4. lymph nodes

B. Scrotum and Testes

C. Breast~~s~~ and Axilla

D. Vascular Exams
   1. venous extremity Doppler (lower and upper)
   2. carotid Doppler
   3. post-procedure ~~catheterization~~ complications
   4. penile Doppler

E. Pediatric Exams
   1. infant ~~neonatal~~ (head, spine, hips)
   2. bowel ~~gastrointestinal tract~~ (e.g., appendix, pylorus, intussusception)

F. Ultrasound-Guided Interventional Procedures (e.g., fine needle aspiration, biopsy, catheter placement, paracentesis, thoracentesis, intraoperative, sonohysterography)

G. Miscellaneous
   1. musculoskeletal (MSK)
   2. superficial masses
   3. noncardiac chest (e.g., pleural space~~, lung~~)
   4. abdominal wall
   5. inguinal region

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