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 at entry level. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of sonographers.[1] 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 Sonography* may be found on the ARRT's website (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 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 on 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, which makes up the remaining pages of this document.

Content Category	Number of Scored Questions[2]
Patient Care	**29**
Patient Interactions and Management (26)	
Image Production	**115**
Basic Principles of Ultrasound (45)	
Image Formation (47)	
Evaluation and Selection of Representative Images (26)	
Procedures	**216**
Abdomen (75)	
First Trimester Obstetrics (19)	
Second/Third Trimester and High Risk Obstetrics (57)	
Gynecology (31)	
Superficial Structures and Other Sonographic Procedures (34)	
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. 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 Communications
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, nuclear medicine, radiography, bone densitometry~~ discipline differences, patient preparations)

C. Physical Assistance and Monitoring
~~1. patient transfer and movement~~
1~~a~~. body mechanics (balance, alignment, movement)
a~~b~~. 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[1]
   a. equipment
   b. work environment
   c. body mechanics

* 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.

[1] 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)

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)

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

~~F~~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

~~G~~H. Interventional Procedures
   1. patient preparation
   2. time-out
   3. informed consent
   4. sterile technique
   5. fluid and tissue sample handling
   ~~5~~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/energy

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/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
   11. 3D/4D imaging

(Image Production continues on the following page.)

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. tardus parvus waveform

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~~4~~.improvement of suboptimal images

B~~D~~. Real-Time Imaging
   1. echogenicity of reflectors
   2. 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~~B~~. Imaging Informatics ~~Image Archiving~~
   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. Abdomen

A. Abdominal and Transplant Vasculature
   1. aorta and branches
   2. inferior vena cava (IVC) and confluences
   3. portal veins and confluences
   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. gastrointestinal tract (e.g., appendix)
      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 continues on the following page.)

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 ~~(corpus luteum)~~

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/Third Trimester and High Risk Obstetrics

A. Standard Measurements (e.g., BPD, HC, AC, FL)

B. Maternal Anatomy
   1. uterus
   2. cervix
   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. cord
   6. placenta
   7. cardiac activity
   8. anatomic systems visualized (e.g., GI, CNS, cardiovascular)
   9. nuchal fold

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 continues on the following page.)

Procedures (continued)

TYPE OF EXAM

3. Second/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
L. Placenta (e.g., trophoblastic disease, previa, accreta, insufficiency, abruption)
M. Amniotic Fluid (e.g., polyhydramnios, oligohydramnios, PROM)
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)
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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Abnormalities

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Doppler Applications and~~/~~ Blood Flow Characteristics

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(Procedures continues on the following page.)

Procedures (continued)

TYPE OF EXAM

5. Superficial Structures and Other Sonographic Procedures

A. Neck
   1. thyroid
   2. parathyroid
   3. salivary glands and ~~/~~parotid glands
   4. lymph nodes

B. Scrotum and Testes

C. Breasts and ~~/~~Axilla

D. Vascular Exams
   1. venous extremity Doppler (lower and upper)
   2. carotid Doppler
   3. post catheterization complications

E. Pediatric Exams
   1. neonatal (head, spine, hips)
   2. gastrointestinal tract (e.g., appendix, pylorus, intussusception~~s~~)
   3. abdomen, ~~/~~adrenal, ~~/~~renal

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

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

FOCUS OF QUESTIONS

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Doppler Applications and~~/~~ Blood Flow Characteristics
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