Standards and Guidelines for the Accreditation of Educational Programs in Diagnostic Medical Sonography

Essentials/Standards initially adopted in 1979; revised in 1987, 1996, 2007, 2011, 2020, xxxx; and effective xx/xx/xxxx

Developed by
Joint Review Committee on Education in Diagnostic Medical Sonography

Endorsed by
American College of Radiology
American Institute of Ultrasound in Medicine
American Society of Echocardiography
American Society of Radiologic Technologists
International Contrast Ultrasound Society
Society of Diagnostic Medical Sonography
Society for Vascular Surgery
Society for Vascular Ultrasound

and

Approved by the
Commission on Accreditation of Allied Health Education Programs

The Commission on Accreditation of Allied Health Education Programs (CAAHEP) accredits programs upon the recommendation of the Joint Review Committee on Education in Diagnostic Medical Sonography (JRC-DMS).

These accreditation **Standards** are the minimum standards of quality used in accrediting programs that prepare individuals to enter the Diagnostic Medical Sonography profession. Standards are the minimum requirements to which an accredited program is held accountable. Guidelines are descriptions, examples, or recommendations that elaborate on the Standards. Guidelines are not required but can assist with interpretation of the Standards.

Standards are printed in regular typeface in outline form. *Guidelines are printed in italic typeface*.

Preamble

The Commission on Accreditation of Allied Health Education Programs (CAAHEP), Joint Review Committee on Education in Diagnostic Medical Sonography (JRC-DMS), American College of Radiology, American Institute of Ultrasound in Medicine, American Society of Echocardiography, American Society of Radiologic Technologists, In**ternational Contrast Ultrasound Society**, Society of Diagnostic Medical Sonography, Society for Vascular Surgery, and Society for Vascular Ultrasound cooperate to establish, maintain and promote appropriate standards of quality for educational programs in diagnostic medical sonography and to provide recognition for educational programs that meet or exceed the minimum standards outlined in these accreditation **Standards and Guidelines for the Accreditation of Educational Programs**. CAAHEP encourages innovation and quality education programs throughout the CAAHEP accreditation process, consistent with CAAHEP policy on institutional autonomy. These **Standards and Guidelines** are designed to ensure the integrity of the CAAHEP

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accreditation process. Directories of accredited programs are published for the information of students, employers, educational institutions and organizations, credentialing bodies, and the public.

These **Standards and Guidelines** are to be used for the development, evaluation, and self-analysis of diagnostic medical sonography programs. Site review teams assist in the evaluation of a program's compliance with the accreditation standards.

Description of the Profession

Diagnostic medical sonography is a multi-specialty profession comprised of abdominal sonography, breast sonography, cardiac sonography, musculoskeletal sonography, obstetrics and gynecology sonography, vascular sonography, and other emerging clinical areas. These diverse areas all use ultrasound as a primary technology in their daily work.

The diagnostic medical sonographer is an individual who provides patient care services using ultrasound and related diagnostic procedures. The diagnostic medical sonographer must be educationally prepared and clinically competent as a prerequisite to professional practice. Demonstration and maintenance of competency through certification by a nationally recognized sonography credentialing organization is the standard of practice in sonography, and maintenance of certification in all areas of practice is endorsed.

The diagnostic medical sonographer functions as a delegated agent under the supervision of a physician.

Diagnostic medical sonographers are committed to enhanced patient care and continuous quality improvement that increases knowledge and technical competence.

Diagnostic medical sonographers use independent, professional, and ethical judgment, and critical thinking to safely perform diagnostic sonographic procedures.

The diagnostic medical sonographer generally performs the following:

- Obtains, reviews, and integrates pertinent patient history and supporting clinical data to facilitate optimum diagnostic results;
- Performs appropriate procedures and records anatomic, pathologic, and/or physiologic data for interpretation by a physician;
- Records, analyzes, and processes diagnostic data and other pertinent observations made during the procedure for presentation to the interpreting physician;
- Exercises discretion and judgment in the performance of sonographic and/or related diagnostic services;
- Demonstrates appropriate communication skills with patients and colleagues;
- Acts in a professional and ethical manner;
- Facilitates communication and education to elicit patient cooperation and understanding of expectations and responds to questions regarding the sonographic examination.

As a multi-specialty profession, these Standards apply to the following learning concentrations:

- Abdominal Sonography - Extended
- Adult Cardiac Sonography
- Breast Sonography
- Musculoskeletal Sonography
- Obstetrics and Gynecology Sonography
- Pediatric Cardiac Sonography
- Vascular Sonography

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Related diagnostic procedures may include, but not limited to, physiologic arterial testing, venous ablation guidance, guidance for interventional procedures, and addition of contrast administration.

I. Sponsorship

A. Program Sponsor

A program sponsor must be at least one of the following

1. A post-secondary academic institution accredited by an institutional accrediting agency that is recognized by the U.S. Department of Education and must be authorized under applicable law or other acceptable authority to provide a post-secondary program, which awards a minimum of a certificate/diploma at the completion of the program.

2. A hospital, clinic or medical center accredited by a healthcare accrediting agency that is recognized by the U.S. Department of Health and Human Services, and authorized under applicable law to provide healthcare, and authorized under applicable law to provide the post-secondary program, which awards a minimum of a certificate/diploma at the completion of the program.

3. A branch of the United States Armed Forces or other a federal or state agency, which awards a minimum of a certificate/diploma at the completion of the program.

4. A consortium, which is a group made up of two or more education providers, that operate an educational program through a written agreement that outlines the expectations and responsibilities of each of the partners. At least one of the consortium partners must meet the requirements of a program sponsor set forth in I.A.1.- I.A.3.

Consortium does not refer to clinical affiliation agreements with the program sponsor.

B. Responsibilities of Sponsor

The program sponsor must

1. Ensure that the program meets the Standards.

2. Award academic credit for the program or have an articulation agreement with an accredited post-secondary institution; and

3. Have a preparedness plan in place that assures continuity of education services in the event of an unanticipated interruption.

Examples of unanticipated interruptions may include unexpected departure of key personnel, natural disaster, public health crisis, fire, flood, power failure, failure of information technology services, or other events that may lead to inaccessibility of educational services.

II. Program Goals

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A. Program Goals and Minimum Expectations

The program must have the following minimum expectations statement: "To prepare competent diagnostic medical sonographers in the cognitive (knowledge), psychomotor (skills), and affective (behavior) learning domains to enter the profession for the following concentration(s) it offers:

Abdominal sonography - Extended
Adult cardiac sonography
Breast sonography
Musculoskeletal sonography
Obstetrics and gynecology sonography
Pediatric cardiac sonography
Vascular sonography."

Programs that adopt educational goals beyond the minimum expectations statement must provide evidence that all students have achieved those goals prior to entry into the field.

Program goals must be compatible with the mission of the sponsoring institution(s), the expectations of the communities of interest, and accepted standards of roles and functions of a diagnostic medical sonographer. Goals are based upon the substantiated needs of health care providers and employers, and the educational needs of the students served by the educational program. Program goals must be written referencing one or more of the learning domains.

The program must assess its goals at least annually and respond to changes in the needs and expectations of its communities of interest.

B. Program Advisory Committee

The program advisory committee must include at least one representative of each of the communities of interest and must meet annually. Communities of interest served by the program include, but are not limited to, students, graduates, faculty members, sponsor administrators, employers, physicians, and the public.

The program advisory committee advises the program regarding revisions to curriculum and program goals based on changing needs and expectations of the program's communities of interest, and an assessment of program effectiveness, including the outcomes specified in these Standards.

Program advisory committee meetings may be conducted using synchronous electronic means.

III. Resources

A. Type and Amount

1. Program Resources

Program resources must be sufficient to ensure the achievement of the program's goals and outcomes. Resources must include, but are not limited to

a. Faculty;
b. Administrative and support staff;
c. Curriculum;
d. Finances;
e. Faculty and staff workspace;
f. Space for confidential interactions;

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g. Classroom and laboratory (physical or virtual);
h. Ancillary student facilities/services;
i. Clinical affiliates;
j. Equipment;
k. Supplies;
l. Information technology;
m. Instructional reference materials; and
n. Support for faculty professional development.

Student services may include, but are not limited to, counseling, advising, health center, and tutoring.

2. Clinical Affiliates

Clinical affiliates must provide each student access to adequate numbers and a variety of types of diagnostic medical examinations to develop clinical competency in both normal and abnormal findings for the learning concentrations(s) being offered.

Programs should provide students with a variety of patient care settings in which sonographic procedures are performed on inpatients and outpatients. These settings may include the following: ambulatory care facilities, specialty centers, emergency/trauma, intensive/critical/coronary care, surgery, angiography/cardiac catheterization.

The number of students assigned to the clinical affiliate should be determined by a student/clinical staff ratio that ensures comparable experiences and outcomes are met.

B. Personnel

The sponsor must appoint sufficient faculty and staff with the necessary qualifications to perform the functions identified in documented job descriptions and to achieve the program's stated goals and outcomes.

At a minimum, the following positions are required: program director, clinical coordinator, and medical advisor.

1. Program Director

a. Responsibilities

The program director must be responsible for all aspects of the program, including but not limited to:

1) Administration, organization and supervision of the program;
2) Continuous quality review and improvement of the program;
3) Academic oversight, including curriculum planning and development;
4) Structure and daily operation of the program; and
5) Effectiveness of all clinical affiliates.

Ensuring the effectiveness of clinical affiliates may be demonstrated through overseeing, monitoring, and communicating with the Clinical Coordinator regarding student clinical rotations, the number of cases, and completion of required competencies by all students.

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b. Qualifications

The program director must

1) Possess a minimum of a bachelor's degree or the equivalent;
2) Possess the appropriate credential(s) specific to one or more of the concentration(s) offered;
3) Have documented education or experience in instructional methodology, supervision, evaluation, student guidance, and
4) Have a minimum of two years of clinical experience as a registered sonographer in the professional sonography field.

A master's degree is preferred.

Documentation of experience in educational theories and techniques may include completed college courses, seminars, or in-service sessions on topics including, but not limited to, learning theory, curriculum design, test construction, teaching methodology, or assessment techniques.

2. Clinical Coordinator(s)

a. Responsibilities

The clinical coordinator(s) must facilitate clinical instruction:

1) Coordinate clinical education with didactic education as assigned by the program director;
2) Ensure documentation of the evaluation and progression of clinical performance;
3) Ensure orientation to the program's requirements for the personnel who supervise or instruct students at clinical sites;
4) Coordinate the assignment of students to clinical sites; and
5) Evaluate and ensure the effectiveness of clinical experiences for the concentration(s) in which students are enrolled.

b. Qualifications

The clinical coordinator(s) must:

1) Possess an academic degree no lower than an associate degree and at least equal to that for which the graduates are being prepared;
2) Possess the appropriate credential(s) specific to the concentration(s) that s/he coordinates;
3) Have a minimum of two years of clinical experience as a registered sonographer in the professional sonography field;
4) Have documented experience in supervision, instruction, evaluation, student guidance, and in educational theories and techniques;
5) Possess knowledge of the curriculum; and
6) Possess knowledge about the program's evaluation of student learning and performance.

Documentation of experience in educational theories and techniques may include completed college courses, seminars, or in-service sessions on topics including, but not limited to, learning theory, curriculum design, test construction, teaching methodology, or assessment techniques.

The Clinical Coordinator may also serve as the Concentration Coordinator for the concentration(s) for which the Program Director does not possess an appropriate credential if the qualifications are met for both positions.

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3. Medical Advisor

a. Responsibilities

The medical advisor must

1) Provide the input necessary to ensure that the medical components of the curriculum, both didactic and supervised practice, meet current standards of medical practice; and
2) Participate in goal determination and outcomes assessment; and
3) Engage in cooperative involvement with the program director.

b. Qualifications

The medical advisor must

1) Be a physician licensed in the United States and board certified in a specialty related to at least one of the program's concentrations; and
2) Have the requisite knowledge and skills to advise the program leadership about the clinical/academic aspects of the program; and
3) Possess relevant experience and knowledge in diagnostic medical sonography.

The medical advisor should be certified by the American Board of Medical Specialties (ABMS).

4. Concentration Coordinator(s)

A concentration coordinator must be designated for each concentration for which the program director does not possess the appropriate credential.

a. Responsibilities

Concentration Coordinator(s) report(s) to the Program Director and must be designated and responsible for the coordination of concentration(s) for which the Program Director does not possess the appropriate credential.

b. Qualifications

Concentration Coordinator(s) must

1) Possess an academic degree no lower than an associate degree and at least equal to that for which the graduates are being prepared;
2) Possess the appropriate credential(s) specific to the concentration(s) that s/he is designated to coordinate;
3) Have documented experience in supervision, instruction, evaluation, student guidance and in educational theories and techniques; and
4) Have a minimum two years of clinical experience as a registered sonographer in the professional sonography field.

Documentation of experience in educational theories and techniques may include completed college courses, seminars, or in-service sessions on topics including, but not limited to, learning theory, curriculum design, test construction, teaching methodology, or assessment techniques.

The Concentration Coordinator may also serve as the Clinical Coordinator for the concentration(s) if the qualifications are met for both positions.

5. Faculty/Instructional Staff

All faculty must be familiar with program goals and be able to demonstrate the ability to develop an organized plan of instruction and evaluation.

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a. Responsibilities

For all didactic, laboratory, and clinical instruction to which a student is assigned, there must be a qualified individual(s) clearly designated by the program to provide instruction, periodic review of course content, supervision, and timely assessments of the student's progress in meeting program requirements.

b. Qualifications

Faculty/Instructional Staff must

1) Be effective in teaching and knowledgeable in subject matter as documented by appropriate education and experience in the designated content area; and
2) Possess appropriate credential(s) for the learning concentration they are providing instruction and performing student evaluations.

6. Clinical Instructor(s)

A clinical instructor must be identified for each clinical affiliate.

a. Responsibilities

A clinical instructor must be available to students whenever a student is assigned to a clinical setting, provide appropriate clinical supervision, and be responsible for student clinical evaluation.

b. Qualifications

Clinical instructors must have the appropriate credential in the concentration(s) for which they evaluate student performance and document required clinical competencies.

C. Curriculum

The curriculum content must ensure that the program goals are achieved. Instruction must be based on clearly written course syllabi that include a course description, course objectives, methods of evaluation, topic outline, and competencies required for graduation. Instruction must be delivered in an appropriate sequence of classroom, laboratory, and clinical activities.

The program must demonstrate that the curriculum offered meets or exceeds the content and competencies specified in Appendix B of these **Standards**.

CAAHEP supports and encourages innovation in the development and delivery of the curriculum.

D. Resource Assessment

The program must, at least annually, assess the appropriateness and effectiveness of the resources described in these **Standards.** The results of resource assessment must be the basis for ongoing planning and change. An action plan must be developed when needed improvements are identified in the program resources. Implementation of the action plan must be documented, and results measured by ongoing resource assessment.

IV. Student and Graduate Evaluation/Assessment

A. Student Evaluation

1. Frequency and purpose

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Evaluation of students must be conducted on a recurrent basis and with sufficient frequency to provide both the students and program faculty with valid and timely indications of the students' progress toward and achievement of the competencies in the required learning domains.

Validity means that the evaluation methods chosen are consistent with the learning and performance objectives being tested.

2. Documentation

Student evaluations must be maintained in sufficient detail to document learning progress and achievements.

Records indicating the number and type of diagnostic medical examinations performed by the student, the examination findings, the extent of student supervision, and the level of involvement of the student in scanning/performance must be maintained.
Official records or electronic equivalent used to document the progression of learning and achievements must include the name, credentials, and signature of the supervising sonographer.

B. Outcomes

The program must meet the established outcomes thresholds.

1. Assessment

The program must periodically assess its effectiveness in achieving its established outcomes. The results of this evaluation must be reflected in the review and timely revision of the program.

Outcomes assessments must include, but are not limited to, national credentialing examination(s) performance, programmatic retention, graduate satisfaction, employer satisfaction, and placement in full or part-time employment in the profession or in a related profession.

A related profession is one in which the individual is using cognitive, psychomotor, and affective competencies acquired in the educational program.

Graduates pursuing academic education related to progressing in health professions or serving in the military are counted as placed.

A national certification examination program should be accredited by the National Commission for Certifying Agencies (NCCA), American National Standards Institute (ANSI), or under International Organization for Standardization (ISO).

Results from an alternative examination may be accepted as an outcome if designated as equivalent by the organization whose credentialing examination is so accredited.

2. Reporting

At least annually, the program must submit to the JRC-DMS the program goal(s), outcomes assessment results, and an analysis of the results.

If established outcomes thresholds are not met, the program must participate in a dialogue with and submit an action plan to the JRC-DMS that responds to the identified deficiency(ies). The action plan

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must include an analysis of any deficiencies, corrective steps and timeline for implementation. The program must assess the effectiveness of the corrective steps.

V. Fair Practices

A. Publications and Disclosure

1. Announcements, catalogs, publications, advertising and websites must accurately reflect the program offered.

2. At least the following must be made known to all applicants and students

- **a.** Sponsor's institutional and programmatic accreditation status;
- **b.** Name and website address of CAAHEP;
- **c.** Admissions policies and practices;
- **d.** Technical standards;
- **e.** Occupational risks;
- **f.** Policies on advanced placement, transfer of credits, and credits for experiential learning;
- **g.** Number of credits required for completion of the program;
- **h.** Availability of articulation agreements for transfer of credits;
- **i.** Tuition/fees and other costs required to complete the program;
- **j.** Policies and processes for withdrawal and for refunds of tuition/fees; and
- **k.** Policies and processes for assignment of clinical experiences.

3. At least the following must be made known to all students

- **a.** Academic calendar;
- **b.** Student grievance procedure;
- **c.** Appeals process;
- **d.** Criteria for successful completion of each segment of the curriculum and graduation;
- **e.** Policies by which students may perform clinical work while enrolled in the program; and
- **f.** Policies for student leave of absence, exposure to bloodborne pathogens, communicable diseases, infection control, and pregnancy.

4. The sponsor must maintain, and make available to the public on its website a current and consistent summary of student/graduate achievement that includes these program outcomes: national credentialing examination(s), programmatic retention, and placement in full or part-time employment in the profession or a related profession as established by the JRC-DMS.

B. Lawful and Non-discriminatory Practices

All activities associated with the program, including student and faculty recruitment, student admission, and faculty employment practices, must be non-discriminatory and in accordance with federal and state statutes, rules, and regulations. There must be a faculty grievance procedure made known to all paid faculty.

A procedure should be established for determining that a student's health will permit him or her to meet the documented technical standards of the program.

C. Safeguards

The health and safety of patients/clients, students, faculty, and other participants associated with the educational activities of the students must be adequately safeguarded. Diagnostic medical sonography students must be readily identifiable as diagnostic medical sonography students.

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All activities required in the program must be educational and students must not be substituted for staff.

The program must ensure voluntary and prudent use of students or other human subjects for non-clinical scanning. Students' grades and evaluations must not be affected by participation or non-participation. When incidental findings are identified, students and human participants shall be advised to seek evaluation from an appropriate medical provider.

D. Student Records

Grades and credits for courses must be recorded on the student transcript and permanently maintained by the program sponsor in an accessible and secure location. Students and graduates must be given direction on how to access their records. Records must be maintained for student admission, advisement, and counseling while the student is enrolled in the program.

E. Substantive Change

The sponsor must report substantive change(s) as described in Appendix A to CAAHEP/JRC-DMS in a timely manner. Additional substantive change(s) to be reported to JRC-DMS within the time limits prescribed include:

1. Added or deleted learning concentrations;
2. Change in award (certificate, diploma, degree) granted at the completion of the program;
3. Change in clock or credit hours for completion of a program;
4. Change in the length of a program; and
5. Change in location or method of delivery of curriculum (ex: satellite campus, distance education).

F. Agreements

There must be a formal affiliation agreement or memorandum of understanding between the program sponsor and all other entities that participate in the education of the students describing the relationship, role, and responsibilities between the sponsor and that entity.

The delineation of responsibilities should include student supervision, benefits, liability and financial arrangements, if any. The agreement should include a clause to protect students and to ensure due process.

An affiliate is an institution having adequate resources to provide a broad range of appropriate clinical education opportunities for students.

A clinical education center is a department, division, or other designated part of a clinical affiliate having adequate resources to provide clinical education opportunities for students. Multiple clinical education centers may be identified within a clinical affiliate.

Appendix B

Curriculum Content and Competencies for Educational Programs in Diagnostic Medical Sonography

The curricular requirements are designed to demonstrate and assess knowledge progressively from general education requisite content, common core, and concentration-specific theory through clinical competency in preparation to become a competent entry-level sonographer. Clinical competency requirements must be assessed in a diagnostic clinical affiliate.

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Demonstration of knowledge may be assessed and documented in a variety of ways. Methods for assessment may include, but are not limited to, written exams, assignments, or lab activities. Documentation of proficiency in scan techniques may occur in the simulated lab environment or diagnostic clinical setting.

1. General Education Curriculum

Basic medical science and interpersonal communication education is required as a foundation for the clinical role of the diagnostic medical sonographer. The following must be at the post-secondary/college-level education courses:

a. Communication
b. Human anatomy and physiology
c. Mathematics
d. Physics

The program and sponsor may determine which mathematics and physics, including applied physics, courses will meet their needs and yield the outcomes desired for their graduates.

Upon completion of the Diagnostic Medical Sonography program, the student must have successfully completed the following cognitive (indicated with a "C"), psychomotor (indicated with a "P"), and affective (indicated with a "A") learning outcomes.

2. Learning Competencies Common to All Concentrations

a. Demonstrate knowledge of ergonomic techniques and mechanisms to reduce musculoskeletal injury. (C)

1) Industry standards and OSHA guidelines
2) Types of work-related musculoskeletal disorders
3) Role of Administration in the prevention of MSI
4) Role of Sonographer in the prevention of MSI
5) Best practices for prevention
    a) Daily exercises in the workplace
    b) Neutral posture
    c) Patient transfer and assistance
    d) Patient positioning
    e) Equipment and accessories
    f) Supports, tools, and devices
    g) Transducer grip and pressure
    h) Schedules/Workload
    i) Workstation/work area(s)

b. Demonstrate application of best practices in ergonomic techniques. (P)

1) Daily exercises in the workplace
2) Neutral posture
3) Patient transfer and assistance
4) Patient positioning
5) Equipment and accessories
6) Supports, tools and devices
7) Transducer grip and pressure

c. Demonstrate knowledge of the types and methods of infection control. (C)

1) Personal and patient

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a) Standard precautions
b) Isolation procedures
c) Aseptic and sterile technique

2) Levels of disinfection
a. High-level
b. Intermediate
c. Low-level

3) Environment
a) Equipment
b) Transducer cleaning and disinfection
c) Accessories

d. Demonstrate application of methods for infection control. (P)

1) Don and Doffing
2) Transducer care and cleaning
3) Equipment and accessories sanitation
4) Aseptic technique
5) Sterile technique

e. Demonstrate knowledge and application of patient care principles. (A)(C)(P)

1) Policies and procedures (C)
a) Compliance with program and clinical education facility policies, protocols, and safety requirements
b) Documentation and reporting of adverse events and incidents

2) Patient rights and ethical practice (A)
a) Principles of the Patient Care Partnership
b) Patient directives, informed consent, and advance directives

3) Patient needs and interactions (C)
a) Respond to patient needs in diverse clinical situations
b) Demonstrate age-appropriate and culturally competent communication and care
c) Demonstrate appropriate patient care in settings outside of the sonography department.
(1) Emergency room
(2) Intensive care unit
(3) Neonatal intensive care unit

4) Patient transport and transfer techniques with supportive equipment (C)
a) Oxygen delivery systems
b) Intravenous lines and pumps
c) Urinary catheters
d) Drainage tubes

5) Assessment of patient conditions (C)
a) Vital signs
b) Skin color
c) Skin integrity
d) Clinical history

6) Patient positioning and comfort (P)
a) Proper patient positioning and draping technique
b) Maintain patient comfort, dignity, and privacy throughout the examination
c) Privacy

7) Procedure-related care (C)

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a) Room and equipment set up
b) Communicate procedural steps
c) Review clinical history and labs
d) Provide appropriate post-intervention care and discharge support

8) Pharmacology as related to the concentration (C)
9) Emergency response and critical situations (C)
a) Recognize life threatening situations and implement emergency care as permitted by institutional policy, threatening situations and implement emergency care as permitted by institutional policy.
(1) Pertinent patient care procedures
(2) Principles of psychological support
(3) Emergency conditions and procedures
(4) First aid and resuscitation techniques
b) Active threat and de-escalation processes
10) Reporting and documentation (C)
a) Document and report incidents, adverse reactions, and patient care concerns

f. Demonstrate knowledge of contrast enhanced imaging (C)
1) Basic principles of contrast-enhanced ultrasound
2) Safety and administration of contrast
3) Routes of transmission
a) IV insertion and injection technique
b) Urinary catheter
4) Common clinical applications of contrast enhanced ultrasound (CEUS)
5) Enhancement patterns

g. Demonstrate knowledge of the roles and responsibilities of healthcare professions to effectively communicate and collaborate in the healthcare environment. (A)
1) Team development
2) Conflict resolution
3) Interprofessional communication and education

h. Demonstrate knowledge of medical ethics and law. (C)
1) Patient's right to privacy based on applicable legal and regulatory standards
2) Health Insurance Portability and Accountability Act (HIPAA)
3) Electronic documentation and transmission
4) Terminology related to ethics, values, and morals
5) Types of law
6) Risk management
7) Medical malpractice liability coverage
8) Ethical use of artificial intelligence
9) Professional scope of practice and clinical standards
10) Professional code of ethics

i. Demonstrate knowledge of medical and sonographic terminology. (C)
1) Definitions, abbreviations, symbols, terms, and phrases
2) Correlating diagnostic and imaging procedures
3) Sonographic appearances

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j. Obtain, evaluate, document, and communicate relevant information related to sonographic examinations. (C)

1) Clinical information and historical facts from the patient and the medical records, which may impact the diagnostic examination.
    a) Clinical signs and symptoms
    b) Laboratory tests
    c) Imaging and diagnostic procedures
    d) Oral and/or written summary of sonographic findings.
2) Deviation from practice parameters for the sonographic examination as required by patient history or initial findings
3) Changes from a previous examination
4) Examination findings that require an immediate clinical response and notify the interpreting physician.

k. Identify and evaluate anatomic structures. (C)

1) Sectional anatomy
2) Relational anatomy
3) Normal sonographic appearances of organs, muscles, tissue, vascular and skeletal structures
4) Differentiation of normal from abnormal sonographic findings

l. Demonstrate knowledge of disease processes with application to sonographic and Doppler patterns. (C)

1) Iatrogenic
2) Degenerative
3) Inflammatory
4) Traumatic
5) Neoplastic
6) Infectious
7) Obstructive
8) Congenital
9) Metabolic
10) Immunologic

m. Demonstrate knowledge of the principles of sound, image production, and storage. (C)

1) Mathematical formulas and relationships
2) Sound production and propagation
3) Interaction of sound and matter
4) Transducer types and construction
5) Sound beam formation
6) Principles of ultrasound instruments and modes of operation
7) Operator control options
8) Contrast-enhanced imaging
9) Acoustic artifacts
10) 3D/4D technology
11) Emerging technologies
12) Image storage devices

n. Demonstrate knowledge of Doppler techniques, hemodynamics, and imaging. (C)

1) Doppler equation

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2) Principles of Doppler techniques
3) Methods of Doppler flow analysis
4) Hemodynamics of blood flow
5) Measurement and calculations
6) Equipment parameters to optimize images
7) Artifacts with Doppler imaging

o. Demonstrate knowledge of biological effects. (C)

1) In-vitro and in-vivo ultrasound effects
2) Exposure/equipment display indices
3) Generally accepted maximum safe exposure levels
4) ALARA principle
   a) Mechanisms that affect the mechanical and thermal indices
   b) Techniques to decrease the mechanical and thermal indices

p. Demonstrate application of equipment features to promote image optimization. (P)

1) Transducer selection and frequency
2) Gray scale equipment features
3) Color and power Doppler parameters
4) Pulsed wave Doppler parameters
5) Effect of equipment features on mechanical and thermal indices

q. Demonstrate knowledge of quality control and improvement program. (C)

1) Lab accreditation
2) Quality assurance
   a) Appropriate use criteria
   b) Evaluation of technical protocols
   c) Correlation with imaging studies
   d) Statistical definitions and calculations
      (1) Accuracy
      (2) Sensitivity and specificity
      (3) Positive and negative predictive values
3) Credentialing organizations
4) Equipment operation and maintenance
   a) Phantom testing
   b) Records maintenance

r. Demonstrate knowledge of resources for professional development. (C)

1) Professional organizations and resources
2) Professional journals and online resources
3) Continuing education conferences
4) Clinical conferences, lectures, and in-house educational offerings
5) Recent developments in sonography
6) Research design and statistics

s. Demonstrate achievement of clinical competency through the performance of the requirements to provide quality patient care and optimal examination outcomes. Clinical competencies must include evaluation and documentation of: (P)

1) Use of proper ergonomics

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2) Safety and infection control
3) Obtain clinical history and utilize information appropriately
4) Oral and written communication
5) Image optimization techniques
6) ALARA
7) Professionalism
8) Document sonographic findings for communication with the interpreting physician
9) Finalize examination for permanent storage
10) Process for reporting critical findings

The above competencies may be embedded within the learning concentration clinical competencies.

3. Learning Competencies for the Abdominal Sonography - Extended Concentration

a. Identify anatomy, relational anatomy, anatomic variants, and sonographic appearances of normal anatomical structures. (C)

1) Abdominal
   a) Abdominal wall
   b) Adrenal glands
   c) Aorta and branches
   d) Biliary system
   e) Gastrointestinal tract
   f) Great vessels and branches
   g) Liver
   h) Lung/pleura
   i) Lymphatic system
   j) Pancreas
   k) Peritoneal and retroperitoneal cavities
   l) Spleen
   m) Urinary tract

2) Extended
   a) Extremity non-vascular
   b) Infant hips
   c) Neck (thyroid and non-thyroid)
   d) Neonatal/infant head
   e) Neonatal/infant spine
   f) Penis
   g) Prostate
   h) Scrotum
   i) Superficial soft-tissue structures

b. Demonstrate knowledge of normal and abnormal physiology, pathophysiology, sonographic technique, measurement principles, sonographic appearances, and as applicable, Doppler patterns. (C)

1) Abdominal
   a) Abdominal wall
   b) Adrenal glands
   c) Aorta and branches
   d) Biliary system

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e) Gastrointestinal tract
f) Great vessels and branches
g) Liver
h) Lung/pleura
i) Lymphatic system
j) Pancreas
k) Peritoneal and retroperitoneal cavities
l) Spleen
m) Urinary tract

2) Extended
a) Extremity (non-vascular)
b) Infant hips
c) Neck (thyroid and non-thyroid)
d) Neonatal/infant head
e) Neonatal/infant spine
f) Penis
g) Prostate
h) Scrotum
i) Superficial soft-tissue structures

c. Demonstrate knowledge of the sonographer's role, responsibilities, and professional conduct during sonographically guided procedures. (C)
1) Role of the sonographer
2) Clinical information
3) Informed consent
4) Procedural time out
5) Transducer guidance and needle visualization techniques
6) Sterile setup and field maintenance
7) Pre-and post-procedural documentation

d. Demonstrate knowledge of scanning protocols and appropriate protocol modification(s) based on the sonographic findings and the differential diagnostic considerations. (C)
1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
4) Clinical differential diagnosis
5) Contrast-enhanced imaging
6) Application of elastography
7) Role of sonography in patient management and follow-up

e. Demonstrate proficiency in the scanning technique and application for abdominal vascular and gastrointestinal assessment. (P)
1) Abdominal vascular Doppler assessment
a) Hepatic
b) Mesenteric
c) Renal
2) Gastrointestinal tract assessment

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The above proficiencies may be demonstrated in a clinical setting or in a simulated environment on a human participant.

f. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the abdomen and superficial structures, in accordance with practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of: (A)(P)

1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment. (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination. (A)
3) Identification of anatomical and relational structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization techniques in grayscale (P)
6) Image optimization techniques in Doppler (where applicable) (P)
7) Measurement techniques (P)
8) Abdominal competencies (P)
    a) Complete abdominal examination
    b) Limited abdominal examination
        (1) Aorta/IVC
        (2) Biliary system
        (3) Liver
        (4) Pancreas
        (5) Spleen
        (6) Kidneys
        (7) Bladder
        (8) Pleural space
    c) Complete or limited abdomen examination with pathology
9) Superficial Structures (P)
    a) Thyroid
    b) Scrotum
    c) Superficial structure examination with pathology
10) Interventional procedure with sonographic guidance (P)
    a) Sonographic-guided procedure (assistance)

The above structures listed under limited abdominal examination may be completed as individual clinical competencies or may be incorporated with other structures/techniques as part of a limited or complete examination.

4. Learning Competencies for the Adult Cardiac Sonography Concentration

a. Identify anatomy, anatomic variants, and sonographic appearances of normal cardiac structures. (C)

1) Embryology and fetal cardiac development
2) Cardiac chambers and septation
3) Coronary artery anatomy and distribution
4) Pulmonary artery and venous return
5) Relationships of cardiac chambers and great vessels
6) Valve anatomy and function

b. Demonstrate knowledge of normal and cardiovascular physiology and hemodynamics. (C)

1) Ventricular systolic function

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2) Ventricular diastolic function
3) Influence of loading conditions
4) Normal intracardiac pressures
5) Normal filling pressures
6) Measurement of cardiac output
7) Electrophysiology and exercise physiology

c. Demonstrate knowledge of mechanisms of disease, cardiovascular pathophysiology, and hemodynamics, sonographic technique, measurements, quantitative principles, and Doppler patterns in both the normal heart and with cardiac disease. (C)

1) Valvular heart disease
2) Prosthetic heart valves
3) Ventricular dysfunction
4) Diastolic dysfunction
5) Ischemic cardiac disease
6) Cardiomyopathy
7) Pericardial disease
8) Congenital heart disease
9) Endocarditis, neoplasms, and masses
10) Cardiac trauma
11) Pulmonary vascular disease
12) Diseases of the aorta and great vessels
13) Intracardiac shunt
14) Intracardiac pressures
15) Cardio-oncology
16) Systemic diseases
17) Systemic and pulmonary hypertension
18) Common arrhythmias and conduction abnormalities

d. Demonstrate knowledge of interventional and surgical cardiac procedures. (C)

1) Cardiac catheterization
2) Cardiac assist devices
3) Echo-guided procedures
4) Heart transplant
5) Intracardiac devices
6) Valve clips
7) Transcatheter aortic valve replacement

e. Demonstrate knowledge of the indications, utility, limitations, and technical procedures for related echocardiographic studies. (C)

1) Transthoracic echocardiography
2) Stress echocardiography
3) Transesophageal echocardiography
4) Intraoperative echocardiography
5) Contrast enhanced ultrasound
6) Agitated saline ultrasound
7) IV administration techniques
8) Three-dimensional echocardiography
9) Echo-guided procedures

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10) Strain echocardiography
11) Speckle tracking
12) Cardiac ultrasound respirogram
13) Pharmacology

f. Demonstrate knowledge, application, and proficiency in the use of quantitation principles applied to echocardiographic images and flow data. (C)
1) Standard M-mode, two-dimensional, and Doppler measurements and calculations
2) Knowledge and understanding of normal and abnormal values for M-mode, two-dimensional and Doppler echocardiography
3) Evaluation of normal and abnormal systolic and diastolic ventricular function
4) Evaluation of the severity of valve stenosis and regurgitation
5) Evaluation of normal and abnormal prosthetic valves, assist devices and interventional procedures

g. Demonstrate knowledge of scanning protocols and appropriate protocol modification(s) based on the sonographic findings and the differential diagnostic considerations. (C)
1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
   a) Chest X-ray
   b) Angiography and cardiac catheterization
   c) Electrocardiography, electrophysiologic studies, Holter monitoring
   d) Stress testing protocols
   e) Radionuclide studies
   f) Cross-sectional imaging procedures
   g) Post interventional and surgical procedure
4) Clinical differential diagnosis
5) Role of sonography in patient management
6) Effects of pharmacotherapy on echocardiographic findings

h. Demonstrate proficiency in scanning technique and application of echocardiographic assessment: (P)
1) Quantitative principles applied to echocardiographic images and flow data
2) Stress echocardiography – exercise
3) Stress echocardiography – pharmacologic
4) Transthoracic enhanced echocardiogram

The above proficiencies may be demonstrated in a clinical setting or in a simulated environment on a human participant.

i. Demonstrate achievement of clinical competency through the performance of adult cardiac sonography, in accordance with practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of: (A)(P)
1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination (A)
3) Identification of anatomical and relational structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization and measurement techniques with: (P)

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a) 2D imaging
b) M-mode
c) Spectral Doppler: PW, CW and Tissue Doppler
d) Color flow Doppler
e) Use of non-imaging CW Doppler transducer

6) Adult cardiac sonography competencies (P)
a) Complete transthoracic echocardiogram – Normal
b) Systolic dysfunction
c) Diastolic dysfunction
d) Aortic valve or aortic root pathology
e) Mitral valve pathology
f) Right heart pathology
g) Cardiomyopathy
h) Pericardial pathology
i) Prosthetic valve
j) Coronary artery disease
k) Contrast-enhanced echocardiography (observe)

The above may be completed as individual clinical competencies or may be incorporated with other organs as part of a limited or complete examination.

5. Learning Competencies for the Breast Sonography Concentration

a. Identify anatomy, congenital and developmental variants, and sonographic appearances of normal breast structures. (C)

1) Areolar complex/nipple
2) Fibrous planes
a) Skin
b) Subcutaneous fat
c) Mammary zone
d) Retromammary space
e) Muscle layers
f) Rib cage and intercostal muscles
3) Cooper's ligaments
4) Ductal system
5) Lymph nodes
6) Vasculature
a) Arterial
b) Venous
7) Variants
a) Amastia
b) Amazia
c) Athelia
d) Polymastia
e) Polythelia
f) Nipple inversion/flattening
g) Early ripening
h) Age-related sonographic changes of breast tissue and its components

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b. Demonstrate knowledge of normal and abnormal physiology and pathophysiology of breast structures. (C)

1) Embryologic development
2) Age-related development of the breast to involution
3) Normal blood flow patterns within the breast and its components
4) Lymphatic drainage
5) Effect of pregnancy
6) Lactation
7) Male breast
8) Infectious processes
9) Neoplasms
    a) Cystic
    b) Benign
    c) Malignant
10) Trauma

c. Demonstrate knowledge of sonographic technique, measurement principles, sonographic appearances, integration of data, and Doppler patterns. (C)

1) Scan planes
2) Scan techniques
3) Patient position
4) Imaging techniques
5) Image labeling/distance from nipple
6) Image optimization
7) Artifacts
8) Implants
9) Lymph node assessment
10) Postoperative biopsy site
11) BI-RADS assessment categories
12) Correlation of other imaging modalities
13) Spectral Doppler of the vasculature related to a mass
14) Color Doppler of a mass/lesion
15) Power Doppler of a mass/lesion

d. Demonstrate knowledge of the sonographer's role, responsibilities, and professional conduct during sonographically guided procedures. (C)

1) Role of the sonographer in ultrasound-guided procedures and sentinel lymph node biopsy
2) Clinical information
3) Informed consent
4) Procedural time out
5) Transducer guidance
6) Sterile setup
7) Pre-and post-procedural documentation
8) Sonography-assisted procedures

e. Demonstrate knowledge of scanning protocols and appropriate protocol modification based on sonographic findings and differential diagnostic considerations. (C)

1) Indications and contraindications
2) History and physical examination

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3) Related imaging, laboratory, and functional testing procedures
   a) Correlation with mammography
      (1) BIRADS
   b) Correlation with MRI
   c) Correlation with Nuclear Medicine
4) Clinical differential diagnosis
5) Role of sonography in patient management
6) Elastography
7) Role of three-dimensional sonography

f. Demonstrate knowledge of treatment options. (C)
1) Medical
2) Surgical
3) Brachytherapy

g. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the breast, in accordance with practice parameters established by national professional organizations and the protocol of the clinical affiliate/clinical education centers. Clinical competencies must include evaluation and documentation of: (A)(P)
1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment. (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination. (A)
3) Identification of anatomical and relational structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization techniques in grayscale (P)
6) Image optimization techniques in Doppler (where applicable) (P)
7) Measurement techniques (where applicable) (P)
8) Breast competencies (P)
   a) Targeted exam
   b) Lymph node evaluation
   c) Cystic lesion
   d) Solid lesion
   e) Doppler evaluation of mass
   f) Implant
   g) Breast interventional procedures
      (1) Fine needle aspiration
      (2) Core biopsy
      (3) Needle localization

The above may be completed as individual clinical competencies or may be incorporated with other structures/techniques as part of a limited or complete examination.

6. Learning Competencies for the Musculoskeletal Sonography Concentration

a. Define and describe the sonographic characteristics of the components of the musculoskeletal system. (C)
1) Bursae
2) Cartilage
3) Fascia
4) Fat pads

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5) Ligaments
6) Muscles
7) Retinaculum
8) Tendons
9) Nerves
10) Lymph nodes
11) Types of joints

b. Demonstrate knowledge of the anisotropic effect and the ability to distinguish this artifact from normal variants and pathology. (C)

c. **Identify anatomical structures, nerves and vascular supply, normal sonographic appearances, normal Doppler patterns, measurements (and contralateral comparison when applicable), and changes with the dynamic assessment. (C)**

1) Abdominal wall
2) Shoulder
3) Upper arm
4) Elbow
5) Forearm
6) Wrist
7) Hands
8) Fingers
9) Hip, to include groin and pelvis
10) Upper leg
11) Knee
12) Lower leg
13) Ankle
14) Foot
15) Toes
16) Chest wall
17) Differentiation between adult and pediatric anatomy

d. Demonstrate knowledge of normal and abnormal physiology, pathophysiology, sonographic technique, measurement principles, sonographic appearances, and as applicable, Doppler patterns in musculoskeletal injuries and disease processes. (C)

1) Abdominal wall
2) Shoulder
3) Upper arm
4) Elbow
5) Forearm
6) Wrist
7) Hands
8) Fingers
9) Hip, to include groin and pelvis
10) Upper leg
11) Knee
12) Lower leg
13) Ankle
14) Foot

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15) Toes
16) Chest wall
17) Differentiation between adult and pediatric pathologies

e. Identify sonographic and Doppler patterns in clinical diseases, injury, and post-surgical changes that may occur in the following categories. (C)

1) Bone pathology and erosion
2) Bursa pathology
3) Cartilage
4) Crystal deposits
5) Cystic structures
6) Fluid collections
7) Foreign bodies
8) Hernias
9) Impingement, subluxation/dislocation and altered function
10) Infections
11) Joint effusions
12) Joint laxity/altered function
13) Ligament pathology and tears
14) Masses/neoplastic processes
15) Muscle pathology and tears
16) Neuromas
17) Nerve pathology and entrapment
18) Pediatric specific musculoskeletal pathology
19) Postsurgical anatomy and hardware (including prosthetic hip)
20) Pully and sagittal band pathology
21) Retinaculum pathology
22) Soft tissue pathology
23) Sternoclavicular joint pathology
24) Subcutaneous abnormalities
25) Synovitis
26) Synovial proliferation
27) Tendon pathology, tears, and calcifications
28) Vascular malformations

f. Demonstrate knowledge of the sonographer's role, responsibilities and professional conduct during sonographic guided procedures (C)

1) Role of sonographer
2) Clinical information
3) Informed consent
4) Procedural time out
5) Transducer guidance
6) Sterile setup
7) Pre-and post-procedural documentation
8) Procedures
    a) Ablation
    b) Aspiration
    c) Platelet-Rich Plasma (PRP) Injection
    d) Dry needling

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e) Biopsy
f) Nerve mapping
g) Nerve block
h) Surgical planning

g. Demonstrate knowledge of scanning protocols and appropriate protocol modification based on the sonographic findings and the differential diagnostic considerations. (C)

1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
4) Clinical differential diagnosis
5) Role of sonography in patient management

h. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the musculoskeletal system, in accordance with practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of: (A)(P)

1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination (A)
3) Identification of anatomical and relational structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization techniques in grayscale (P)
6) Image optimization techniques in Doppler (where applicable) (P)
7) Dynamic or provocative maneuvers (P)
8) Evaluate bony surface irregularities (where applicable) (P)
    a) Abdominal wall
        (1) Valsalva maneuver to assess for a ventral hernia
    b) Shoulder
        (1) Biceps subluxation – Rotate the arm in external and internal rotation
        (2) Supraspinatus impingement – Arm abduction
        (3) Acromioclavicular joint – Cross-arm maneuver
        (4) Posterior labrum – Rotate the arm in external and internal rotation
    c) Elbow
        (1) Ulnar nerve subluxation—Flexion and extension
        (2) Ulnotrochlear joint--Valgus stress
        (3) Radiocapitellar joint – Varus stress
        (4) Extensor carpi ulnaris (ECU) subluxation – Pronation to supination
    d) Hands and fingers
        (1) Trigger finger—Flexion & extension
        (2) Stenner lesion—Valgus stress of the ulnar collateral ligament
    e) Hip, to include groin and pelvis
        (1) Valsalva maneuver is used to assess an inguinal or femoral hernia
        (2) Iliopsoas snapping—hip flexion with external rotation and abduction, followed by hip extension and internal rotation
        (3) Iliotibial band snapping—hip flexion and extension or symptom-driven dynamic maneuver
    f) Knee
        (1) Anterior – Flexion and extension to evaluate the patellar tendon
        (2) Lateral – Lateral compartment joint space

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g) Ankle
   (1) Lateral – Peroneal tendon subluxation evaluation during eversion circumduction
   (2) Medial – Dorsiflexion and inversion to check for tibialis posterior tendon instability
   (3) Posterior – Dorsiflexion/plantar flexion to evaluate the Achilles tendon
h) Foot
   (1) Dorsiflex the 2-4 metatarsophalangeal joint (MTP) to evaluate tendon movement, the integrity of the plantar plate, and for plantar tears
i) Neuromuscular
   (1) Peripheral neuropathies
   (2) Compression disorders

The above may be completed as individual clinical competencies or may be incorporated with other structures/techniques as part of a limited or complete examination.

1. Learning Competencies for the Obstetrics and Gynecology Sonography Concentration

a. Identify anatomy, anatomic variants, and sonographic appearances of normal structures of the female pelvis. (C)

1) Pelvic muscles
2) Pelvic vasculature
3) Peritoneal spaces
4) Reproductive organs
   a. Vagina
   b. Cervix
   c. Uterus
   d. Ovaries
   e. Uterine (Fallopian) tubes
5) Suspensory ligaments

b. Demonstrate knowledge of normal and abnormal physiology, pathophysiology, sonographic technique, measurement principles, sonographic appearances, and as applicable, Doppler patterns. (C)

1) Menstrual cycle
2) Hormonal cycle
3) Inflammatory processes
4) Congenital anomalies
5) Benign uterine masses
6) Malignant uterine masses
7) Benign ovarian and adnexal masses
8) Malignant ovarian masses
9) Contraceptive devices
10) Infertility procedures
11) Post-partum

c. Demonstrate knowledge of the sonographer's role, responsibilities, and professional conduct during sonographically guided procedures and advanced imaging. (C)

1) Infertility procedures
2) Sonohysterography
3) Operative guidance
4) Three-dimensional sonography

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d. Identify anatomy, anatomic variants, and sonographic appearances of normal maternal, embryonic, and fetal anatomic structures during the first, second, and third trimesters. (C)

1) First trimester structures

a) Gestational sac
b) Embryonic pole
c) Yolk sac
d) Early placenta
e) Fetal cardiac activity
f) Uterus
g) Cervix
h) Adnexa
i) Pelvic spaces
j) Multiple gestations

2) Detailed less than 14 weeks (C)

a) Intracranial anatomy
b) Transventricular cranial bones
c) Face
d) Nuchal translucency
e) Fetal heart rate and rhythm
f) Heart/great vessels
g) Thorax
h) Abdomen and pelvis
i) Anterior abdominal wall
j) Spine
k) Extremities
l) Umbilical cord

3) Second- and Third-trimester fetal and maternal structures (C)

a) Intracranial anatomy
   (1) Lateral ventricles/choroid plexus
   (2) Midline Falx
   (3) Cavum septum pellucidum
   (4) Thalami
   (5) Cerebellum
   (6) Cisterna Magna
   (7) Nuchal fold
b) Face
   (1) Nose/Lips
   (2) Profile
   (3) Orbits
c) Thoracic cavity
d) Heart
   (1) Position and size
   (2) Four-chamber view
   (3) LVOT and RVOT views
   (4) IVC and SVC inflow view
   (5) Three-vessel and three-vessel tracheal views

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(6) Aortic and ductal arches

e) Abdomen and pelvis
(1) Situs
(2) Stomach
(3) Liver/umbilical vein
(4) Kidneys
(5) Bladder

f) Abdominal wall
g) Spine
h) Extremities
i) External genitalia
j) Amniotic fluid
k) Placenta
l) Umbilical cord
m) Fetal cardiac activity
n) Maternal cervix
o) Maternal adnexa
p) Multiple gestations

e. Demonstrate knowledge of normal and abnormal pathology, physiology, pathophysiology, sonographic technique, measurement principles, sonographic appearance, and as applicable, Doppler patterns. (C)

1) First trimester complications
2) Congenital anomalies
3) Genetic syndromes
4) Growth abnormalities
5) Multiple gestation complications
6) Viability
7) Amniotic fluid
8) Placenta
9) Umbilical cord
10) Fetal monitoring
11) Effects of maternal conditions
12) Post-partum

f. Demonstrate knowledge of the sonographer's role, responsibilities, and professional conduct during sonographically guided procedures and advanced imaging. (C)

1) Amniocentesis
2) Chorionic villus sampling
3) Fetal therapy
4) Three-dimensional obstetric sonography

g. Demonstrate knowledge of scanning protocols and appropriate protocol modification based on sonographic findings and differential diagnostic considerations. (C)

1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
4) Clinical differential diagnosis
5) Role of sonography in patient management

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h. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the gravid and non-gravid pelvis with both transabdominal and endocavitary transducers, and Doppler/M-mode display modes, according to practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of: (A)(P)

1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination (A)
3) Identification of anatomical and related structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization techniques in grayscale (P)
6) Image optimization techniques in Doppler and M-mode (where applicable) (P)
7) Knowledge and application of ALARA (P)
8) Measurements as applicable (P)
9) Gynecology competencies (P)
    a) Complete pelvic sonogram
    b) Pelvic sonogram with pathology
    c) Cervix/uterus
    d) Posterior and anterior cul-de-sac
    e) Ovaries
    f) Adnexa
10) Obstetrical competencies (P)
    a) First-trimester obstetric structures
        (1) Gestational sac
        (2) Embryonic pole
        (3) Yolk sac
        (4) Fetal cardiac activity
        (5) Placenta
        (6) Uterus
        (7) Cervix
        (8) Adnexa
        (9) Pelvic spaces
    b) First trimester sonogram with complications
    c) Second- and Third-trimester fetal and maternal structures
        (1) Intracranial anatomy
        (2) Face
        (3) Thoracic cavity
        (4) Heart
            (a) Position and size
            (b) Four-chamber view
            (c) LVOT and RVOT views
            (d) Three-vessel and three-vessel tracheal views
        (5) Abdomen
        (6) Abdominal wall
        (7) Spine
        (8) Extremities
        (9) Amniotic fluid
        (10) Placenta

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(11) Umbilical cord
(12) Fetal cardiac activity
(13) Maternal cervical length
(14) Maternal adnexa

d) Second or third trimester sonogram demonstrating abnormality
e) Biophysical profile

The above may be completed as individual clinical competencies or may be incorporated with other structures/techniques as part of a limited or complete examination.

2. Learning Competencies for the Pediatric Cardiac Sonography Concentration

a. Identify anatomy, anatomic variants, and sonographic appearances of normal and abnormal cardiac structures (adult, pediatric, and fetal). (C)

1) Embryology and fetal cardiac development
2) Cardiac chambers and septation
   a) Morphology of left and right ventricles
   b) Morphology of left and right atria
3) Valve anatomy and dynamics
4) Coronary artery anatomy
5) Relationships of cardiac chambers and great arteries
6) Mediastinal structures
7) Arch anatomy
8) Pulmonary artery and venous anatomy
9) Systemic venous return
10) Variations of normal anatomy
11) Visceral and cardiac situs

b. Demonstrate knowledge of normal cardiovascular physiology and hemodynamics. (C)

1) Fetal circulation
2) Transitional physiology
3) Ventricular function
4) Pulmonary and systemic circulation
5) Electrophysiology
6) Exercise physiology

c. Demonstrate knowledge of cardiovascular pathophysiology (embryology of congenital abnormalities, mechanisms of acquired disease), and hemodynamics, sonographic technique, measurements, quantitative principles, and Doppler patterns in both the normal heart and with cardiac disease. (C)

1) Congenital heart disease (CHD)
   a) Situs abnormalities
   b) Defects in cardiac septation
   c) Abnormalities in atrial-ventricular connections
   d) Abnormalities in the ventriculo-arterial connection
   e) Ventricular hypoplasia
   f) Ventricular inflow anomalies
   g) ventricular outflow anomalies
   h) Abnormalities within cardiac chambers
   i) Vascular abnormalities

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j) Abnormalities within the thorax
k) Abnormal vascular connections
l) Postoperative repair/treatment
m) Diseases of the aorta and great vessels
n) Valvular abnormalities
o) Pericardial abnormalities

2) Acquired heart disease
a) Valvular heart disease
b) Ischemic cardiac disease
c) Cardiomyopathy
d) Pericardial and pleural abnormalities
e) Cardiac thrombi, endocarditis, neoplasms, and masses
f) Cardiac trauma
g) Pulmonary vascular disease
h) Systemic and pulmonary hypertension
i) Infection of native structures and devices

d. Demonstrate knowledge and applications of the indications, utility, limitations, and technical procedures for related echocardiographic studies. (C)

1) Stress echocardiography
2) Transesophageal echocardiography
3) Intraoperative echocardiography
4) Contrast-enhanced ultrasound
5) Agitated saline ultrasound
6) IV administration techniques
7) Three-dimensional echocardiography
8) Echo-guided procedures
9) Myocardial strain echocardiography
10) Targeted obstetric exam

e. Demonstrate knowledge, application, and proficiency in the use of quantitation principles applied to echocardiographic images and flow data. (C)

1) Standard M-mode, two-dimensional, and Doppler measurements and calculations (normalized based on body surface area, and/or other biometric measurements for the fetus)
2) Knowledge and understanding of normal and abnormal values for M-mode, two-dimensional and Doppler echocardiography
3) Evaluation of normal and abnormal systolic and diastolic ventricular function
4) Evaluation of the severity of valve stenosis and regurgitation
5) Knowledge of normal and abnormal sonographic appearances of peripheral vascular anatomy
6) Calculation of Qp: Qs ratio
7) Correlation of measurement to Z-score
8) Miscellaneous measurements specific to patient history

f. Demonstrate knowledge and application of clinical cardiology as appropriate to the fetus and patients with congenital heart disease (CHD). (C)

1) Relationship of echocardiography to history and physical examination, including indications for echocardiography - diagnostic approach to CHD
2) Acquired heart disease, noncardiac disease, and the effects of systemic diseases on cardiovascular anatomy and physiology

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3) Differential diagnosis as it relates to the echocardiographic examination
4) Cardiac arrhythmias
5) Genetic syndromes and chromosomal anomalies associated with CHD
6) Connective tissue disorders
7) Functional abnormalities associated with drug toxicity
8) Current trends of caring for the fetus, pediatric and adult patient with CHD

g. Demonstrate knowledge of interventional cardiology, post-intervention, surgical procedures, and the associated appearances on echocardiography (C)
1) Arterial switch operation
2) Atrial switch operation
3) Conotruncal repair
4) Pulmonary artery banding
5) Septal defect repair
6) Shunt closure
7) Valve repair
8) Staged palliation and repair
9) Implantable devices and lines
10) Cardiac transplantation and rejection

h. *Demonstrate knowledge of scanning protocols and appropriate protocol modification based on sonographic findings and differential diagnostic considerations*. **(C)**
1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
   a) Chest X-ray
   b) Angiography and cardiac catheterization
   c) Electrocardiography, electrophysiologic studies, Holter monitoring
   d) Stress testing
   e) Radionuclide studies
   f) Tomographic imaging procedures
   g) Fetal /Pediatric/Adult interventions for congenital heart disease
4) Clinical differential diagnosis
5) Role of sonography in patient management
6) Pharmacology

i. Demonstrate proficiency in the technique and application of: (P)
1) Quantitation principles applied to echocardiographic images and flow data
2) Calculation of Qp:Qs ratio

The above proficiencies may be demonstrated in a clinical setting or in a simulated environment.

j. Demonstrate achievement of clinical competency through the performance of pediatric cardiac sonography in accordance with practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of:(A)(P)
1) Demonstrate empathy, patience, and emotional awareness when interacting with infants, young children, and their caregivers. (A)

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2) Provide family-centered care by explaining the examination in age-appropriate and caregiver-appropriate language. (A)
3) Acknowledges and responds appropriately to caregiver concerns, anxiety, and questions before, during, and after the examination. (A)
4) Identification of anatomical and relational structures (P)
5) Differentiation of normal from pathological/disease process (P)
6) Image optimization and measurement techniques with: (P)
    a) 2D imaging
    b) M-mode
    c) Spectral Doppler: PW, CW and Tissue Doppler
    d) Color flow Doppler
    e) Use of non-imaging CW Doppler transducer
7) Pediatric cardiac sonography competencies (P)
    a) Complete transthoracic examination - Normal
    b) Patent foramen ovale or atrial septal defect
    c) Ventricular septal defect
    d) Patent ductus arteriosus
    e) Conotruncal defect (repaired or unrepaired)
    f) Left heart structural/valvular disease
    g) Right heart structural/valvular disease
    h) Repaired structural heart disease

The above may be completed as individual clinical competencies or may be incorporated with other organs as part of a limited or complete examination.

3. Learning Competencies for the Vascular Sonography Concentration

a. Demonstrate knowledge of anatomy and anatomic variants of the cardiovascular system. (C)

1) Heart
    a) Chambers
    b) Valves
    c) Vessels
2) Pulmonary circulation
3) Vessel structure
    a) Arteries
    b) Veins
    c) Capillaries
4) Aorta and branches
5) Superior vena cava
6) Inferior vena cava and iliac veins
7) Cerebrovascular
8) Hepatoportal venous
9) Mesenteric arterial system
10) Peripheral arterial
11) Peripheral venous
12) Renal vessels

b. Demonstrate knowledge of normal and abnormal peripheral vascular physiology and hemodynamics. (C)

1) Principles of pressure, flow, and resistance

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2) Pulsatile flow
3) Laminar and non-laminar flow patterns
4) Poiseuille's law
5) Bernoulli's principle
6) Reynold's number
7) Cardiac influence on flow
8) Occlusive diseases
9) Collateral circulation
10) Exercise and hyperemia
11) Systemic diseases and other conditions
12) Venous physiology, valve function, calf pump

c. Demonstrate knowledge of mechanisms of vascular diseases, vascular pathophysiology, and hemodynamic effects. (C)

1) Aneurysm and pseudoaneurysm
2) Arterial embolism
3) Arteriovenous fistulae and shunts
4) Atherosclerosis
5) Congenital anomalies
6) Dissection
7) Fibromuscular dysplasia
8) Genetic disorders
9) Hepatoportal disorders
10) Iatrogenic injury
11) Infection
12) Intimal hyperplasia
13) Ischemia
14) Neoplasia
15) Organ transplantation
16) Pharmacologic alterations
17) Systemic hypertension
18) Trauma
19) Vascular entrapment and extrinsic compression
20) Vascular malformations
21) Vasculitis
22) Vasospastic disorders
23) Venous thromboembolism
24) Venous valvular disorders

d. Demonstrate knowledge of sonographic technique, measurement principles, sonographic appearances, and Doppler flow characteristics in both normal and abnormal vascular structures. (C)

1) Aorta and branches
2) Cerebrovascular
3) Hepatoportal venous
4) Mesenteric arterial system
5) Peripheral arterial
6) Peripheral venous
7) Renal vessels
8) Vena cava and iliac veins

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e. Demonstrate knowledge of physiologic vascular testing principles and techniques. (C)

1) Continuous-wave and pulse Doppler
2) Pressure measurements, including ankle/brachial index
3) Pneumoplethysmography (pulse volume recording)
4) Segmental pressure
5) Waveform analysis
6) Exercise treadmill testing
7) Photoplethysmography (PPG), arterial and venous
8) Air plethysmography, venous
9) Laser Doppler, including skin perfusion pressure measurements

f. Demonstrate knowledge of the principles and calculations related to vascular testing (C)

1) Acceleration time
2) Ankle/brachial pressure ratios
3) Aorta/renal ratios
4) Area and diameter reduction measurements
5) Digit/brachial indices
6) Velocity change across stenosis for grading arterial lesions
7) Pulsatility index
8) Resistive index
9) Segmental pressures, including digits
10) Velocity ratios
11) Venous reflux time
12) Volume flow

g. Demonstrate knowledge of the sonographer's role, responsibilities and professional conduct during sonographically guided procedures. (A)

1) Role of the sonographer
2) Clinical information
3) Informed consent
4) Procedural time out
5) Sterile technique
6) Pre- and post-procedure documentation
7) Superficial vein ablation
8) Use of thrombin injection for pseudoaneurysm treatment

h. Demonstrate knowledge of the role of ultrasound for evaluation of vascular surgical procedures or interventions, including a role in planning, intra-procedural guidance/technical evaluation, and/or post-procedure assessment. (C)

1) Angioplasty
2) Atherectomy
3) Coil embolization
4) Dialysis fistula/graft
5) Embolectomy
6) Endarterectomy
7) Endovascular aortic aneurysm repair (EVAR)
8) Endovenous ablation
9) Inferior vena cava filter

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10) Patch angioplasty
11) Stents
12) Synthetic grafts
13) Thrombolysis and thrombectomy
14) Trans-jugular intrahepatic porto-systemic shunt (TIPS)
15) Vein bypass grafts

i. Demonstrate knowledge of scanning protocols and appropriate protocol modification(s) based on sonographic findings, patient-specific factors, and differential diagnostic considerations. (C)

1) History, including indication, prior vascular procedures
2) Physical examination and assessment of patient-specific factors
3) Contraindications
4) Related imaging, laboratory, and functional testing procedures
5) Clinical differential diagnosis
6) Role of ultrasound in patient management
7) Pharmacology

j. Demonstrate knowledge and application of quality assurance and statistical tests used in a vascular laboratory. (C)

1) Correlations of clinical findings and other imaging examinations
2) Accuracy
3) Sensitivity
4) Specificity
5) Positive predictive value
6) Negative predictive value
7) Quality improvement program components
   a) Appropriate use criteria
   b) Evaluation of technical quality
   c) Compliance with protocols
   d) Diagnostic criteria

k. Demonstrate proficiency in scanning technique and application for vascular assessments. (P)

1) Intracranial cerebrovascular
2) Upper extremity and digital arterial physiologic testing
3) Upper extremity arterial duplex
4) Palmar arch
5) Lower extremity and digital arterial physiologic testing
6) Lower extremity exercise testing
7) Lower extremity venous insufficiency testing
8) Vessel mapping
9) Visceral vascular

The above proficiencies may be demonstrated in a clinical setting or in a simulated environment on human participants.

l. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the vascular system in accordance with practice parameters established by national

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professional organizations and the protocol of the clinical affiliates. Clinical competencies must include evaluation and documentation of: (A) (P)

1) Demonstrate respect, cultural sensitivity, and accountability in the clinical environment. (A)
2) Provide patient care by explaining the ultrasound procedure, addressing patient concerns, and responding appropriately throughout the examination. (A)
3) Identification of anatomical and relational structures (P)
4) Differentiation of normal from pathological/disease process (P)
5) Image optimization in grayscale, color Doppler and spectral Doppler (P)
6) Measurement techniques (P)
7) Vascular competencies (P)
    a) Extracranial cerebrovascular, including vertebral vessels
    b) Aortoiliac duplex
    c) Ankle and brachial pressures/ABI
    d) Lower extremity arterial duplex
    e) Lower extremity venous duplex
    f) Upper extremity venous duplex
    g) Vascular examination with pathology

The above may be completed as individual clinical competencies or may be incorporated with other structures/techniques as part of a limited or complete examination.

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