Commission on Accreditation of Allied Health Education Programs

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 and 20xx by the:

American College of Cardiology
American College of Radiology
American Institute of Ultrasound in Medicine
American Society of Echocardiography
American Society of Radiologic Technologists
Society of Diagnostic Medical Sonography
Society for Vascular Surgery
Society for Vascular Ultrasound
Joint Review Committee on Education in Diagnostic Medical Sonography
and
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 and Guidelines** 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 in narrative form.

Preamble

The Commission on Accreditation of Allied Health Education Programs (CAAHEP), Joint Review Committee on Education in Diagnostic Medical Sonography (JRC-DMS), the American College of Cardiology, American College of Radiology, American Institute of Ultrasound in Medicine, American Society of Echocardiography, American Society of Radiologic Technologists, 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**. Lists of accredited programs are published for the information of students, employers, educational institutions and agencies, and the public.

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

Description of 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 of the physician and does not practice independently.

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

Programs may be developed to meet one or more of these learning concentrations.

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. Sponsoring Institution

A sponsoring institution must either award credit for the program or have an articulation agreement with an accredited post-secondary institution, and 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 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 that is institutionally accredited and authorized under applicable law or other acceptable authority to provide healthcare, 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 Federal agency, which awards a minimum of a certificate/diploma at the completion of the program.

B. Consortium Sponsor

1. A consortium sponsor is an entity consisting of two or more members that exists for the purpose of operating an educational program. In such instances, at least one of the members of the consortium must meet the requirements of a sponsoring institution as described in I.A.

2. The responsibilities of each member of the consortium must be clearly documented as a formal affiliation agreement or memorandum of understanding, which includes governance and lines of authority.

C. Responsibilities of Sponsor

The Sponsor must assure that the provisions of these **Standards and Guidelines** are met.

II. Program Goals

A. Program Goals and Outcomes

There must be a written statement of the program's goals and learning domains consistent with and responsive to the demonstrated needs and expectations of the various communities of interest served by the educational program. The communities of interest that are served by the program must include, but are not limited to, students, graduates, faculty, sponsor administration, employers, physicians, and the public.

Program-specific statements of goals and learning domains provide the basis for program planning, implementation, and evaluation. Such goals and learning domains must be compatible with the mission of the sponsoring institution(s), the expectations of the communities of interest, and nationally accepted standards of roles and functions. Goals and learning domains are based upon the substantiated needs of health care providers and employers, and the educational needs of the students served by the educational program.

B. Appropriateness of Goals and Learning Domains

The program must regularly assess its goals and learning domains. Program personnel must identify and respond to changes in the needs and/or expectations of its communities of interest.

An advisory committee, which is representative of at least each of the communities of interest named in these **Standards**, must be designated and charged with the responsibility of meeting at least annually, to assist program and sponsor personnel in formulating and periodically revising appropriate goals and learning domains, monitoring needs and expectations, and ensuring program responsiveness to change.

Advisory committee meetings may include participation by synchronous electronic means.

C. Minimum Expectations

The program must have the following goal defining minimum expectations: To prepare competent entry-level sonographers in the cognitive (knowledge), psychomotor (skills), and affective (behavior) learning domains 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 adopting educational goals beyond entry-level competence must clearly delineate this intent and provide evidence that all students have achieved the basic competencies prior to entry into the field.

Nothing in this Standard restricts programs from formulating goals beyond entry-level competence.

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: faculty, clerical and support staff; curriculum; finances; offices; classroom, laboratory, and ancillary student facilities; clinical affiliates; equipment; supplies; computer resources, instructional reference materials, and faculty/staff continuing education.

Support staff should be available to provide counseling or referral for problems that may interfere with the student's progress through the program. Guidance should be available to assist students in understanding course content and in observing program policies and practices.

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 in-patients 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 equitable 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.

1. Program Director

The program director must hold an academic degree and be an appointed faculty member or institutional equivalent with the sponsor.

a. **Responsibilities**

The program director must be responsible for:

1) the structure and daily operation of the program;
2) the organization, administration, periodic review and evaluation, continued development, and effectiveness of program curricula; and
3) ensuring the effectiveness of all clinical affiliates is maintained.

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.

b. Qualifications

The program director must:

1) possess a minimum of a Baccalaureate degree;
2) possess the appropriate credential(s) specific to one or more of the concentration(s) offered;
3) have documented experience in supervision, instruction, evaluation, student guidance and in educational theories and techniques; 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)

Programs must have a faculty member or institutional equivalent designated as the Clinical Coordinator.

The Clinical Coordinator(s) must be an appointed faculty member or institutional equivalent with the sponsor.

a. Responsibilities

The clinical coordinator(s) must:

1) be responsible for coordinating clinical education with didactic education as assigned by the program director;
2) evaluate and ensure the effectiveness of clinical experiences for the concentration(s) students are enrolled in; and

3) provide clinical instruction and document the evaluation and progression of clinical performance leading to clinical competence.

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 documented experience in supervision, instruction, evaluation, student guidance and in educational theories and techniques; and
4) have a minimum of 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 Clinical Coordinator may also serve as the Concentration Coordinator for the concentration(s) for which the Program Director does not possess an appropriate credential.

3. Concentration Coordinator(s)

The Concentration Coordinator(s) must be appointed faculty member or institutional equivalent with the sponsor.

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) for which the Program Director does not possess an appropriate credential.

4. Medical Advisor

a. Responsibilities

The medical advisor must provide guidance that the medical components of the didactic and clinical curriculum meet current acceptable performance standards.

b. Qualifications

The medical advisor must be a licensed physician, certified by the American Board of Medical Specialties (ABMS), with relevant experience and knowledge in diagnostic medical sonography.

The medical advisor should participate in goal determination, curriculum development, and outcomes assessment.

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.

a. Responsibilities

Faculty/Instructional Staff must be responsible for providing instruction, evaluation of students, documentation of progress, and periodic review of course content.

b. Qualifications

Faculty/Instructional Staff must:

1) be qualified by education and experience, and be effective in teaching the subjects assigned; and
2) possess appropriate credential(s) for the learning concentration s/he 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 must ensure the achievement of program goals and learning domains. Instruction must be an appropriate sequence of the classroom, laboratory, and clinical activities. 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.

The program must demonstrate by comparison that the curriculum offered meets or exceeds the content and competencies specified in Appendix B.

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 appropriate change. An action plan must be developed when deficiencies 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 (Outcomes) Evaluation/Assessment

A. Student Evaluation

1. Frequency and purpose

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 and learning domains stated in the curriculum.

2. Documentation

Records of 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 name, credentials, and signature of the supervising sonographer.

B. Outcomes

1. Outcomes Assessment

The program must periodically assess its effectiveness in achieving its stated goals and learning domains. 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/attrition, graduate satisfaction, employer satisfaction, job (positive) placement and programmatic summative measures. The program must meet the outcomes assessment thresholds.

"Positive Placement" means that the graduate is employed full or part-time in the profession or in a related field, or continuing his/her education or serving in the military. A related field is one in which the individual is using cognitive, psychomotor, and affective competencies acquired in the educational program.

"National credentialing examinations" are those accredited by the National Commission for Certifying Agencies (NCCA) or American National Standards Institute (ANSI). Participation and pass rates on national credentialing examination(s) performance may be considered in determining whether or not a program meets the designated threshold, provided the credentialing examination(s), or alternative examination(s) offered by the same credentialing organization, is (are) available to be administered prior to graduation from the program. Results from said alternative examination(s) may be accepted, if designated as equivalent by the organization whose credentialing examination(s) is (are) so accredited.

2. Outcomes Reporting

The program must periodically submit to the JRC-DMS the program goal(s), learning domains, evaluation systems (including type, cut score, and appropriateness), outcomes, its analysis of the outcomes, and an appropriate action plan based on the analysis.

Programs not meeting the established thresholds must begin a dialogue with the JRC-DMS to develop an appropriate plan of action to respond to the identified shortcomings.

V. Fair Practices

A. Publications and Disclosure

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

2. At least the following must be made known to all applicants and students: the sponsor's institutional and programmatic accreditation status as well as the name, mailing address, web site address, and phone number of the accrediting agencies; admissions policies and practices, including technical standards (when used); policies on advanced placement, transfer of credits, and credits for experiential learning; number of credits required for completion of the program; tuition/fees and other costs required to complete the program; policies and processes for withdrawal and for refunds of tuition/fees.

3. At least the following must be made known to all students: academic calendar, student grievance procedure, criteria for successful completion of each segment of the curriculum and graduation, policies for student leave of absence, exposure to bloodborne pathogens, communicable diseases, and pregnancy, and policies and processes by which students may perform clinical work while enrolled in the program.

4. The sponsor must maintain, and make available to the public, current and consistent summary information about student/graduate achievement that includes the results of one or more of the outcomes assessments required in these Standards.

The sponsor should develop a suitable means of communicating to the communities of interest the achievement of students/graduates (e.g. through a website or electronic or printed documents).

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, students, and faculty, and other participants associated with the educational activities of the students must be adequately safeguarded.

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

Diagnostic medical sonography students must be readily identifiable to patients and clinical co-workers as diagnostic medical sonography students.

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.

D. Student Records

Satisfactory records must be maintained for student admission, advisement, counseling, and evaluation. Grades and credits for courses must be recorded on the student transcript and permanently maintained by the sponsor in a safe and accessible location.

E. Substantive Change

The sponsor must report substantive change(s) as described in Appendix A to CAAHEP/JRC-DMS in a timely manner. Other 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
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 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 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.

Demonstration of knowledge may be assessed and documented in a variety of ways. Methods for assessment may include, but 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 its needs and yield the outcomes desired of their graduates.

2. Learning Competencies Common to All Concentrations

a. Demonstrate knowledge and application of ergonomic techniques.

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 knowledge and application of types and methods of infection control.

1) Personal and patient
    a) Standard precautions
    b) Isolation procedures
    c) Aseptic and sterile technique
2) Environment
    a) Equipment
    b) Transducer cleaning and disinfection
    c) Accessories

c. Demonstrate knowledge and application of patient care.

1) Compliance with program and clinical education facility policies and procedures
2) Patient Care Partnership

3) Patient directives
4) Anticipate and be able to respond to the needs of the patient
    a) Demonstrate age-related and cultural competency
    b) Demonstrate appropriate patient care in settings outside of the sonography department.
5) Transport and transfer of patients with support equipment
    a) Oxygen
    b) Intravenous lines/pumps
    c) Urinary catheters
    d) Drainage tubes
6) Vital signs
7) Color
8) Skin integrity
9) Clinical history
10) Proper patient positioning and draping
11) Comfort
12) Privacy
13) IV insertion and injection with use of contrast-enhanced imaging
14) Basic pharmacology as related to the concentration
15) Post interventional procedure care and discharge
16) Life-threatening situations and implement emergency care as permitted by institutional policy, including the following:
    a) Pertinent patient care procedures
    b) Principles of psychological support
    c) Emergency conditions and procedures
    d) First aid and resuscitation techniques
17) Reporting and documentation of incidents and/or adverse reactions

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

e. Demonstrate knowledge of medical ethics and law.
1) Patient's right to privacy based on applicable legal and regulatory standards
2) 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) Informed consent
9) Documentation of clinical incidents
10) Professional scope of practice and clinical standards
11) Professional code of ethics

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

g. Obtain, evaluate, document, and communicate relevant information related to sonographic examinations.
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.

h. Identify and evaluate anatomic structures.

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

i. Demonstrate knowledge of disease processes with application to sonographic and Doppler patterns.

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

j. Demonstrate knowledge and application of image production and optimization.

1) Sound production and propagation
2) Interaction of sound and matter
3) Instrument options and transducer selection
4) Principles of ultrasound instruments and modes of operation
5) Operator control options
6) Physics of Doppler
7) Principles of Doppler techniques
8) Methods of Doppler flow analysis
9) Hemodynamics of blood flow
10) Contrast-enhanced imaging
11) Acoustic artifacts
12) Emerging technologies
13) Image storage devices

k. Demonstrate knowledge and application of biological effects.

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

l. Demonstrate knowledge of a quality control and improvement program.

1) Lab accreditation
2) Credentialing organizations
3) Equipment operation and maintenance
   a) Phantom testing
   b) Records maintenance

m. Demonstrate awareness of resources for professional development.

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

n. Demonstrate achievement of clinical competency through the performance of the requirements to provide quality patient care and optimal examination outcome. Clinical competencies must include evaluation and documentation of:

1) Use of proper ergonomics
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 interpreting physician
9) Finalize examination for permanent storage
10) Process for reporting of 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.**

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
   d) Neonatal/infant head
   e) Neonatal/infant spine
   f) Penis
   g) Prostate
   h) Scrotum
   i) Superficial soft-tissue structures

b. Demonstrate knowledge of the physiology, pathophysiology, sonographic technique, measurements, sonographic appearances, and Doppler patterns, where applicable, in both normal and abnormal structures.

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
   d) Neonatal/infant head
   e) Neonatal/infant spine
   f) Penis
   g) Prostate
   h) Scrotum
   i) Superficial soft-tissue structures

c. Demonstrate knowledge in sonographic guided procedures.

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

d. Evaluate scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses.

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) Role of sonography in patient management

e. Document proficiency in the scanning technique and application for:

1) Abdominal vascular Doppler assessment
   a) Hepatic
   b) Mesenteric
   c) Renal
2) Gastrointestinal tract assessment

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

f. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the abdomen and superficial structures, according to practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of:

1) Identification of anatomical and relational structures
2) Differentiation of normal from pathological/disease process
3) Image optimization techniques in grayscale
4) Image optimization techniques in Doppler (where applicable)
5) Measurement techniques
6) Abdominal competencies
    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
        (9) Sonographic guided procedure (assistance)
7) Superficial Structures
    a) Thyroid
    b) Scrotum

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.

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.

1) Ventricular systolic and diastolic function, including the influence of loading conditions, filling pressures, normal intracardiac pressures, and measurement of cardiac output
2) 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.

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) Cardiac assist devices
14) Intracardiac devices
15) Heart transplant
16) Intracardiac shunt
17) Intracardiac pressures
18) Cardio-oncology
19) Systemic diseases
20) Systemic and pulmonary hypertension
21) Common arrhythmias and conduction abnormalities

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

1) Transthoracic echocardiography
2) Stress echocardiography
3) Transesophageal echocardiography
4) Intraoperative echocardiography
5) Enhanced cardiac ultrasound
6) IV administration techniques
7) Three-dimensional echocardiography
8) Echo-guided procedures
9) Strain echocardiography
10) Speckle tracking
11) Cardiac ultrasound respirogram
12) Pharmacology

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

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

f. Awareness of scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses.

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) Adult interventions

4) Clinical differential diagnosis
5) Role of sonography in patient management
6) Effects of pharmacotherapy on echocardiographic findings

g. Demonstrate proficiency in technique and application of:

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.

h. Demonstrate achievement of clinical competency through the performance of adult cardiac sonography, according to practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of:

1. Identification of anatomical and relational structures
2. Differentiation of normal from pathological/disease process
3. Image optimization and measurement techniques with:
   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

4. Adult cardiac sonography competencies
   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.

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

b. Demonstrate knowledge of physiology and pathophysiology in both normal and abnormal breast structures.

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 the sonographic technique, measurements, sonographic appearances, integration of data, and Doppler patterns in both normal and abnormal breast structures.

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 in interventional and intraoperative procedures.

1) Role of 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. Evaluate scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses.

1) Indications and contraindications
2) History and physical examination
3) Related imaging, laboratory, and functional testing procedures
    a) Correlation with mammography
    b) BIRADS
    c) Correlation with MRI
    d) 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.
1) Medical
2) Surgical
3) Brachytherapy

g. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the breast, according to 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:
1) Identification of anatomical and relational structures
2) Differentiation of normal from pathological/disease process
3) Image optimization techniques in grayscale
4) Image optimization techniques in Doppler (where applicable)
5) Measurement techniques (where applicable)
6) Breast competencies
   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.
1) Bursae
2) Cartilage
3) Fascia
4) Fat pads
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. **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.**
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

d. Demonstrate knowledge of the physiology, pathophysiology, sonographic technique, measurements, sonographic appearances, and Doppler patterns in musculoskeletal injuries and disease processes.

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

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

1) Bone pathology
2) Cartilage
3) Crystal deposits
4) Cystic structures
5) Fluid collections
6) Foreign bodies
7) Hernias
8) Infections
9) Joint effusions
10) Joint laxity/altered function
11) Ligament pathology and tears
12) Masses/neoplastic processes
13) Muscle pathology and tears
14) Neuromas
15) Nerve pathology and entrapment
16) Soft tissue pathology
17) Subcutaneous abnormalities
18) Synovitis
19) Synovial proliferation
20) Tendon pathology, tears, and calcifications
21) Vascular malformations

f. Demonstrate knowledge in sonographic guided procedures

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

g. Evaluate scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses

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, according to practice parameters established by national professional organizations and the protocol of the clinical affiliate. **Clinical competencies must include evaluation and documentation of:**

1. Identification of anatomical and relational structures
2. Differentiation of normal from pathological/disease process
3. Image optimization techniques in grayscale
4. Image optimization techniques in Doppler (where applicable)
5. Dynamic or provocative maneuvers
6. Evaluate bony surface irregularities (where applicable)
    a) Abdominal wall
        (1) Valsalva maneuver to assess for ventral hernia
    b) Shoulder
        (1) Biceps subluxation – Rotate arm in external and internal rotation
        (2) Supraspinatus impingement – Arm abduction
        (3) Acromioclavicular joint – Cross-arm maneuver
        (4) Posterior labrum – Rotate 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 ulnar collateral ligament
    e) Hip, to include groin and pelvis
        (1) Valsalva maneuver when to assess for 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
        (3) Ankle
        (4) Lateral – Peroneal tendon subluxation evaluation during eversion circumduction
        (5) Medial – Dorsiflexion and inversion to check for tibialis posterior tendon instability
        (6) Posterior – Dorsiflexion/plantar flexion to evaluate the Achilles tendon

g) Foot
   (1) Dorsiflex the 2-4 metatarsophalageal joint (MTP) to evaluate tendon movement, the integrity of the plantar plate, and for plantar tears
h) 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.

7. Learning Competencies for the Obstetrics and Gynecology Sonography Concentration

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

1) Pelvic muscles
2) Pelvic vasculature
3) Peritoneal spaces
4) Reproductive organs
5) Suspensory ligaments

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

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) Second- and Third-trimester fetal and maternal structures

a) Intracranial anatomy
b) Face
c) Thoracic cavity
d) Heart
   (1) Position and size
   (2) Four-chamber view
   (3) LVOT and RVOT views
   (4) Three-vessel and three-vessel tracheal views
e) Abdomen and pelvis
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

c. Demonstrate knowledge of pathology, physiology, pathophysiology, sonographic technique, measurements, sonographic appearances, and Doppler patterns in gynecologic disease processes.

1) Inflammatory processes
2) Congenital anomalies
3) Benign uterine/adnexal masses
4) Malignant uterine/adnexal masses
5) Contraceptive devices
6) Infertility procedures
7) Post-partum

d. Demonstrate knowledge of pathology, physiology, pathophysiology, sonographic technique, sonographic appearance, measurements, and Doppler patterns in obstetric abnormalities.

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

e. Demonstrate knowledge and understanding of the role of the sonographer in performing interventional/invasive/advanced procedures.

1) Infertility procedures
2) Amniocentesis
3) Chorionic villus sampling
4) Fetal therapy
5) Nuchal translucency
6) Sonohysterography
7) Three-dimensional obstetric and gynecologic sonography

f. Evaluate scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses.

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

g. 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:

1) Identification of anatomical and related structures
2) Differentiation of normal from pathological/disease process
3) Image optimization techniques in grayscale
4) Image optimization techniques in Doppler and M-mode (where applicable)
5) Knowledge and application of ALARA
6) Measurements as applicable
7) Gynecology competencies
    a) Complete pelvic sonogram
    b) Vagina/cervix/uterus

c) Posterior and anterior cul-de-sac
d) Adnexa, including ovaries and fallopian tubes

8) Obstetrical competencies
   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) 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
      (11) Umbilical cord
      (12) Fetal cardiac activity
      (13) Maternal cervical length
      (14) Maternal adnexa
   c) 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.

8. 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).

1) Embryology and fetal cardiac development
2) Cardiac chambers and septation
3) Valve anatomy and dynamics
4) Coronary artery anatomy
5) Relationships of cardiac chambers and great vessels
6) Mediastinal structures
7) Arch anatomy
8) Pulmonary artery and venous anatomy
9) Systemic venous return

b. Demonstrate knowledge of normal cardiovascular physiology and hemodynamics.

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

1) Congenital heart disease (CHD)
   a) Situs abnormalities
   b) Defects in cardiac septation
   c) Abnormalities in atrial-ventricular connections
   d) Ventricular hypoplasia
   e) Ventricular Inflow anomalies
   f) Abnormalities in ventriculoarterial connection
   g) Ventricular outflow anomalies
   h) Abnormalities within cardiac chambers
   i) Vascular abnormalities
   j) Abnormalities within 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 disease
   e) Cardiac 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.

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

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

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) 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).

1) Relationship of echocardiography to history and physical examination, including indications for echocardiography - diagnostic approach to CHD
2) Acquired heart disease and noncardiac disease and the effects of systemic diseases on cardiovascular anatomy and physiology
3) Differential diagnosis as it relates to the echocardiographic examination
4) Cardiac arrhythmias
5) Genetic syndromes and chromosomal anomalies associated with CHD
6) Cardiovascular surgery and interventional cardiology
7) Post-operative repair evaluation
8) Current trends of caring for the fetus, pediatric and adult patient with CHD

g. Awareness of scanning protocol and modification(s) based on the sonographic findings and the differential diagnoses.

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

h. Demonstrate proficiency in the technique and application of:

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.

i. Demonstrate achievement of clinical competency through the performance of pediatric cardiac sonography according to practice parameters established by national professional organizations and the protocol of the clinical affiliate. Clinical competencies must include evaluation and documentation of:

1) Identification of anatomical and relational structures
2) Differentiation of normal from pathological/disease process
3) Image optimization and measurement techniques with:
    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
4) Pediatric cardiac sonography competencies
    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.

9. Learning Competencies for the Vascular Sonography Concentration

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

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) Cerebrovascular
6) Hepatoportal venous
7) Mesenteric arterial system
8) Peripheral arterial
9) Peripheral venous
10) Renal vessels
11) Vena cava and iliac veins

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

1) Principles of pressure, flow, and resistance
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.

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

21) Vasospastic disorders
22) Venous thromboembolism
23) Venous valvular disorders

d. Demonstrate knowledge of sonographic appearances, sonographic techniques, measurements, and Doppler flow characteristics in both normal and abnormal vascular structures.
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

e. Demonstrate knowledge of physiologic vascular testing principles and techniques.
1) Continuous-wave and pulse Doppler
2) Pressure measurements, including ankle/brachial index
3) Pneumoplethysmography (pulse volume recording)
4) Segmental pressure and waveform analysis
5) Exercise treadmill testing
6) Photoplethysmography (PPG), arterial and venous
7) Air plethysmography, venous
8) Laser Doppler, including skin perfusion pressure measurements

f. Demonstrate knowledge and application in the use of quantitative principles applied to vascular testing.
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 in ultrasound-guided procedures.
1) Role of 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.
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
10) Patch angioplasty
11) Stents
12) Synthetic grafts
13) Thrombolysis and thrombectomy
14) Trans-jugular intrahepatic porto-systemic shunt
15) Vein bypass grafts

i. Evaluate scanning protocol and modification(s) based on patient-specific factors.
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.
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, including test appropriateness, evaluation of the technical quality and compliance with protocols

k. Demonstrate proficiency in the technique of:
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) Vessel mapping
8) Visceral vascular

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

l. Demonstrate achievement of clinical competency through the performance of sonographic examinations of the vascular system according to practice parameters established by national professional organizations and the protocol of the clinical affiliates. Clinical competencies must include evaluation and documentation of:
1) Identification of anatomical and relational structures
2) Differentiation of normal from pathological/disease process
3) Image optimization in grayscale, color Doppler and spectral Doppler
4) Measurement techniques
5) Vascular competencies
   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) Lower extremity venous insufficiency testing
   g) Upper extremity venous duplex

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.