
**AMERICAN SOCIETY OF ECHOCARDIOGRAPHY
POSITION PAPER**

**Guidelines for Cardiac Sonographer
Education: Recommendations of the
American Society of Echocardiography
Sonographer Training and Education
Committee**

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In 1992, the American Society of Echocardiography published a report of the Sonographer Education and Training Committee's recommendations for education of sonographers who perform echocardiographic procedures. Since the publication of the original document, there has been continual progress in technology with the development of more sophisticated diagnostic applications that allow more infor-

mation to be obtained from echocardiographic procedures. These recent changes in the clinical application of echocardiography should be included in all cardiac sonographer education programs. The American Society of Echocardiography, a professional society that currently represents approximately 2500 cardiac sonographers, provides these updated guidelines. (J Am Soc Echocardiogr 2001;14:77-84.)

Echocardiography is recognized as a highly valuable diagnostic modality for the evaluation of cardiac anatomy, function, and hemodynamics. As such, it is the most commonly used imaging procedure for the diagnosis of heart disease. The cardiac sonographer plays an integral role in this diagnostic process, applying independent judgment, problem-solving skills, and the ability to obtain and integrate accurate diagnostic information during the performance of the examination. The operator-dependent nature and complexity of practice dictate that the cardiac sonographer function at a professional level. A detailed description of the profession can be found in the document, "The Scope of Practice for the Diagnostic Ultrasound Professional."¹ The education required to reach a professional level of competence must in-

corporate detailed, structured, and comprehensive curricula. The increasing sophistication of echocardiographic instrumentation, coupled with the complexities of the cardiac evaluation, make on-the-job training as the primary educational pathway inadequate. In the interest of the profession and, ultimately, the patient, we recommend that persons who enter the field of cardiac sonography attend educational programs that are recognized and supported by the American Society of Echocardiography (ASE), such as those accredited by the Commission on Accreditation of Allied Health Programs (CAAHEP),^{2,3} the Joint Review Committee for Cardiovascular Technology (JRC-CVT),⁴ and the Joint Review Committee for Diagnostic Medical Sonography (JRC-DMS),⁵ and earn the appropriate cardiac sonography certificate or degree.

This report serves to update the 1992 document, "Guidelines for Cardiac Sonographer Education: Report of the American Society of Echocardiography Sonographer Education and Training Committee,"⁶ to incorporate new modalities, techniques, and procedures and to explain the manner in which these advancements affect the educational process for the

From the American Society of Echocardiography Sonographer Training and Education Committee.

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cardiac sonographer. Specific goals of this revision include the following:

- Define the role of the cardiac sonographer
- Provide recommendations for educational pathways
- Provide recommendations for on-the-job orientation and continuing education.

Echocardiography includes the following complementary techniques: 2-dimensional echocardiographic imaging, M-mode tracings derived from the 2-dimensional image, continuous wave and pulsed wave Doppler flow velocity recordings, and color flow Doppler imaging. Pharmacologic stress agents and the performance of exercise are additional methods that expand the diagnostic capabilities of echocardiography. The use of contrast agents may be incorporated into any of these imaging modalities. Additional techniques such as transesophageal, intravascular, intracardiac, and intraoperative echocardiography are primarily performed by a trained physician.^{7,8} Despite this fact, it is recommended that the cardiac sonographer have an understanding of these techniques and their diagnostic value for the evaluation of cardiac anatomy, function, and hemodynamics.

THE ROLE OF THE CARDIAC SONOGRAPHER

The cardiac sonographer is an allied health practitioner who, as the result of comprehensive, specialized education in the medical and technical aspects of diagnostic cardiac sonography, is qualified to perform echocardiographic examinations in compliance with protocols and techniques, as outlined in *Essentials and Standards* by the Intersocietal Commission for the Accreditation of Echocardiographic Laboratories.⁹ The primary role of the cardiac sonographer is to obtain diagnostic recordings of cardiac ultrasonography images and Doppler hemodynamic data. The technique is extremely operator-dependant, and its optimal performance requires a highly skilled and well-educated person who can continuously integrate known clinical information, ultrasonographic image content, and related physiologic data to tailor the examination to ensure that it is comprehensive and accurate. Continuous application of the principles of ultrasound physics and instrumentation during the examination is requisite to obtain optimal data. Accordingly, the cardiac sonographer must assume significant responsibility for the examination and therefore must exercise independent judgment, apply knowledge of clinical cardiology, and use prob-

lem-solving skills. The cardiac sonographer must possess sophisticated cognitive skills and be proficient in the use of sonographic techniques to produce accurate and appropriate anatomic and physiologic information for the physician to review for diagnostic interpretation.

The cardiac sonographer is required to have a detailed understanding of cardiac and thoracic anatomy, physiology, hemodynamics, embryology, tomographic anatomy, and pathophysiology. This knowledge base is a prerequisite to the understanding of echocardiographic data and quantitation of derived parameters. The cardiac sonographer must be able to recognize abnormalities, form a preliminary set of differential diagnoses, and extend the scope of the examination to explore these possible pathologic conditions.

The cardiac sonographer should be able to obtain pertinent clinical information from the patient, referring physician, and patient's record, including cardiac-related physical findings and pertinent laboratory data, and to apply the necessary sonographic techniques to obtain comprehensive and diagnostic echocardiographic information. Failure to obtain and integrate such data may lead to an incomplete examination or erroneous clinical interpretation of the echocardiogram—or both. A cardiac sonographer must be skilled in interacting with patients, which involves explaining the procedure to the patient but not discussing the clinical findings of the examination.

The cardiac sonographer must be skilled in selecting relevant echocardiographic data, making quantitative calculations from these data, and communicating his or her impressions to the physician interpreting the study. Although the performance, focusing, and integration of the various components of the echocardiographic examination require the cardiac sonographer to be knowledgeable about cardiac pathophysiology, its sequelae, and the techniques available for evaluating its severity, it is the responsibility of the physician, not of the cardiac sonographer, to provide diagnostic clinical interpretations.

The cardiac sonographer should work under the supervision of physicians trained to a Level 3 status or by Training Level 2 physicians who themselves are under the supervision of a Training Level 3 physician.⁸ The supervising physician should be available for assistance in the performance of the examination when it is technically difficult, confusing, or nondiagnostic or when ancillary techniques or interventions are needed. The cardiac sonographer should participate with the supervising physician in the interpretive review of the examination to provide

input in the evaluation of data and to contribute relevant technical information. This collaborative, cooperative effort is necessary to ensure that the diagnostic information obtained and reported will be as complete as possible. It is also essential for quality assurance, as recommended by the Intersocietal Commission for the Accreditation of Echocardiography Laboratories (ICAEL).⁹

The cardiac sonographer must have a complete understanding of the physical principles of ultrasound, the operation of diagnostic instruments, and the bioeffects of ultrasound. He or she should be responsible for obtaining routine periodic quality assurance and safety checks on the ultrasonography equipment. The sonographer also should be cognizant of patient exposure to ultrasonic energy and its effects on human tissue systems to ensure patient safety without sacrificing examination quality.

The nature of the patient population mandates that the cardiac sonographer be qualified to perform cardiopulmonary resuscitation.

Specialty Practice

Adult transthoracic echocardiography. The cardiac sonographer must have a broad understanding of cardiovascular diseases and noncardiac illnesses that complicate cardiac pathology and pathophysiologic findings in the adult patient population. In addition, a broad understanding of the manifestations of congenital heart disease in the adult population is essential. The ability to adapt the examination to optimize imaging when body habitus and/or immobility present technical limitations is important when performing adult transthoracic echocardiography. The cardiac sonographer must also have an understanding of the expected outcomes and potential complications of surgical and nonsurgical cardiac interventions, know the manner in which each affects the anatomy and physiology, and be able to tailor the examination accordingly.

Pediatric transthoracic echocardiography. Evaluation of the pediatric patient with congenital heart disease requires specialty training in the embryonic development of the heart, lungs, and circulation. Knowledge of the incidence, causes, inheritance patterns, and pathologic consequences of congenital cardiac malformations is also required. Cardiac sonography in the pediatric population requires the ability to evaluate the cardiac status by using a logical and systematic approach to analyze the heart and related structures segmentally. This segmental approach

includes determination of the following anatomic features:

- Thoracoabdominal situs
- Cardiac position
- Atrial situs
- Atrioventricular connection
- Ventricular morphology
- Ventriculoarterial connection
- Great vessel relation.

The pediatric sonographer must also have an understanding of surgical procedures for the repair or partial repair of congenital heart disease and the various modifications encountered for different congenital disorders.¹⁰ Knowledge of the 3 major categories of corrective procedures (total correction, partial correction, and palliation) and the variations encountered is vital when performing pediatric echocardiography. It should be within the skills of all cardiac sonographers to provide appropriate studies to the physician for the diagnosis of simple forms of congenital heart disease, such as atrial and ventricular septal defects. Evaluation of complex forms of congenital heart disease should be performed by a cardiac sonographer with specialty training as a pediatric cardiac sonographer, as described later in this article.

Transesophageal echocardiography. The role of the cardiac sonographer in the performance of the transesophageal echocardiography examination is usually limited to manipulation of the controls on the ultrasonography system. An understanding of the standard views, the order in which they are obtained, and the potential complications of the examination are important aspects of the sonographer's participation in the procedure. The sonographer may be involved in preparing the patient, which involves explaining the procedure, obtaining informed consent, and spraying local anesthesia into the oropharynx to establish topical anesthesia and suppress the gag reflex. Monitoring the hemodynamic status of the patient is required of all personnel involved with the procedure. Knowledge of sterile technique and the surgical environment is required when performing transesophageal echocardiography procedures in the operating room.

Stress echocardiography. Stress echocardiography is one of the more challenging techniques used in cardiac ultrasonography laboratories. The cardiac sonographer should have extensive experience in the evaluation of patients with ischemic heart disease and a thorough understanding of wall motion abnormalities and the corresponding coronary artery perfusion regions. It is essential that the cardiac sonog-

rapher record and capture 2-dimensional views to ensure visualization of left ventricular segments supplied by each of the 3 coronary artery distributions. Doppler echocardiography may be used in selected patients during and/or after stress. The sonographer must be familiar with the use of specialized digital echocardiography equipment necessary to optimally display high-resolution images of the left ventricular endocardial borders. The cardiac sonographer should be adept at using digital image acquisition systems to effectively record representative images during pharmacologic and supine bicycle stress examinations and immediately after stress in treadmill, bicycle, and pharmacologic examinations. Expertise is necessary to acquire high-quality images within 60 to 90 seconds after exercise termination.

Contrast echocardiography. Contrast echocardiography consists of intravenous or intra-arterial injection of sterile microbubble agents to enhance detection of blood flow within or between cardiac chambers or to improve the definition of cardiac target information. The supervising physician and/or the cardiac sonographer determine whether contrast injection is indicated. Because of the ever-evolving advancements in the use of contrast agents in echocardiography, it is increasingly important that sonographers maintain a high level of expertise in contrast administration and imaging techniques. The sonographer will determine which views to image during contrast injection and the timing of the injection for optimal visualization. A thorough understanding of the physical principles of ultrasound is required, including its various effects on microbubbles and the manner in which ultrasonographic control settings can be optimized with regard to attenuation, harmonic imaging, and bubble destruction. Sonographers involved in the establishment of intravenous access and contrast administration should have appropriate training and certification.

RECOMMENDED EDUCATIONAL PATHWAY FOR THE CARDIAC SONOGRAPHER

The education and credentialing of cardiac sonographers are extremely important to the future of the field to ensure the appropriate professional status of competent practitioners and to enhance the standards of practice in echocardiography. These criteria in turn enhance the quality and cost-effectiveness of patient care.

The ASE recognizes that several pathways are

currently being used to educate cardiac sonographers: programs dedicated to cardiac diagnostic ultrasonography, those offering cardiac and general diagnostic ultrasonography, and those focused toward cardiovascular technology. The ASE recommends that institutions with such educational programs provide a standardized curriculum to promote uniform quality for the education of the cardiac sonographer. The curriculum should include comprehensive and rigorous didactic instruction as well as a supervised clinical internship of at least 6 months.

The curricular guidelines below assume successful completion of prerequisites for undertaking sonographer education, including comprehensive college-level courses in the following areas:

- Anatomy and physiology
- Pathophysiology
- Algebra and trigonometry
- Basic sciences (eg, biology, chemistry, and physics, to provide the foundation necessary to understand more advanced concepts).

The student cardiac sonographer should complete an educational program that consists of at least 12 months of full-time echocardiography education. The curriculum should consist of competency-based academic, laboratory, and clinical experience. Hands-on imaging time in the laboratory and clinical setting is essential. An additional 6 months (minimum) of clinical instruction in a primary pediatric setting is recommended for comprehensive training in pediatric echocardiography.

Providing quality education is a complex task. It requires a substantial commitment on the part of those doing the educating to provide the level of rigor and types of educational experiences necessary to ensure competence and a professional level of practice. Although suggested numbers of hours and cases are given in these ASE guidelines, it is important to recognize that several variables are inherent to the education process, including but not limited to the background of the persons being educated, the educators' experience and interests in teaching, and the professional standards practiced by the institution. Many factors contribute significantly to the quality and effectiveness of any program, including the following:

- Qualification and competency admission/acceptance criteria
- Intellectual level of textbooks
- Pedagogic approach (which must include formal exercises to promote critical thinking and integration of materials)

- Formal methods of evaluating student progress, problem-solving ability, and mastery of skills and knowledge
- Focus, content, detail, and rigor of didactic courses
- Emphasis on competence in oral and written communication
- Format of instruction and student accountability for material
- Methods for evaluating the effectiveness of didactic and clinical curricula and competence of graduates
- Formal approach to clinical education: evaluation of students' progress and competence
- Use of formal projects and exercises to reinforce and integrate clinical and didactic material as well as to familiarize students with literature, other resources, and research methods
- Qualifications and competence of participating faculty (clinical sites where training is conducted should have instructors that are credentialed in cardiac sonography).

The overview below serves as a curricular content guideline for the education of the cardiac sonographer. The ASE publication *Educational Outline—Echocardiography and Doppler Echocardiography*¹¹ serves as a comprehensive outline. It is recommended that educators review their own curriculum on an ongoing basis to ensure that it includes the appropriate structures presented in this document.

ASE Recommended Educational Curriculum for Cardiac Sonographers

Given the factors delineated above, the following curricular guidelines are intended to provide general assistance with program designs. A comprehensive, detailed expansion of each of the topics listed below can be found in *Educational Outline—Echocardiography and Doppler Echocardiography*,¹¹ published by the ASE. The entire curriculum must lead to competence in all aspects of cardiac sonography. It should also lead to verification of competence through each student's earning of the appropriate professional-level credential in echocardiography.

Didactic curriculum. This curriculum assumes that college-level prerequisites have been met.

- Cardiac anatomy and physiology
- Physical principles of ultrasound
- Cardiac pathology and pathophysiology
- Medical ethics and legal issues
- Professionalism, health care delivery
- Pharmacology

- Special procedures
 - Cardiopulmonary resuscitation
 - Isolation technique
 - Universal precaution technique
 - Sterile technique
- Basic history-taking and cardiac physical examination
- Electrocardiography interpretation
- Echocardiography modalities: techniques and applications
- Echocardiographic quantitative methods
- Determinants of echocardiographic image quality
- Basic interpretation and understanding of other cardiac diagnostic methods
- Understanding of cardiovascular therapeutic techniques and intervention; echocardiographic evaluation
- Research techniques and statistical analysis
- Continuing professional development.

Clinical internship. The clinical internship portion of the curriculum should be a minimum of 6 months of full-time supervised instruction. During this clinical training portion, the student cardiac sonographer should optimally perform echocardiographic examinations (ie, "hands-on" scanning that incorporates 2-dimensional and M-mode imaging as well as spectral and color flow Doppler recordings), including measurement and preliminary impressions on a minimum of 40 patients per month (2 per day), with an additional 240 echocardiograms (2 per day) observed and reviewed. The optimal clinical internship should extend for 12 months and include examination of a minimum of 480 patients (2 per day, hands-on scanning), with observation and review of an additional 480 echocardiograms (2 per day) with the supervising physician. The student cardiac sonographer should independently perform a minimum of 10 stress echocardiograms as part of his or her clinical internship. These may be performed on other students, on faculty volunteers, or on patients undergoing a stress electrocardiography procedure only, allowing the student to acquire echocardiographic images that are not interpreted as part of the patient record. The cardiac sonographer intern should perform and participate in the interpretation of 50 stress echocardiograms under supervision during the clinical internship.

Recommended Standards for an Echocardiography Training Environment

The ASE Sonographer Education and Training Committee recommends that cardiac sonographer educa-

tion be conducted in an environment in which a broad educational experience can be obtained. Quality education of cardiac sonographers is extremely important to the future of the field because it enhances the standards of practice in echocardiography. The ASE recommends that cardiac sonographer students consider entering programs that have been awarded accreditation by the CAAHEP, JRC-CVT, or JRC-DMS. Although specific guidelines for approval are found in the CAAHEP's standards and guidelines documents,^{2,3} such an environment should optimally contain the following:

- A broad spectrum of cardiovascular medicine to provide the full breadth of cardiovascular diagnostic procedures
- Comprehensive patient evaluation and care
- Exposure to preoperative and postoperative cardiac surgery patients
- A patient population that encompasses the full disease spectrum, from neonatal cardiovascular abnormalities to cardiac abnormalities of the elderly, and includes patients who present with a variety of other medical and pediatric illnesses that may or may not influence cardiovascular dynamics
- A variety of ultrasonographic imaging modalities for use in training, including M-mode, 2-dimensional, Doppler (continuous wave, pulsed wave, color flow, tissue velocity), harmonics, and advanced automated imaging techniques as part of the ultrasonography equipment
- Competent practitioners in echocardiography, including physicians, cardiac sonographers, and specialists in the fields of ultrasound physics and instrumentation, anatomy, physiology, and pathology
- An echocardiography laboratory that performs and interprets a minimum of 100 echocardiograms per month.

The ASE Sonographer Education and Training Committee recommends that the teaching program and the educational environment be evaluated annually to ensure that the established curricula reflect state-of-the-art practice in echocardiography.

RECOMMENDED PRACTICE ORIENTATION FOR THE CARDIAC SONOGRAPHER

The operator-dependent nature of echocardiography dictates that the cardiac sonographer assume significant responsibility for the examination. The newly

graduated cardiac sonographer and the institution that hires the new graduate must be aware of the need for a comprehensive orientation process to familiarize the sonographer with all aspects of the echocardiography laboratory and the institution. The orientation period should last a minimum of 6 months and ideally should consist of 9 months of direct supervision under one or more members of the technical staff and/or the technical director. All clinical studies should be supervised. It is recommended that every echocardiography laboratory have in place clearly defined protocols for every examination type performed.⁹ The newly graduated cardiac sonographer should be proficient at performing all examinations according to the defined protocols. The sophisticated and rapidly evolving nature of technology in echocardiography demands an advanced level of understanding from the cardiac sonographer. Familiarization with all equipment used in the echocardiography laboratory, including emergency equipment, is a vital part of the cardiac sonographer's orientation.

Each echocardiography laboratory and institution should have written policies and procedures for provision of patient care. The cardiac sonographer graduate should also be familiar with all policies and procedures before completing an orientation period. Interaction between the cardiac sonographer and the medical staff/director is another aspect of the echocardiography laboratory that varies from institution to institution. It is important that the roles and responsibilities for communication be clearly defined and understood by the newly employed cardiac sonographer.

Continuing Education

The credentialing and accreditation bodies for the practice of cardiac sonography mandate accumulation of specified credits in continuing education. With additional developments in specialized procedures and technologies, it is recommended that the cardiac sonographer stay current in the field of echocardiography because these and other new procedures become a part of everyday practice. The credentialing organizations for cardiac sonography have established minimum continuing medical education hour requirements to maintain active status. The ICAEL requires that each technical staff member earn 30 hours of echocardiography-related continuing medical education over a 3-year period for the laboratory to be granted and to maintain accreditation.⁹ It is important for individual sonographers to take responsibility for their own education. Institu-

tional or corporate commitments to education only facilitate this individual responsibility.

PERFORMANCE REQUIREMENTS

Physical Demands

The practice of cardiac sonography requires a full range of body motion, including the handling and lifting of patients, manual dexterity, and eye-hand coordination. Performance of echocardiography involves standing, walking, and occasional moving of heavy ultrasonography equipment. Physical positioning of the patient is important in minimizing physical stress on the sonographer and in avoiding musculoskeletal injuries.

Mental Demands

The cardiac sonographer is responsible for solving daily operational problems related to performing echocardiograms, including trouble-shooting equipment malfunctions. The cardiac sonographer must be prepared to recognize any condition, whether observed in the echocardiogram or in patient behavior, that may pose an immediate threat to health or life and must react appropriately. Because of the unpredictable nature of echocardiographic procedures (technical quality, unexpected cardiac findings, etc), the cardiac sonographer must exhibit flexibility, independent judgment, and critical thinking.

CONCLUSION

Cardiac sonography is a challenging and rewarding career that demands individual initiative, clinical judgment, critical thinking, and a commitment to ongoing professional development in the rapidly evolving field of echocardiography. By defining the role of the cardiac sonographer and recommending educational standards, this committee expects that the education and training of persons in this highly specialized medical field will be fostered and improved. The committee recognizes the present and projected clinical need for highly qualified cardiac sonographers and anticipates that the recommendations outlined in this report will provide guidelines to assist in the establishment and maintenance of educational programs for the cardiac sonographer. It is strongly recommended that each sonographer earn the appropriate credentials in echocardiography.

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