

American Society of Echocardiography and Society of Cardiovascular Anesthesiologists Task Force Guidelines for Training in Perioperative Echocardiography

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When expertly used, perioperative echocardiography can lead to improved outcome in patients requiring cardiovascular surgery and in those who suffer from perioperative cardiovascular instability. However, prior publications have not specified the requisite training for perioperative echocardiography. Therefore, the American Society of Echocardiography (ASE) and the Society of Cardiovascular Anesthesiologists (SCA) appointed a joint task force to delineate guidelines for training in perioperative echocardiography, including the prerequisite medical knowledge and training, echocardiographic knowledge and skills, training components and duration, training environment and supervision, and equivalence requirements for postgraduate physicians already in practice. This document is the result of the task force's deliberations and recommendations.

For the purposes of these guidelines, perioperative echocardiography is defined as transesophageal echocardiography (TEE), epicardial echocardiography, or epiaortic ultrasonography performed in surgical patients immediately before, during, or after surgery. Although transthoracic echocardiography may be indicated and is often performed before and after surgery, it is rarely performed during surgery. Thus, these guidelines do not apply to perioperative transthoracic echocardiography, nor do they apply to TEE performed in nonsurgical patients.

RELATED GUIDELINES PREVIOUSLY PUBLISHED

In 1987, the ASE recommended 3 levels of training in echocardiography for physicians.¹ In 1995, the American College of Cardiology task force on Training in Echocardiography reaffirmed these recom-

mendations.² Level 1 requires 3 months of full-time echocardiography training in an approved fellowship and supervised participation in 150 transthoracic studies. This level of training does "not qualify the trainee to perform echocardiography or to interpret echocardiograms independently." Level 2 training requires an additional 3 months of full-time training and an additional 150 supervised studies. This level of training "should provide the knowledge and experience necessary to be capable fully of performing and interpreting an M-mode, 2-dimensional Doppler examination independently under the supervision of a laboratory director." Level 3 requires an additional 6 months of training (for a total of 1 year) and 450 additional examinations (total of 750), including experience in specialized techniques such as TEE. This level of training qualifies the trainee to supervise an echocardiography laboratory and the training of others.

In 1992 the ASE Committee for Physician Training in Echocardiography published its guidelines for training in TEE.³ They are based on the prior recommendations for training in transthoracic echocardiography (see previous discussion) and are directed at training for TEE in both operative and nonoperative applications. These guidelines require the trainee to attain at least level 2 training in echocardiography and also perform and interpret at least 50 supervised TEE examinations.

In 1996 a joint task force of the American Society of Anesthesiologists (ASA) and the SCA published guidelines for perioperative TEE, which defined 2 levels (basic and advanced) of perioperative TEE practice.⁴ Anesthesiologists with basic training in perioperative TEE "should be able to use TEE for indications that lie within the customary practice of anesthesiology" and "must be able to recognize their limitations in this setting and request assistance, in a timely manner, from a physician with advanced training." Anesthesiologists with advanced training in perioperative TEE "should, in addition to the above, be able to exploit the full diagnostic potential of TEE in

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the perioperative period.” Although these guidelines broadly defined the general principles for training in perioperative TEE, including cognitive and technical objectives, they provided no specific requirements.

GENERAL PRINCIPLES

Practitioners from different specialties must attain comparable expertise in perioperative echocardiography. However, they will need different training to attain this goal. Thus, although these recommendations provide specific guidelines for training, they are designed to allow enough flexibility to ensure that individual circumstances are appropriately accommodated. Minimum numbers of cases are delineated; however, these numbers are less important than the depth and diversity of the clinical experience and quality of training. The goal of the training must be to provide exposure to the entire spectrum of perioperative echocardiography that a trainee will likely encounter in subsequent practice. Although these guidelines should serve equally well for adult or pediatric practices, the delineated minimum requirements are not sufficient for training in both disciplines. The trainee who plans to practice both adult and pediatric perioperative echocardiography should complete appropriate curricula in both.

Like prior published guidelines, these guidelines recognize different levels of expertise in echocardiography and make level-specific recommendations for training. Specifically, these guidelines provide training recommendations for a basic level and an advanced level of perioperative echocardiography. Regardless of the level of expertise, all practitioners, even experts, must recognize that timely consultation during perioperative echocardiography may be necessary because of constraints of time or experience. Unlike prior guidelines, these guidelines do not specify the duration of training. Instead, these guidelines emphasize the goals of training and the number and diversity of cases required to meet those goals. The time required for perioperative training will vary markedly depending on the volume and diversity of the affiliated cardiac surgical program.

PREREQUISITE MEDICAL KNOWLEDGE AND TRAINING

Trainees in perioperative echocardiography must be licensed physicians enrolled in, or having completed, an accredited residency.

SCOPE OF ECHOCARDIOGRAPHIC KNOWLEDGE AND SKILLS

The 1996 ASA and SCA guidelines delineated training objectives for cognitive and technical skills for perioperative TEE.⁴ For the current guidelines, these training objectives have been updated and modified to include epicardial echocardiography and epivascular ultrasonography (Table 1). Essentially, basic training in perioperative echocardiography should impart a detailed appreciation of when and how to perform perioperative echocardiography, as well as the underlying principles of ultrasound. In addition to these cognitive skills, a basic practitioner should possess the technical skills to use TEE to recognize markedly abnormal cardiac structure and function, severe hypovolemia, large pericardial effusions, and the presence of intracardiac air. As defined in these guidelines, basic training does not prepare the practitioner to influence the surgical plan without the assistance of a physician with advanced training in perioperative echocardiography. Advanced training in perioperative echocardiography should impart the cognitive and technical skills necessary to use independently the full diagnostic potential of perioperative echocardiography, including the expertise to affect changes in cardiac surgical procedures.

COMPONENTS OF TRAINING

Basic Training

The essential components of basic training include independent work, supervised activities, and assessment programs. Through a structured independent reading and study program, trainees must acquire an understanding of the principles of ultrasound and indications for perioperative echocardiography. This independent work should be supplemented by regularly scheduled didactics such as lectures and seminars designed to reinforce the most important aspects of perioperative echocardiography. Under appropriate supervision (refer to the section on Training Environment and Supervision), the trainee learns to place the TEE probe, operate the ultrasonograph, and perform a TEE examination. Subsequently, some clinical work should be performed with progressively more independence. However, a practitioner with advanced training must review every examination performed by the trainee with him/her. The trainee should be encouraged to master the comprehensive examination defined by the ASE and SCA.^{5,6} Although not all components of this examination are

Table 1 Recommended training objectives for basic and advanced perioperative echocardiography*

Basic training

Cognitive skills

1. Knowledge of the physical principles of echocardiographic image formation and blood velocity measurement
2. Knowledge of the operation of ultrasonographs, including all controls that affect the quality of data displayed
3. Knowledge of the equipment handling, infection control, and electrical safety associated with the techniques of perioperative echocardiography
4. Knowledge of the indications, contraindications, and potential complications for perioperative echocardiography
5. Knowledge of the appropriate alternative diagnostic techniques
6. Knowledge of the normal tomographic anatomy as revealed by perioperative echocardiographic techniques
7. Knowledge of commonly encountered blood flow velocity profiles as measured by Doppler echocardiography
8. Knowledge of the echocardiographic manifestations of native valvular lesions and dysfunction
9. Knowledge of the echocardiographic manifestations of cardiac masses, thrombi, cardiomyopathies, pericardial effusions, and lesions of the great vessels
10. Detailed knowledge of the echocardiographic presentations of myocardial ischemia and infarction
11. Detailed knowledge of the echocardiographic presentations of normal and abnormal ventricular function
12. Detailed knowledge of the echocardiographic presentations of air embolization

Technical skills

1. Ability to operate ultrasonographs including the primary controls affecting the quality of the displayed data
2. Ability to insert a TEE probe safely in the anesthetized, tracheally intubated patient
3. Ability to perform a comprehensive TEE examination and differentiate normal from markedly abnormal cardiac structures and function
4. Ability to recognize marked changes in segmental ventricular contraction indicative of myocardial ischemia or infarction
5. Ability to recognize marked changes in global ventricular filling and ejection
6. Ability to recognize air embolization
7. Ability to recognize gross valvular lesions and dysfunction
8. Ability to recognize large intracardiac masses and thrombi
9. Ability to detect large pericardial effusions
10. Ability to recognize common echocardiographic artifacts
11. Ability to communicate echocardiographic results effectively to healthcare professionals, the medical record, and patients
12. Ability to recognize complications of perioperative echocardiography

Advanced training

Cognitive skills

1. All the cognitive skills defined under basic training
2. Detailed knowledge of the principles and methodologies of qualitative and quantitative echocardiography
3. Detailed knowledge of native and prosthetic valvular function, including valvular lesions and dysfunction
4. Knowledge of congenital heart disease (if congenital practice is planned, then this knowledge must be detailed)
5. Detailed knowledge of all other diseases of the heart and great vessels that is relevant in the perioperative period (if pediatric practice is planned, then this knowledge may be more general than detailed)
6. Detailed knowledge of the techniques, advantages, disadvantages, and potential complications of commonly used cardiac surgical procedures for treatment of acquired and congenital heart disease
7. Detailed knowledge of other diagnostic methods appropriate for correlation with perioperative echocardiography

Technical skills

1. All the technical skills defined under basic training
2. Ability to acquire or direct the acquisition of all necessary echocardiographic data, including epicardial and epiaortic imaging
3. Ability to recognize subtle changes in segmental ventricular contraction indicative of myocardial ischemia or infarction
4. Ability to quantify systolic and diastolic ventricular function and to estimate other relevant hemodynamic parameters
5. Ability to quantify normal and abnormal native and prosthetic valvular function
6. Ability to assess the appropriateness of cardiac surgical plans
7. Ability to identify inadequacies in cardiac surgical interventions and the underlying reasons for the inadequacies
8. Ability to aid in clinical decision making in the operating room

TEE, Transesophageal echocardiography.

*Adapted from Practice guidelines for perioperative transesophageal echocardiography: a report by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography. *Anesthesiology* 1996;84:986-1006.

needed for a basic examination, the basic practitioner should be able to acquire all 20 of the recommended cross sections in the event they are needed for remote consultation with an advanced practitioner. For basic training, the task force recommends study of 150 complete examinations under appropriate supervi-

sion (definition of appropriate supervision is discussed in the next section). These examinations must include the full spectrum of commonly encountered perioperative diagnoses, and at least 50 comprehensive intraoperative TEE examinations personally performed, interpreted, and reported by the trainee (Ta-

Table 2 Numbers of examinations and other key training recommendations for basic and advance perioperative echocardiography

	Basic*	Advanced*
Minimum number of examinations†	150	300
Minimum number personally performed‡	50	150
Program director qualifications	Advanced perioperative echocardiography training	Advanced perioperative echocardiography training plus at least 150 additional perioperative TEE examinations
Program qualifications	Wide variety of perioperative applications of echocardiography	Full spectrum of perioperative applications of echocardiography

TEE, Transesophageal echocardiography.

*Totals for basic training may be counted toward advanced training provided the basic training was completed in an advanced training environment. See text for additional details and explanation of training environments and program director qualifications.

†Complete echocardiographic examinations interpreted and reported by the trainee under appropriate supervision. May include transthoracic studies recorded by qualified individuals other than the trainee.

‡Comprehensive intraoperative TEE examinations personally performed, interpreted, and reported by the trainee under appropriate supervision.^{5,6}

ble 2). The trainee must be taught how to convey and document the results of his/her examination effectively. Periodic formal and informal evaluations of the trainee's progress should be conducted during training. Trainees should keep a log of examinations performed and reviewed to document the depth and breadth of their training.

Advanced Training

For advanced practice, the comprehensiveness of training is paramount. The essential components include independent work, supervised activities, and assessment programs. The task force recommends study of 300 complete examinations under appropriate supervision (discussed in *Training Environment and Supervision*). These examinations must include a wide spectrum of cardiac diagnoses and at least 150 comprehensive intraoperative TEE examinations personally performed, interpreted, and reported by the trainee (Table 2). The trainee must develop the skills to convey and document the results of his/her examinations effectively and independently. Periodic formal and informal evaluations of the trainee's progress should be conducted during the training. The experience and case numbers acquired during basic training may be counted for advanced training, provided the basic training was completed in an advanced training environment (discussed in *Training Environment and Supervision*).

The task force recognizes that trainees from different specialties should use their time in training somewhat differently, depending on their varying backgrounds. A cardiologist with little operating room experience will need to spend more time in this environment than a cardiac anesthesiologist or surgeon to understand fully cardiac surgical techniques. A cardiac anesthesiologist or surgeon working in a center with a limited variety of cardiac surgery will

need to spend more time in the echocardiographic laboratory than a cardiologist to understand fully the diagnostic techniques of echocardiography. Like basic trainees, advanced trainees should keep a log of examinations performed and reviewed to document the depth and breadth of their training.

Comparison with Previously Published Guidelines

Training guidelines in basic and advanced perioperative echocardiography are similar to the training guidelines for level 1 and level 2 in general echocardiography, except that a greater number of personally performed cases (previously discussed) and a specified number of months are required for training in general echocardiography.¹⁻³ The task force believes these differences are justified because the spectrum of cardiac diagnoses is more limited in perioperative echocardiography than in general echocardiography and because the volume and diversity of the supporting surgical program is more crucial for attaining training goals in perioperative echocardiography than the absolute duration of training.

TRAINING ENVIRONMENT AND SUPERVISION

Basic Training

The director of the echocardiographic training program should be a physician with advanced training and demonstrated expertise in perioperative echocardiography or equivalent experience. At the start of training, the trainee must be supervised directly as he/she learns to place the TEE probe, operate the ultrasonograph, and perform a TEE examination. This direct supervision should continue until the trainee can introduce the TEE probe safely and con-

sistently and perform an appropriate examination. The trainee should have access to a wide variety of surgery in which TEE is performed as an integral part of patient management. The perioperative echocardiography training program should have an affiliation with an echocardiography laboratory so that basic trainees can gain regular and frequent exposure to teaching and clinical resources within that laboratory.

Advanced Training

Advanced training should take place in a training program specifically designed to accomplish comprehensive training in perioperative echocardiography. The director of the training program must be a physician with advanced training and demonstrated expertise in perioperative echocardiography who has performed at least 450 complete examinations, including 300 personally performed intraoperative TEE examinations or equivalent experience. If the advanced trainee has not already accomplished basic training, then the same initial direct supervision should be provided for the advanced trainee as outlined previously for the basic trainee. Subsequently, some clinical work may be performed with progressively more independence, but the immediate availability and direct involvement of an advanced practitioner is an essential component of advanced training. The supporting surgical program must have the volume and diversity to ensure that the trainee will experience a wide spectrum of diagnostic challenges encountered in perioperative echocardiography. The task force wishes to emphasize the importance of case diversity by noting that practitioners with advanced training must be able to use TEE effectively in all its established perioperative applications.⁴ The perioperative echocardiography training program should have an affiliation with an echocardiography laboratory so that trainees can gain regular and frequent exposure to teaching and clinical resources within that laboratory.

TRAINING WITHIN SPECIALTY FELLOWSHIP PROGRAMS

Both accredited and nonaccredited fellowship programs may wish to offer training in perioperative echocardiography. This may require revision of their current curricula to accomplish the training goals outlined in this document. Alternatively, the task force recommends the creation of fellowships solely devoted to advanced perioperative echocardiography and offered to graduates of qualifying training programs.

TRAINING EQUIVALENCE FOR SPECIALISTS ALREADY IN PRACTICE

Physicians already in practice can achieve appropriate training in perioperative echocardiography without enrolling in a formal training program. However, the same prerequisite medical knowledge, medical training, and goals for cognitive and technical skills (Table 1) apply to them as apply to physicians in formal training programs. When a physician has already acquired extensive experience in perioperative echocardiography, then this physician should document his/her experience in detail and be able to demonstrate its equivalence in depth, diversity, and case numbers to the training levels delineated previously.

When a physician has no experience in perioperative echocardiography, then he/she should work with another physician who has advanced TEE training or equivalent experience to achieve the same training goals and case numbers as the training levels delineated previously. In addition, the task force recommends that physicians seeking basic training via this pathway should have at least 20 hours of continuing medical education devoted to echocardiography. Physicians seeking advanced training via this pathway should have at least 50 hours of continuing medical education devoted to echocardiography. The continuing medical education should be obtained during the time the physician is acquiring the requisite clinical experience in TEE.

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