

diagnostic cardiac catheterization and angiography shall include documentation (in the form of a logbook*) of the performance of a minimum of 300 procedures, 200 as primary operator (Level 2).

Evaluation of the individual training in catheterization-related interventional procedures shall, in addition, include documentation (in the form of a logbook*) of the performance of a minimum of 300 procedures in angioplasty, 125 with primary responsibilities (Level 3).

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*The logbook should contain clinical information, procedure performed and outcome of procedure, including complications.

Task Force 4: Training in Echocardiography

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Echocardiography is currently the most widely used imaging technique for assessing cardiovascular anatomy and function. Clinical application of ultrasound encompasses M-mode, two-dimensional, pulsed and continuous wave Doppler and color flow imaging. Echocardiography (like invasive catheterization) provides information concerning cardiovascular 1) anatomy, 2) function (i.e., ejection fraction), 3) hemodynamic variables (i.e., gradient, pressure), and 4) flow disturbances by means of pulsed and color flow Doppler imaging. Today an echocardiography laboratory can appropriately be called an ultrasound imaging and hemodynamic laboratory.

Fellowship training in echocardiography should include instruction in the basic aspects of ultrasound, but only those fellows who go beyond the basic level are trained sufficiently for independent interpretation of echocardiographic studies. Every trainee should be educated in the physical

principles and instrumentation of ultrasound and in cardiovascular anatomy, physiology and pathophysiology, both with regard to the cardiovascular system in general and in relation to the echocardiogram in particular. At all levels of training, trainees should be required to perform the echocardiographic and Doppler examination to integrate their understanding of three-dimensional cardiac anatomy. Trainees should be encouraged to correlate the findings from the echocardiographic and Doppler examination with the results of other imaging modalities and physical examination. The trainee should master the relation between the results of the echocardiographic examination and findings of other cardiovascular tests, such as catheterization, angiography and electrophysiology. Exposure to computer sciences and bioengineering may also be beneficial. The trainee should also master the relation between the results of the echocar-

Table 1. Summary of Training Requirements for Echocardiography

	Duration of Training	Cumulative Duration of Training	Minimal Additional No. of Examinations	Cumulative No. of Examinations	TEE and Special Procedures
Level 1	3 mo	3 mo	150*	150	No
Level 2	3 mo	6 mo	150*	300	No
Level 3	6 mo	12 mo	450	750	Yes

*Performance and interpretation of the study. TEE = transesophageal echocardiography.

diographic examination and surgical and medical management of the patient.

Every cardiology fellow should be exposed to and familiar with the technical performance, interpretation, strengths and limitations of two-dimensional echocardiographic/Doppler technology and its multiple clinical applications. It is recognized that ultrasound is an evolving technology in a rapid phase of development and improvement with an expanding list of clinical indications.

For appropriate use of this technology, it is possible to define three levels of expertise (Table 1). All cardiologists must attain at least the *first level* of expertise. This entails understanding the basic principles, indications, applications and technical limitations of echocardiography and the interrelation of this technique with other diagnostic methods. This level will not qualify a trainee to perform echocardiography or to interpret echocardiograms independently. The *second level* of training in echocardiography should provide the knowledge and experience necessary to be fully capable of performing and interpreting an M-mode, two-dimensional and Doppler examination independently under the supervision of a laboratory director. A *third level* of expertise would enable the trainee to direct an echocardiography laboratory, as well as perform various special ultrasound procedures (i.e., transesophageal, stress, intraoperative). Requirements for optimal training for these three levels differ and are addressed separately.

General Standards

Training in echocardiography should be integrated closely with the educational experience in cardiovascular catheterization and intervention, surgery and pathology. The echocardiographic laboratory in which training of cardiology fellows is undertaken should be under the direct supervision of a full-time qualified director (or directors) who has achieved level 3 training (1,2). The training center should be a full-service laboratory providing all modalities of echocardiography, including transthoracic, ambulatory and intraoperative transesophageal echocardiography and stress (exercise or pharmacologic, or both) echocardiography. Echocardiographic/Doppler examination in children or adults with congenital heart disease requires specific training at cardiology centers experienced in the management of these patients. Specific requirements for examination of pediatric patients have been published elsewhere (3-5). Training guidelines in the present document are primarily directed to trainees performing echo-

cardiographic examinations in adult patients with acquired and congenital heart disease. A fully trained (level 3) director of a laboratory should supervise the fellowship training program in echocardiography (1,2). Participation of additional full-time or part-time faculty is highly desirable because of the multiple applications of echocardiography (i.e., transesophageal, stress, contrast, intraoperative, intravascular, congenital).

The echocardiographic examination is an operator-dependent procedure in which it is possible to introduce confounding artifacts or omit data of diagnostic importance. Accordingly, the echocardiographic examination is interactive and requires the instantaneous recognition of normal variants and specific diagnostic findings to obtain an optimal study. Therefore, fellowship training in echocardiography must emphasize the ability to perform a "hands-on" examination with on-line interpretation of results. To help with this training, availability of highly skilled cardiac sonographers with broad experience in the performance of the echocardiographic examination is desirable.

Content of the Training Program

Echocardiography plays an important role in the diagnosis and treatment of a wide variety of acquired and congenital cardiac disorders in a diverse group of patients. Accordingly, it is highly desirable that any laboratory in which cardiology fellows undertake echocardiographic training provide exposure to the entire spectrum of acquired and congenital heart diseases in patients of varying age and gender (6,7). Generally, such a laboratory should conform to continuing quality improvement guidelines (8) and perform at least 2,000 echocardiographic studies/year, to give the fellow an appropriate variety of experience.

Although numbers of studies and time intervals of training are given as guidelines, these numbers are less important than depth of understanding and quality of the clinical experience. The criteria described herein are identical to some (1,2,9) and similar to others (10-12) in previous publications on this topic. If the case mix available for the trainee is skewed, additional numbers of cases beyond the criteria quoted herein may be required to achieve a broad spectrum of experience (13). It is recommended that the fellow keep a logbook documenting his or her involvement in echocardiographic studies.

To provide acceptable fellowship training in echocardiography, a laboratory must provide equipment with the capability for comprehensive transthoracic and transesophageal echocar-

diography, including M-mode and two-dimensional imaging, pulsed and continuous wave Doppler echocardiography and color flow imaging. These capabilities may be contained in a single device or in multiple instruments.

The ability to complete adequate training in echocardiography will be dependent on the background and abilities of the trainee, as well as the effectiveness of the instructor and laboratory. The current trend to introduce the fundamental principles, indications, applications and limitations of echocardiography into the education of medical students and residents is encouraged and will facilitate subsequent mastery of this discipline.

Level 1 training (3 months, 150 examinations). The first (or introductory) level requires 3 months of full-time training, or its equivalent, devoted to an understanding of functional anatomy and physiology in relation to the echocardiographic examination. During this time, the trainee should participate in the performance and interpretation of a minimum of 150 complete (M-mode, two-dimensional and Doppler) ultrasound imaging and Doppler hemodynamic examinations under the supervision of the laboratory director, designated faculty and cardiac sonographers. The level 1 trainee should be able to recognize the common cardiovascular pathologic entities.

Level 2 training (3 months of additional training and 150 additional examinations). During level 2 training, emphasis should be placed on the intensity, quality and completeness of studies; on quantitation in diagnostic studies; and correlation with other diagnostic and clinical results in a broad range of clinical problems. To accomplish this, the fellow should devote an additional 3 months, or the equivalent, of full-time training performing and interpreting a minimum of 150 additional (300 total) complete ultrasound imaging and Doppler hemodynamic examinations. The fellow who has accomplished level 2 training should be able to perform an echocardiographic and Doppler study that is diagnostic, complete and quantitatively accurate. Competence at the second level denotes that the trainee is sufficiently experienced to interpret the echocardiographic examination accurately and independently.

Level 3 training (additional 6 months of training and 450 additional examinations). For a trainee desiring to direct an echocardiographic laboratory (level 3), an additional 6-month period of time (total of 12 months of training) devoted to echocardiography is required. To attain level 3, the trainee should perform or interpret a minimum of 450 additional, complete imaging and hemodynamic studies (a total of 750 studies) in a patient population in which a broad spectrum of adult acquired and congenital heart disease is present. At the discretion of the director, increasing independence in interpretation and overreading of echocardiographic studies should be encouraged. Level 3 training should also include exposure to administrative aspects of running an echocardiographic laboratory and documented experience in echocardiographic research. Initiation of the process of learning special procedures (transesophageal echocardiography) should be undertaken only after completion of *level 2 training*. To complete level 3, the trainee should fulfill all of the previously described require-

ments and be competent in performing and interpreting special procedures, such as transesophageal, stress, and contrast echocardiography.

Ultrasound Special Procedures

Special procedures include (but are not limited to) exercise and pharmacologic stress, ambulatory and intraoperative, transesophageal, epicardial and epivascular, intravascular, intracardiac and contrast echocardiography, echocardiography during interventional procedures (myocardial biopsy, pericardiocentesis, mitral balloon valvulotomy) and transthoracic echocardiography in patients with complex congenital heart disease. Training in these procedures should begin only after attaining or surpassing *level 2 training* (6 months). These examinations require special expertise, involve the management of high risk patients and often entail the performance of invasive ultrasound procedures in ways that cannot readily be repeated if the initial study is not diagnostic. There is a certain procedure-specific learning curve to these advanced studies (14-16), which are best learned under the close supervision of a fully qualified expert in the particular ultrasound application. This may be the echocardiographic laboratory director or another qualified echocardiographic physician who is regularly performing and interpreting the special procedure. The designated physician instructor should perform and interpret a minimal number of this specific procedure per year (8,9). As with any echocardiographic technique, adequate training in special ultrasound procedures is dependent on a full understanding of the principles, indications, applications and technical limitations of these techniques. This can only be obtained by direct participation in a sufficient number of studies using each of these techniques. For transesophageal echocardiography, a consensus of experts has recommended previous level 2 training, 25 supervised esophageal intubations and 50 supervised diagnostic studies before independent performance (9). For exercise and pharmacologic stress echocardiography, participation in a sufficient number (at least 100) of supervised interpretations (beyond level 2) represents a minimal amount of specialized training (14,15). Special procedures for pediatric patients, including but not limited to transesophageal and fetal echocardiography, require different and specific prerequisites (3-5).

Evaluation

Evaluation of competency is an integral and critical part of the education process in echocardiography for a cardiology fellow. Optimal evaluation should be carried out by direct observation of the ability of the trainee to perform and interpret the echocardiographic examination or may take the form of a practical or written examination, or both. It is recommended that such observational evaluation be done on a daily basis by the director of the laboratory or his or her associates and must involve both "hands-on" and reading sessions. Evaluation of the competence of a cardiology fellow

in echocardiography should be the responsibility of the director of the echocardiographic training laboratory and the director of the cardiology training program.

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Task Force 5: Training in Nuclear Cardiology*

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Training in Nuclear Cardiology

Nuclear cardiology methods (Table 1) provide important diagnostic and prognostic information with which all modern cardiologists should be conversant. Training for cardiology fellows should be divided into three levels:†

*The recommendations of this task force were developed jointly with the American Society of Nuclear Cardiology and will be published in the *Journal of Nuclear Cardiology*. These recommendations were approved by the Board of Directors of the Society.

†The issues of ongoing clinical competence and training or retraining of practicing cardiologists are beyond the scope of this document. However, it should be noted that these issues are currently being addressed by the American Society of Nuclear Cardiology (ASNC). For additional information, contact ASNC at 9111 Old Georgetown Road, Bethesda, Maryland 20814.

1. *General training* (2 months) for all cardiology fellows is designed to make the fellow conversant with the field of nuclear cardiology (level 1).
2. *Specialized training* (4 to 6 months) for fellows who wish to have special expertise in clinical nuclear cardiology and practice nuclear cardiology (level 2).
3. *Advanced training* (1 year) for trainees who wish to pursue an academic direction in nuclear cardiology, including patient care, teaching and research (level 3).

Training should include the study of the indications for specific nuclear cardiology tests and proper clinical application of the diagnostic information derived from the appropriate