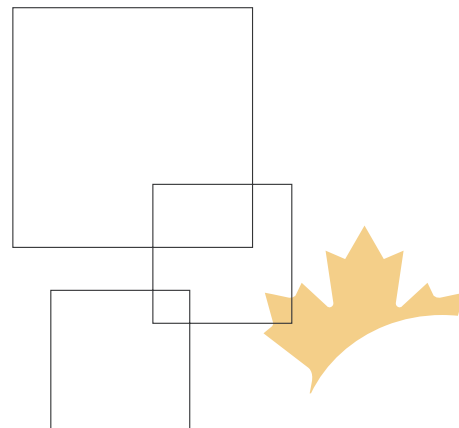


# 2010 CCS/CSE Guidelines

## for Physician Training and Maintenance of Competence in Adult Echocardiography

POSITION STATEMENT AND RECOMMENDATIONS OF THE  
CANADIAN SOCIETY OF ECHOCARDIOGRAPHY CONSENSUS PANEL



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## (I) Introduction

Physicians providing clinical echocardiography come from a diverse background with different clinical experiences. Standards for training in adult echocardiography have previously been written, but require revision to accommodate for differences in clinical experience and the diverse and varying array of responsibilities required of the physician (1-4). A physician's responsibilities may encompass the performance and interpretation of a wide range of echocardiography techniques, supervision of sonographer activity, administration of the procedures or policies of the echocardiography laboratory, and participation in the education of sonographers, medical trainees, or physicians pursuing advanced specialization in echocardiography. While a minority of physicians will be required to function in all of these roles, most physicians will have more limited responsibilities depending on their specific and unique circumstances. Therefore, training requirements should vary depending on the physician's role in the clinical application of echocardiography. Less intense training is needed for physicians who require only a familiarity with echocardiography, while more intense training or a fellowship in echocardiography will be necessary for physicians wishing to independently perform and interpret a comprehensive echocardiography examination, or supervise an echocardiography laboratory involved in the training of advanced echocardiographic techniques to sonographers or medical personnel. In this regard, three primary levels of training and expertise in echocardiography have been defined.

It is important to emphasize that the specific duration of training and case volumes required for each level of expertise, and subsequent maintenance of competence, should be considered *minimal* rather than *optimal* requirements. Individuals participating in specialized training programs may have other educational or clinical obligations (i.e. academic half days, on-call duties, post-call absence) that detract from full time dedicated training in echocardiography. These additional duties may lengthen

the training time requirements in order for the trainee to be exposed to the required depth and breadth of cardiovascular pathology and attain competence.

## (II) Training and Proficiency Levels

### Level I (Proficiency in Focused Limited Transthoracic Echocardiography)

Level I training is an introductory level that provides individuals with an understanding of the role and importance of echocardiography in clinical practice and is recommended for any physician utilizing echocardiography on a routine basis (i.e. physicians involved in a cardiovascular training program, and some critical care, anesthesia and emergency medicine training programs). Level I training should provide limited exposure to the performance and interpretation of transthoracic echocardiography and trainees successfully completing Level I training should be conversant with this imaging modality and its clinical utility. Successful achievement of level I training should impart physicians with a basic knowledge on the physics of ultrasound, indications for transthoracic echocardiography, familiarity with image acquisition (M-mode, two-dimensional, and Doppler modalities), along with recognition of standard two dimensional imaging planes and familiarity with commonly encountered cardiac pathology on transthoracic imaging. The ability to independently perform or interpret a complete or comprehensive transthoracic echocardiogram is *not* a requirement or appropriate for this level of training. However, completion of level I training could allow the physician to perform a limited point-of-care two-dimensional transthoracic examination to recognize a predefined limited list of diagnoses in a hemodynamically unstable patient or emergent situation where access to a comprehensive echocardiographic examination interpreted by a Level 2 or 3 trained physician is unavailable or not possible because the delay would lead to potential undue compromise to the patient (Table I). In this regard, an essential component of level I training is to develop a good understanding of the limitation of a focused

transthoracic examination and recognition of when a comprehensive echocardiogram with interpretation by a level 2 or 3 trained physician is appropriate. (See *Transthoracic Echocardiography – Level 1*).

Successful completion of Level 1 training is insufficient for the unsupervised performance or interpretation of a transesophageal echocardiogram. The primary panel unanimously agrees that the unsupervised performance or interpretation of a transesophageal echocardiogram by a physician with only Level 1 proficiency is inappropriate and should be discouraged.

### **Level 2 (Proficiency in the Independent Practice of Transthoracic Echocardiography)**

Level 2 is defined as an advanced proficiency in echocardiography for physicians with knowledge of clinical cardiology and a demonstrated ability to independently perform and interpret a comprehensive transthoracic echocardiogram. Level 2 training emphasizes an exposure to a diverse array of cardiac pathologies, achievement of an advanced level of proficiency in the performance and interpretation of a complete transthoracic echocardiogram using M-mode, two-dimensional, Doppler blood flow and tissue Doppler imaging modalities, and proficiency in the use of quantitative techniques to evaluate cardiac chamber size, systolic function, diastolic function and cardiac hemodynamics, including techniques to evaluate intracardiac pressures, the severity of a valve stenosis or regurgitation and pulmonary artery pressure (Table 2). Level 2 training should include an exposure to three-dimensional (3D) echocardiography, contrast echocardiography, transesophageal echocardiography and stress echocardiography. However, successful completion of basic Level 2 training does not provide trainees with the competence to independently perform or interpret a transesophageal or stress echocardiogram. Level 2 training with proficiency in the specialized modalities of transesophageal, contrast or stress echocardiography can be obtained if the trainee fulfills the additional training requirements for these techniques. Physicians completing

Level 2 training are expected to have acquired sufficient skills to supervise a sonographer.

A physician who successfully completes a three year Royal College of Physician and Surgeons of Canada certified cardiology-training program that includes a mandatory minimum six months of training in echocardiography is expected to have attained basic Level 2 proficiency in transthoracic echocardiography. Documentation of the achievement of basic Level 2 proficiency is a pre-requisite for participation in the Royal College of Physician and Surgeons of Canada cardiology examinations.

### **Level 3 (Fellowship in Echocardiography, Diplomate in Echocardiography)**

Level 3 training is designed for physicians interested in developing proficiency or expertise in the major modalities of echocardiography (transthoracic, transesophageal and stress echocardiography). Physicians entering an echocardiography fellowship will have already achieved basic Level 2 training. Successful completion of Level 3 training will enable the physician to independently perform and interpret a transthoracic, transesophageal and stress echocardiogram; supervise and train sonographers and physicians in echocardiography; and potentially direct an echocardiography laboratory. Physicians in a level 3 training program should have exposure to intra-operative echocardiography and emerging technologies such as 3D-echocardiography, contrast echocardiography, and strain/strain rate imaging. In addition, Level 3 trainees should be exposed to echocardiography research and the associated methodologies, and participate in educational activities for sonographers and physician trainees, in order to develop the skills needed to pursue a career in academic echocardiography with a potential focus on research or education. A cardiologist successfully completing Level 3 training would be a Diplomate in Echocardiography.

### (III) Entry Criteria to an Echocardiography Training Program

#### Level 1

Physicians entering a Level 1 echocardiography training program are required to have a solid understanding of normal cardiac anatomy and physiology, and the pathologic processes that can result in cardiac disease. Acquisition of this knowledge can be obtained during specialty training in cardiology. Other specialty training programs such as radiology, internal medicine, emergency medicine, critical care, cardiac surgery and anaesthesia may provide adequate exposure to clinical cardiology and cardiovascular imaging to allow entry into Level 1 training in echocardiography. It is recommended that physicians in these programs satisfactorily complete at least two clinical cardiology training blocks (8 weeks; 1 training block = 4 weeks) prior to entry into a Level 1 echocardiography training program. This clinical experience is important to ensure that trainees entering the program have an adequate understanding of the pathologic processes causing cardiovascular disease and an appreciation of the potential role that echocardiography fulfills in the diagnosis, evaluation and management of patients with potential cardiovascular disease.

Physicians currently in practice may enter a Level 1 training program if they have received certification in the specialties outlined above and have demonstrated continued maintenance of competence through the Royal College of Physicians and Surgeons of Canada. These individuals should provide documentation of adequate cardiology or cardiovascular imaging experience within the last year or should complete at least 8 weeks of training in clinical cardiology prior to entering a Level 1 training program.

#### Level 2

Most physicians entering a Level 2 training program in echocardiography will be involved in specialty training in cardiology. However, physicians involved in a non-cardiology specialty training program as outlined in

Level 1 may also pursue Level 2 training provided they satisfactorily complete at least two clinical cardiology training blocks (8 weeks) during their training program.

Physicians currently in practice may enter a Level 2 training program if they have received certification in cardiology or a non-cardiology specialty as outlined in Level 1 and have demonstrated continued maintenance of competence through the Royal College of Physicians and Surgeons of Canada. Non-cardiology specialists should provide documentation of adequate cardiology or cardiovascular imaging experience within the last year or should complete at least 8 weeks of clinical cardiology training.

#### Level 3

Physicians entering a Level 3 program must have successfully completed basic Level 2 training in echocardiography. Physicians who have completed Level 2 training in the past and have met the requirements for maintenance of competence in transthoracic echocardiography in the previous two years require no further training. However, an additional 4 weeks of training in echocardiography (one training block) should be undertaken prior to entering a level 3 training program if the minimal requirements to maintain competence have not been met in the previous two years. Twelve additional weeks of echocardiography training (3 training blocks) and the interpretation of at least 300 transthoracic studies should be undertaken if the minimal requirements to maintain competence have not been met in the previous five years.

### (IV) Components of a Training Program

#### (a) The Echocardiography Laboratory

##### Level 1 and 2 Training

Level 1 and level 2 training in echocardiography should be completed in a University affiliated echocardiography laboratory under the direct supervision of at least one Level 3 expert. The echocardiography laboratory should have state of the art equipment with the capacity

to perform M-mode, two dimensional, and Doppler (blood flow and tissue) transthoracic imaging, as well as experience with transesophageal and contrast echocardiography. The laboratory should perform >3000 transthoracic cases per year to provide trainees with an appropriate clinical volume and adequate exposure to the spectrum of cardiac pathology (4).

The widespread dissemination and use of digital technology in the echocardiography laboratory has facilitated the process of image review, image analysis and reporting. Digital technology also has the potential to significantly enhance physician training by facilitating the creation of disease databases and image libraries for teaching. These databases have the potential to provide trainees with an exposure to both common and rare pathologies, which they might not otherwise encounter during their training experience. Echocardiography laboratories providing Level 1 and Level 2 training should be strongly encouraged to develop a database or image library for teaching purposes.

### **Level 3 Training**

Level 3 training should be completed in a University affiliated echocardiography laboratory with at least two level 3 experts to provide the necessary echocardiographic expertise, clinical volume and exposure to the spectrum of cardiac pathology (4). The equipment outlined for a Level 1 or 2 training program should be available, in addition to machines and equipment that can perform 3D echocardiography and allow off-line analysis.

The laboratories should perform a high volume of transthoracic echocardiograms (>5000 per year), transesophageal echocardiograms (>300 per year) and stress echocardiograms (>200 per year). The laboratory should also be experienced in performing contrast echocardiography for left heart opacification (>50 cases per year). The performance of contrast echocardiography to evaluate myocardial perfusion is not essential unless specialized training in this area is a component of the training program. On-site intra-operative transesophageal echocardiography is preferable, but not a requirement of

a level 3 training program. Similarly, access to intravascular and intracardiac ultrasound is not a requirement of a laboratory providing Level 3 training.

Echocardiography laboratories providing Level 3 training should be strongly encouraged to have a digital database or image library containing both common and rare echocardiographic pathology.

An exposure to research is highly recommended for trainees pursuing level 3 training. Accordingly, level 3 training should be preferably performed in laboratories with an active research program in echocardiography, with suitable mentors and resources to ensure successful completion of a project within the training period.

### **(b) Time Period Requirements to Complete Echocardiography Training**

Level 1 training in echocardiography requires at least one block (4 weeks) of dedicated training in the echocardiography laboratory. A training block should be no less than 4 weeks in duration.

Trainees should ideally fulfill the time requirements for Level 2 training within a 3-year period. In the situation of a 4-year training program (i.e. a cardiology training program that includes a dedicated research year), at least one echocardiography training block (4 weeks) should be performed in the last year of the program. Training blocks should be exclusively dedicated to echocardiography and should be no less than 4 weeks in duration.

Level 3 training should be performed continuously over a period of at least one year that is exclusively dedicated to echocardiography.

### **(c) Documentation of Training**

Trainees should maintain a written or electronic logbook to document the amount of time dedicated to echocardiography training and their specific case volume. The logbook should record a study identifying number, study date, extent of the trainee's involvement

(performance [supervised or unsupervised], interpreted, reported) and the primary pathology on the study. Importantly, studies should only be recorded as “performed” if all of the essential imaging planes were obtained and all clinically relevant or major pathology identified. Partial performance of a study with incomplete image acquisition, as usually occurs during the initial period of training, should not be counted as a “performed” study. Similarly, cursory review of a study should not be recorded as “interpreted”. Studies should only be recorded as “interpreted” in the logbook if all clinically relevant or major pathology has been identified. It is recommended that training laboratories have the sonographer or supervising physician sign off on a trainee’s study if it was satisfactorily performed or interpreted under their supervision.

The supervising Level 3 expert should review the trainee’s logbook to verify that the necessary clinical volumes were attained for the specific training level and that the case exposure encompasses an appropriate spectrum of pathology. The supervising Level 3 expert is responsible for certifying that the trainee has successfully attained the necessary skills required of the training level. A written attestation to that effect should be provided to the trainee by the supervising Level 3 expert or Director of the Echocardiography Laboratory, and to the Postgraduate cardiology Training Program Director in the case of a cardiology resident who successfully completes basic Level 2 training in a cardiology training program.

#### **(d) Trainee Evaluation**

##### **Level 1 and 2 Training**

Trainees should receive informal feedback on a daily basis regarding their technical, interpretive and reporting skills when their study is reviewed. However, more formal verbal or written evaluation of the trainee’s progress should be provided by the supervising Level 3 expert at the mid-point of a training block to allow the trainee to potentially modify or adjust their performance.

In addition, trainees should receive a formal written evaluation from the supervising Level 3 expert at the end of the training block. The evaluation should include a summary of the number of studies performed and interpreted, and provide feedback to the trainee on their technical, interpretive and reporting skills. Input from sonographers involved in the trainee’s “hands-on” performance should be solicited for the evaluation. An examination to objectively evaluate the performance and interpretative skills of a trainee using patients and a selection of cases appropriate for the individual’s level of training is highly recommended to confirm that the necessary skills have been achieved. The mechanism for such an objective evaluation is at the discretion of the individual training program. In the situation where the training occurs within a Royal College of Physician and Surgeons of Canada certified cardiology-training program, review of the processes of evaluation should be part of the formal Royal College training program accreditation. Documentation of successful completion of each training block is critical for the final determination of overall competence. In order to attain Level 2 proficiency, the trainee should successfully complete a minimum of six training blocks (24 weeks) dedicated to echocardiography, perform and interpret the suggested minimum required case volumes, and be certified as having sufficient skills for the independent practice of echocardiography by the local Director of Echocardiography Training, Director of the Echocardiography Laboratory or University Training Program Director (in the case of multi-site training).

##### **Level 3 Training**

Direct observation of the trainee over the extended period of an echocardiography fellowship usually allows for a good appreciation of the trainee’s skills. As with Level 2 training, trainees should receive informal feedback on a daily basis regarding their technical, interpretive and reporting skills. Level 3 trainees should receive formal verbal feedback on their progress from the supervising Level 3 expert at 2-month intervals and a written evaluation at 4-month

intervals. These evaluations should include a summary of the number of studies performed and interpreted, and provide feedback on their trainee's technical, interpretive and reporting skills. The evaluations should also include feedback related to the trainee's supervisory skills within the functions of the echocardiography laboratory, research and educational activities.

Specialty examinations in echocardiography do not currently exist in Canada. However, the National Board of Echocardiography in the United States has created an examination to objectively evaluate the proficiency of individuals in the area of general and intra-operative echocardiography. Trainees completing Level 3 training should be encouraged to take this examination. Fellowship programs should also strongly consider developing a site-specific examination using patients and a selection of cases to objectively evaluate the performance and interpretative skills of their trainees. The supervisor Level 3 expert should certify that the trainee has successfully attained Level 3 proficiency.

## (V) Training Requirements for Proficiency

### (a) Transthoracic Echocardiography

#### Level I

Level I training provides physicians with an introduction to the performance and interpretation of transthoracic echocardiography and the potential utility of transthoracic echocardiography in clinical practice. Trainees should acquire an appreciation and understanding of the diagnostic capability of a comprehensive transthoracic echocardiographic examination. The ability to independently perform or interpret a complete transthoracic echocardiogram is not a requirement or appropriate for this level of training. However, completion of level I training could allow the physician to perform a limited point-of-care focused transthoracic echocardiographic examination to recognize a limited list of potential cardiac diagnoses in a hemodynamically

unstable patient or emergent situation, in which access to a comprehensive echocardiographic examination is not immediately available and a delay would unduly compromise patient safety. Emphasis of training is placed on (1) identifying cardiac chambers, valves, pericardium and aorta using the standard imaging windows (parasternal, apical, subcostal), (2) qualitative evaluation of left ventricular global function (normal, mild or severely depressed) and size, (3) qualitative evaluation of right ventricular global function (normal or moderate/severely depressed) and size, (4) identifying the presence and size of a pericardial effusion, (5) identifying potential severe valvular heart disease including aortic stenosis, mitral stenosis, mitral regurgitation and aortic regurgitation using 2D imaging (heavily calcified aortic or mitral valve; flail mitral leaflet or aortic cusp), (6) evaluating central filling pressures using the inferior vena cava, and (7) identifying the dilated ascending aorta (Table 1). Wall motion assessment is not a component of Level I training due to the limited extent of the echocardiographic training, and the common use of echocardiographic equipment that does not perform as well as the standard equipment used during a comprehensive echocardiographic examination.

Acquisition and retention of the necessary knowledge and skills for Level I proficiency requires a combination of time and exposure to an appropriate case volume. A minimum of one dedicated training block (4 weeks) in the echocardiography laboratory is required to potentially achieve proficiency in performing a focused limited transthoracic examination to diagnose the limited list of conditions outlined above (Table 3), understand the limitations of a focused transthoracic examination and appreciate the superior diagnostic capability of a comprehensive transthoracic examination. Trainees are expected to perform at least 40 limited or focused studies and at least half of these studies should include pathological conditions that the trainee is likely to encounter when performing a focused transthoracic exam (Table 1 and 3) (5). These studies should be performed under the direct supervision of a trained sonographer or Level 3 expert



to verify that the trainee's image acquisition is acceptable and adequately evaluates for potential pathology outlined in Table 1. Direct supervision by a trained sonographer or Level 3 expert is essential to provide immediate feedback to the trainee on image acquisition, thereby enhancing their technical and interpretive skills. In addition, trainees are expected to interpret 90 echocardiograms under the supervision of a Level 3 expert and correctly identify the pathological entities as outlined in Table 1. At least half of the interpreted studies should include common cardiac pathologies that may be encountered during a focused transthoracic exam. Of note, a trainee can receive credit for both a "performed" and "interpreted" study if both aspects of the study have been satisfactorily completed. Access to a digital library that includes case with these cardiac pathologies is highly recommended to supplement training.

It is important to emphasize that physicians successfully completing Level 1 training are not certified to independently perform or interpret a complete transthoracic echocardiogram. Furthermore, physicians with Level 1 training should only perform a focused transthoracic echocardiogram in a hemodynamically unstable patient or emergent situation in which a comprehensive echocardiographic examination by a Level 2 or 3-trained physician is not immediately available and a delay would compromise patient safety. These urgent examinations should be limited to identifying the presence or absence of a pericardial effusion, a qualitative evaluation of left and right ventricular size and function, identifying potentially severe aortic or mitral valve disease, evaluating vena cava diameter and compliance, and identifying a significantly dilated ascending aorta. A focused limited transthoracic exam is not indicated to evaluate the etiology of a murmur found on examination. However, identification of potentially severe valve pathology during the performance of an otherwise indicated focused transthoracic echocardiogram might be advantageous and lead to earlier referral for a comprehensive transthoracic echocardiogram and interpretation by a Level 2 or 3-trained physician. Similarly, the presence or absence of aortic dilation on a focused

transthoracic examination is not sufficiently sensitive or specific to rule in or rule out aortic dissection, although identification of a severely dilated aorta may prompt earlier referral for a definitive image study.

Comprehensive transthoracic echocardiograms interpreted by physicians with at least Level 2 training, rather than focused transthoracic echocardiograms, should be performed in the non-emergent setting, when a patient is hemodynamically stable, and when the patient would potentially benefit from referral for a comprehensive study. Patients with known cardiac disease or post cardiac surgery can be extremely challenging to evaluate with a limited focused transthoracic exam and these patients should be referred, if possible, for a comprehensive echocardiogram with interpretation by a Level 2 or 3-trained physician. Patients identified with cardiac disease on a focused transthoracic examination or with a history of cardiac pathology should undergo a comprehensive echocardiographic examination as soon as feasibly possible to better and more fully evaluate their cardiac condition. The use of echocardiography to guide a pericardiocentesis procedure should only be performed by a Level 1 trained physician during a cardiac arrest, hemodynamically unstable patient or emergent situation in which a Level 2 or 3-trained physician is not immediately available and delay would compromise patient safety.

An essential component of Level 1 training is for the physician to develop an appreciation of the limited nature and scope of their training and the focused transthoracic examination. In this regard, trainees should understand that their clinical evaluation should supersede their echocardiographic interpretation when the two evaluations are contradictory.

## **Level 2**

Level 2 training in transthoracic echocardiography imparts physicians with a better understanding of the clinical application of echocardiography in patient management; a proficiency to independently perform, interpret and

report a complete echocardiographic examination using M-mode, two-dimensional, Doppler blood flow and tissue Doppler imaging modalities; and a proficiency in the use of quantitative echocardiography techniques to diagnose the presence and severity of cardiac disease, including measures to evaluate cardiac chamber size and volume, systolic function, diastolic function, the etiology and severity of a valve stenosis or regurgitation, intracardiac hemodynamics, pulmonary artery pressure, intracardiac shunts and pericardial disease (Table 2). Trainees should be exposed to contrast echocardiography using transthoracic imaging during Level 2 training to develop an understanding of the potential clinical utility of this modality (see *contrast echocardiography*).

A minimum of six training blocks (24 weeks) dedicated to echocardiography with active participation in the day-to-day activities of the echocardiography laboratory are required to achieve Level 2 expertise. A hands-on approach to image acquisition and analyses are essential to develop an understanding of the strengths and limitations of transthoracic echocardiography and the quantitative techniques employed. Thus, trainees are expected to perform at least 150 complete transthoracic studies (not focused or limited studies) (Table 3). At least half of these studies should be performed under direct supervision of a trained sonographer to verify that the trainee's image acquisition is acceptable and significant pathology has been appropriately imaged. Direct supervision by the sonographer will provide the trainee with feedback on their image acquisition, facilitate the appreciation of suboptimal images, and enhance the trainee's interpretive skills through the recognition of reliable and unreliable echocardiographic data. Studies should only be recorded as "performed" by a trainee if all essential images were obtained and all clinically relevant or major pathology identified. Partial performance of a study with incomplete image acquisition, as usually occurs during the initial period of training, should not be counted as "performed". In general, performance of a complete transthoracic study will be unlikely to occur during the first month of training.

In addition, trainees are expected to interpret a minimum of 450 complete transthoracic echocardiograms under the supervision of a Level 3 expert (Table 3). A transthoracic echocardiogram performed by the trainee may be included in these numbers if the trainee has satisfactorily interpreted the study. It is essential that the trainee be exposed to cases that encompass the spectrum of common and uncommon cardiac pathologies so that the trainee develops an appreciation of unusual cardiac conditions that may be encountered during independent practice. At least half of the cases scanned and interpreted should include significant cardiac pathology.

A trainee's echocardiographic experience during an echocardiography rotation within the current framework of a Canadian cardiology subspecialty-training program is often diluted by other academic, clinical and on call obligations. These other obligations may impact on the duration of required training and mandate a lengthening of the time requirements in order for the trainee to attain the necessary case volume and breadth of disease.

Participation in the day-to-day activity of the echocardiography laboratory cannot be overstated as a requirement of Level 2 training. Trainees should develop the essential skills for the independent practice of echocardiography related to interacting with sonographers, referring physicians and the management of abnormal findings of varying acuity on the echocardiographic examination.

### **Level 3**

Level 3 training in transthoracic echocardiography should provide physicians with an extensive exposure to common and uncommon cardiac pathologies, superior proficiency in the performance and interpretation of transthoracic echocardiography, and an understanding and exposure to emerging transthoracic technologies including 3D echocardiography, contrast echocardiography, and strain/strain rate imaging for identifying the presence and severity of cardiac disease (see *contrast echocardiography and 3D echocardiography*).

Level 3 training requires a minimum of twelve months (13 training blocks) dedicated to a University affiliated echocardiography laboratory with >5000 cases per year and at least two Level 3 trained physicians to provide the appropriate exposure to cardiac pathology and physician expertise. Trainees entering a Level 3 training program should have already achieved Level 2 proficiency in transthoracic echocardiography and satisfactorily performed and interpreted at least 150 and 450 transthoracic echocardiograms, respectively. Achievement of Level 3 proficiency requires the performance of at least 150 additional complete transthoracic echocardiograms (cumulative total of 300 transthoracic studies) and the interpretation of at least 550 additional studies (cumulative total of 1000 studies) (Table 3). These studies should encompass the spectrum of cardiac disease including acquired conditions and adult congenital heart disease. As with Level 2 training, at least half of these studies should include significant pathology. It is expected that studies performed and interpreted by the Level 3 trainee will utilize quantitative techniques to develop a full appreciation and expertise in the utility and limitations of echocardiographic techniques. Trainees should be exposed to emerging technologies such as strain/strain rate imaging, 3D-transthoracic echocardiography and contrast echocardiography during the performance and interpretation of their studies (see *contrast echocardiography and 3D echocardiography*). It is expected that trainees completing Level 3 training will have a good understanding of the principles of these techniques, potential clinical utility and limitations.

Level 3 trainees should participate in the daily activity of the echocardiography laboratory to develop the necessary skills to independently practice echocardiography and supervise an echocardiography laboratory. Trainees should function as a consultant or reference source for sonographers and review transthoracic studies in which concerns exist, assist with additional image acquisition when necessary, or advising on additional image acquisition or quantitative analysis that may be clinically important. Trainees should also function as a consultant for referring physicians and participate in the management of patients

identified with abnormal echocardiographic findings of varying acuity.

### **(b) Transesophageal Echocardiography**

#### **Level 1**

Performance and interpretation of a transesophageal echocardiogram is not a requirement, expectation or component of Level 1 training. Unsupervised performance or interpretation of a transesophageal echocardiogram by a physician who has only achieved Level 1 proficiency is inappropriate and should be discouraged.

#### **Level 2**

The independent performance and interpretation of a transesophageal echocardiogram is not a requirement or objective of basic Level 2 training. However, physicians pursuing Level 2 training in transthoracic echocardiography may wish to obtain specialized training in transesophageal echocardiography such that they can independently perform and interpret these studies.

Level 2 proficiency in transesophageal echocardiography requires an understanding of the indications, contraindications, clinical utility and complications of transesophageal echocardiography. Trainees should acquire the knowledge and skills necessary to perform conscious sedation, know how to appropriately monitor these patients and understand the potential complications and appropriate management of these complications. Performance of transesophageal echocardiography requires the ability to intubate the esophagus, obtain appropriate echocardiographic images and correctly interpret the findings (1, 6). Trainees are required to perform and interpret at least 100 transesophageal echocardiograms under the supervision of a Level 3 expert (Table 3). Cases should include a variety of pathologies including mitral and aortic valve disease, evaluation of a prosthetic valve, endocarditis, evaluation for a potential cardioembolic source including an atrial septal defect, patent foramen ovale or left atrial appendage thrombus, congenital abnormalities and diseases of the aorta. Transesophageal

echocardiography is frequently required in critically ill intensive care patients, in whom esophageal intubations can be challenging, and it is recommended that at least 5 studies be performed in intubated and ventilated patients.

It is anticipated that the length of basic Level 2 training in transthoracic echocardiography may need to be extended beyond the minimum 6 training blocks (24 weeks) required in order to meet the additional training requirements for proficiency in transesophageal echocardiography.

### **Level 3**

Physicians completing Level 3 training are expected to be both proficient and experts in transesophageal echocardiography as they will likely function as a reference source for other physicians performing echocardiography. Level 3 trainees should have a thorough understanding of the indications, contraindications, clinical utility, complications and management of potential complications related to transesophageal echocardiography as outlined for Level 2 training with proficiency in transesophageal echocardiography (1, 6). Furthermore, it is essential that a Level 3 expert have extensive experience in performing transesophageal echocardiography with exposure to a large volume of cardiovascular pathology. A minimum of 150 studies should be performed and interpreted to obtain the necessary experience required to identify cardiac pathology and differentiate normal anatomic variants (Table 3). This experience should not be focused on one disease entity (i.e. potential cardioembolic source), but include an exposure to the spectrum of cardiac and aortic diseases. As with Level 2 training with additional proficiency in transesophageal echocardiography, it is recommended that at least 5 studies be performed in intubated and ventilated patients.

Intraoperative transesophageal echocardiography is a specialized technique, requiring an understanding of intraoperative hemodynamics, surgical procedures and potential complications of cardiac and aortic surgery. These studies need to be performed and interpreted in a timely manner and the interpretation and decisions can

have immediate and profound implications on the patient. Canadian and American guidelines for the performance of intraoperative transesophageal echocardiography have been published and additional studies will be required in the intra-operative setting if a trainee wishes to be proficient in intra-operative transesophageal echocardiography (7-9).

### **(c) Stress Echocardiography**

#### **Level 1**

The performance and interpretation of a stress echocardiogram is not a requirement, expectation or component of Level 1 training and is inappropriate with this level of training.

#### **Level 2**

The ability to perform or interpret a stress echocardiogram is not a requirement for basic Level 2 training in transthoracic echocardiography. However, trainees may wish to obtain Level 2 training with additional specialized training in stress echocardiography such that they may independently perform or interpret these studies.

Proficiency in stress echocardiography requires that a physician understand the clinical utility of stress echocardiography, various stress modalities (treadmill exercise, semi-supine or supine bicycle exercise, or pharmacologic stress), indications and contraindications of each modality, and potential complications (10-11). In addition, physicians need to have knowledge on the appropriate monitoring of patients during the study and the management of potential complications that may occur. Interpreting wall motion and thickening can be more challenging during stress where walls may be less optimally imaged. To achieve Level 2 competence with proficiency in stress echocardiography, trainees are required to interpret at least 100 stress echocardiograms under supervision of a Level 3 expert (Table 3).

It is anticipated that the length of basic level 2 training in transthoracic echocardiography will need to be extended beyond the minimum 6 training blocks (24 weeks) required in order to meet the additional training requirements for proficiency in stress echocardiography.

### **Level 3**

Physicians completing Level 3 training are expected to have achieved an expertise in stress echocardiography. In this regard, trainees are required to interpret at least 125 stress echocardiograms under supervision of a Level 3 expert (Table 3). Importantly, trainees should be exposed to both exercise and pharmacologic stress testing and no less than 20 studies should be interpreted using either modality. The case exposure should include the spectrum of potential cardiac indications, including the identification of myocardial ischemia, viability testing, detection of intracardiac gradients or pulmonary artery hypertension, and the evaluation of valvular heart disease. Trainees should be thoroughly aware of the indications, contraindications, procedural monitoring and various stress protocols that can be employed to evaluate patients depending on their specific disease process. In addition, Level 3 trainees should understand the physics of contrast echocardiography and have been exposure to the use of contrast agents for the purpose of improving left ventricular opacification during stress echocardiography. The evaluation of myocardial perfusion during stress echocardiography using contrast echocardiography is an evolving field. Physicians successfully completing Level 3 training should understand how contrast echocardiography might potentially be used to evaluate myocardial perfusion.

#### **(d) Contrast Echocardiography**

### **Level 1**

The performance or interpretation of a contrast echocardiogram is not a requirement, expectation or component of Level 1 training and is inappropriate with this level of training.

### **Level 2**

Contrast echocardiography is an accepted technique to detect intracardiac shunts, enhance Doppler velocity signals and improve both right and left-sided chamber opacification (12, 13). The use of contrast echocardiography to evaluate myocardial perfusion is an active area of research and the potential clinical application needs to be elucidated.

Physicians achieving basic level 2 proficiency in transthoracic echocardiography should have an understanding of the application of agitated saline contrast injections to detect right to left shunts and enhance right-sided Doppler velocity signals. Trainees completing basic Level 2 training are also expected to be able to independently perform and interpret an agitated saline contrast injection for these indications. In this regard, trainees successfully completing basic Level 2 training in transthoracic echocardiography should have performed and interpreted at least 10 agitated saline contrast injections.

Trainees should also have acquired a basic knowledge of contrast echocardiography related to the use of non-agitated saline contrast agents to improve left heart opacification and identify left heart pathology. This knowledge should include an understanding of the basic physics and principles by which contrast echocardiography enhances left heart opacification and the potential indications and contraindications of non-saline contrast agents. Physicians successfully completing basic Level 2 training in transthoracic echocardiography should have been exposed to at least 5 contrast studies performed for the purpose of improving left heart opacification or identifying left heart pathology. However while contrast echocardiography can enhance the contemporary performance and interpretation of transthoracic echocardiography and is strongly encouraged, independent performance and interpretation of a contrast echocardiogram for left heart opacification or myocardial perfusion is not a requirement for basic Level 2 proficiency in transthoracic echocardiography.

Level 2 trainees in transthoracic echocardiography may wish to acquire additional expertise for the independent performance and interpretation of a contrast echocardiogram using non-saline contrast agents to enhance left heart opacification or identify left heart pathology. This skill requires advanced knowledge related to available contrast agents, indications and contraindications of contrast agents, administration protocols, instrument settings to obtain optimal image quality, and potential complications of contrast agents. Individuals wishing to obtain Level 2 training with proficiency in contrast echocardiography should perform and interpret at least 20 contrast studies under the supervision of a Level 3 expert (Table 3).

The length of basic level 2 training in transthoracic echocardiography may need to be extended beyond the minimum 6 training blocks (24 weeks) required in order to meet the additional training requirements for proficiency in contrast echocardiography.

### **Level 3**

Physicians completing Level 3 training should have a thorough understanding of contrast echocardiography for improving left heart opacification and identifying left heart pathology. This knowledge should encompass an understanding of the physics of contrast echocardiography, indications and contraindications of contrast agents, available contrast agents, optimal instrument settings, administration protocols, and the potential complications of a contrast echocardiogram (12, 13). Level 3 trainees should perform at least 20 non-saline contrast studies and interpret at least 40 contrast studies performed for left heart chamber opacification or evaluation of left heart pathology (Table 3).

The role of contrast echocardiography to evaluate myocardial perfusion is evolving (13). Trainees achieving Level 3 expertise or a Diplomate in Echocardiography should have acquired an understanding of the methodologies to assess myocardial perfusion; however they are not required to have achieved the skills to independently perform or interpret a contrast

echocardiogram to evaluate myocardial perfusion. Individuals wishing to acquire this expertise should obtain additional training at a high volume center with a special expertise in the use of contrast echocardiography for evaluating myocardial perfusion.

### **(e) Three-dimensional Echocardiography**

#### **Level 1**

Training in 3D-echocardiography is not a component of level 1 training and trainees are not expected to perform or interpret a 3D-echocardiogram. Independent performance and interpretation of a 3D-echocardiogram is inappropriate with this level of training

#### **Level 2**

Three-dimensional echocardiography is an evolving modality that is available with both transthoracic and transesophageal platforms and may add incremental clinically relevant information to a standard transthoracic or transesophageal study. However, it is a technically demanding technique that usually requires post acquisition processing. Trainees pursuing Level 2 training should receive exposure to 3D-echocardiography, but are not required to independently perform or interpret a 3D-echocardiogram.

#### **Level 3**

Ideally, Level 3 trainees should be exposed to 3D-technology and data sets acquired using transthoracic and transesophageal platforms. To obtain proficiency in 3D echocardiography, trainees should acquire the skills to perform, manipulate and interpret a 3D image data set. At least 25 transthoracic or 25 transesophageal 3D data sets should be acquired, manipulated and interpreted to develop proficiency in this modality. These cases should include a spectrum of pathology including native valve disease, prosthetic valves, congenital abnormalities and an evaluation of ventricular function. Proficiency in 3D-echocardiography is not a requirement of Level 3 training or a Diplomate in Echocardiography.

## **(f) Intravascular and Intracardiac Ultrasound**

### **Level 1**

Trainees with this level of expertise are not expected to perform or interpret an intravascular or intracardiac ultrasound.

### **Level 2**

Trainees with this level of expertise are not expected to perform or interpret an intravascular or intracardiac ultrasound.

### **Level 3**

Intravascular and intracardiac ultrasound are specialized techniques performed in the setting of an interventional laboratory such as the cardiac catheterization or electrophysiology laboratory. Exposure to these specialized procedures may be beneficial to a Level 3 trainee, but are not a mandatory requirement. Individuals wishing to acquire this expertise should obtain additional training at a high volume center with a special expertise in these techniques. Proficiency in intravascular or intracardiac echocardiography is not a mandatory requirement for successful completion of Level 3 training or a Diplomate in Echocardiography.

## **(VI) Maintenance of Competence**

The achievement of proficiency in echocardiography is initially dependent on a trainee receiving sufficient exposure to clinical volume and pathology under direct supervision of a Level 3 expert. However, as important is the maintenance of proficiency, which requires a continued exposure to adequate clinical volume, a variety of cardiac pathology and continuing medical education to keep the physician abreast of technological developments and advancements in the use of echocardiographic techniques to improve patient care.

## **(a) Continuing Medical Education**

Physicians independently performing or interpreting echocardiograms should attend at least 12 hours of accredited continuing medical education or an accredited self-assessment program (Section 1 or 3) every 2 years directly related to the technology or application of echocardiography (14). The Canadian Society of Echocardiography and American Society of Echocardiography have annual meetings dedicated to continuing education in the application of echocardiography. Educational sessions related to echocardiography are also available at national and international cardiology scientific sessions (Canadian Cardiovascular Congress, American Heart Association, American College of Cardiology, European Society of Cardiology). In addition, physicians should participate in at least 12 hours of non-accredited continuing medical education related to echocardiography every year which may include preceptorships in a University affiliated laboratory, web-based formats, instructional videos or review of journal articles (Section 2, 4 or 5) (14).

Physicians exclusively performing limited focused transthoracic echocardiography should attend at least 8 hours every 2 years of either accredited continuing medical education programs (Section 1) or accredited self-assessment programs (Section 3) related to the technology or application of echocardiography, or attend an equivalent time at a University affiliated echocardiography laboratory involved in teaching echocardiography. In addition, physicians should participate in at least 8 hours of non-accredited continuing medical education (Section 2 or 4) or a personal practice review (Section 5) directly related to echocardiography every year. This requirement is independent of the previously attained level of echocardiography training (Level 1, 2 or 3).

### **(b) Procedural Volumes (Table 4)**

Transthoracic Echocardiography:  
Interpretation of at least 400 studies per year.

Transesophageal Echocardiography:  
Performance and interpretation of at least 25 studies per year.

Stress Echocardiography:  
Interpretation of at least 75 studies per year.

Contrast Echocardiography:  
Interpretation of at least 10 studies per year performed for left heart opacification or left heart pathology.

Three-dimensional Echocardiography:  
Interpretation of at least 20 studies per year.

Focused Limited Transthoracic Echocardiography:  
Performance and interpretation of at least 40 studies per year.

Maintenance of competence in transesophageal echocardiography and focused transthoracic echocardiography requires both the interpretation and performance of a minimum number of studies. Physicians involved in the supervision of trainees will likely have a large role in the performance of the study early in the trainee's experience, but a much limited role as the trainee's skills develop. These latter studies, in which the supervising physician has a minimal role in the study performance, should not be included in the supervising physician's clinical volume requirements for maintenance of competence.

### **(c) Quality Assurance**

Physicians involved in the independent performance or interpretation of echocardiography, including limited focused transthoracic echocardiography, should have a defined mechanism or program for quality assurance to evaluate their technical and interpretive competence (15). This can be achieved in part by accreditation of the

echocardiography laboratory through the Intersocietal Commission for the Accreditation of Echocardiography Laboratories (ICAEL) or an equivalent body. However, this may not be feasible in all laboratories and alternative processes that provide feedback to the physician are acceptable. Quality assurance programs could consist of peer-review of a sample of performed and interpreted echocardiograms, or correlation of the echocardiographic findings with other imaging modalities, surgical, pathological or autopsy findings.

Physicians performing limited focused transthoracic echocardiography should develop a quality assurance program that includes review of a sample of performed and interpreted studies by a Level 3 expert, or a formal mechanism to correlate the results of the limited focused transthoracic echocardiogram with subsequent comprehensive transthoracic echocardiograms, transesophageal echocardiograms, computed tomography, magnetic resonance imaging, or pathology results.

### **(d) Guidelines for Re-Training Physicians with an Interruption of Active Practice in Echocardiography**

Physicians who have not met the minimum requirements for maintenance of competency in echocardiography in the preceding two years should undertake an additional 4 weeks of dedicated training in echocardiography and perform/interpret the number of cases required to achieve the minimum annual procedural volumes. If maintenance of competence in transthoracic echocardiography has not been achieved in the past five years, twelve additional weeks of echocardiography training (3 training blocks) should be undertaken and include the interpretation of at least 450 transthoracic studies. Additional training consisting of the interpretation of at least 100 stress echocardiograms, or the performance and interpretation of at least 100 transesophageal echocardiograms, should be undertaken if maintenance of competence has not been achieved in these modalities in the past five years.



## **(VII) Additional Issues**

### **(a) Multi-modality Imaging Fellowships**

Training requirements in echocardiography have traditionally been based on the assumption that the physician is exclusively training in echocardiography. However, there has been a developing trend for physicians to desire advanced training in another non-invasive imaging modality such as nuclear cardiology, cardiac magnetic resonance imaging and/or cardiac computed tomography, in addition to echocardiography. Simple addition of the training requirements for each subspecialty can lead to a prolonged training fellowship, which may not be entirely necessary due to an overlap between the anatomic, physiologic and technologic concepts of echocardiography and other imaging modalities (16). However, echocardiography is a highly operator dependent technique that requires extensive hands-on skills to obtain high quality, accurate and reproducible information. Thus, the requirement and necessity to devote adequate time to the performance and interpretation of echocardiography cannot be overstated. In recognition of the presence of overlapping concepts between non-invasive specialties, physicians pursuing multi-imaging modality fellowships that will achieve level 3 training in another non-invasive imaging specialty may only require an additional 9 training blocks (36 weeks) of echocardiography training beyond Level 2 requirements to achieve Level 3 proficiency. However, these 36 weeks should be dedicated exclusively to echocardiography. It is recommended that the training periods be no less than 3 training blocks (12 weeks) in duration during the multi-modality imaging fellowship period. The Level 3 requirements related to the number of studies performed and interpreted are the same as required for a stand-alone echocardiography fellowship.

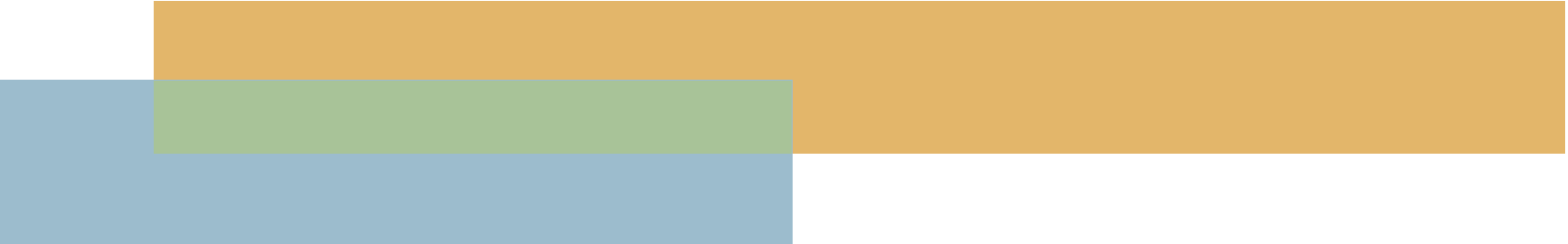
### **(b) Hand-Held Echocardiography**

Miniaturization of echocardiography technology has allowed physicians from a variety of non-cardiology specialties access to inexpensive, portable echocardiography machines. These hand-held portable devices have been used in the emergency department,

intensive care unit and patient wards as an adjunct to the physical exam in an attempt to improve point-of-care diagnosis and guide therapeutic interventions. In contrast to comprehensive echocardiographic examinations, these studies are often focused limited examinations performed to rapidly diagnose important acute life-threatening conditions and assist with emergency management. Despite the limited nature of these examinations, physicians performing these studies need (1) an understanding of ultrasound physics, (2) knowledge of the appropriate indications for a limited study, (3) an understanding of the pitfalls of a limited focused transthoracic echocardiogram, (4) the potential diagnostic capability of a comprehensive transthoracic echocardiogram, and (5) competence in both acquiring and interpreting transthoracic images. At this time, it is recommended that the use of hand-held echocardiographic machines by individuals without Level 2 or 3 training be restricted to the emergent setting in which the patient is hemodynamically unstable, a comprehensive echocardiogram with interpretation by a Level 2 or 3 trained physician is unavailable, and delay would unduly compromise patient safety. Thus, it is essential that hands-on training and exposure to an appropriate variety of expected pathologies as described for Level 1 proficiency in transthoracic echocardiography be attained prior to the use of this technology. The committee recognizes that the use of hand held ultrasound/echocardiography represents a moving target. Further studies are required to determine if earlier introduction of this technology (e.g. medical school level) with application as an adjunct to the physical examination might be beneficial to patient care.

### **(c) Echocardiography Simulators**

Transthoracic and transesophageal echocardiography simulators are being actively developed and are currently available commercially (17-20). Simulators have the potential to enhance echocardiography training by improving the trainee's understanding of the three-dimensional spatial relationship of cardiac structures, improving the understanding of transthoracic and transesophageal anatomy and image orientation, and assisting with the complex development of hand-eye



coordination. This learning process can occur while avoiding potential risk or discomfort to the patient and the inherent time restraints on performance of the examination in a clinical echocardiography laboratory. However, currently available transthoracic and transesophageal echocardiography simulators do not have all of the available echocardiography modalities and pathology datasets are limited (17-20). Furthermore, the value of echocardiography simulation training as a substitute for traditional echocardiography training methods has not been evaluated. At this time, the panel does not consider cases performed on commercially available echocardiography simulators as a substitute to live patient imaging for the purpose of achieving minimal case volumes for certification and maintenance of competence.

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**Table 1** Core Proficiency Skills of Level 1 Training

Technical skills
Ability to perform a limited transthoracic 2D-echocardiogram
Ability to obtain standard parasternal, apical and subcostal views.
Ability to adjust instrument settings appropriately to optimize image quality.
Ability to accurately assess left and right ventricular size, ascending aorta diameter and inferior vena cava size.
Evaluation Skills
Identification of severe left or right ventricular dilation
Identification of left ventricular dysfunction (none, mild, severe)
Identification of severe right ventricular dysfunction
Recognition of potentially significant aortic or mitral valve disease
Identification of a pericardial effusion (small, large)
Evaluation of central filling pressures using the inferior vena cava
Identification of a dilated ascending aorta
Echocardiographic guidance of pericardiocentesis (in a cardiac arrest or hemodynamically unstable patient in whom a delay could compromise patient outcome)

**Table 2** Core Proficiency Skills of Basic Level 2 Training

Technical Skills
M-mode imaging
2D-imaging
Pulsed and continuous wave Doppler imaging
Color flow Doppler imaging
Tissue Doppler imaging
Agitated saline contrast study
Evaluation Skills
Chamber size / volumes
Systolic function
Diastolic function
Valve stenosis and regurgitation (mechanism and severity)
Cardiac hemodynamics
Pulmonary artery pressure
Intracardiac mass (differentiating features)
Intracardiac shunt (identification and quantitation of severity)
Pericardial disease (effusion size, tamponade, constriction)

**Table 3** Minimum Time and Case Volume Requirements for Each Training Level

Proficiency	Minimum Duration of Training (Cumulative Training Blocks [weeks]*)	TTE Performed (Cumulative)	TTE Interpreted (Cumulative)	Contrast	TEE (Cumulative)	Stress Echo (Cumulative)
Level 1 (limited)	1 [4]	40†	90†	-	-	-
Level 2 (basic)	6 [24]	150	450	-	-	-
Level 2 (with TEE)	6 [24]	150	450	-	100	-
Level 2 (with stress)	6 [24]	150	450	-	-	100
Level 2 (with contrast)	6 [24]	150	450	20 Performed 20 Interpreted	-	-
Level 3	19 [76]**	300	1000	20 Performed 40 Interpreted	150	125

\* 1 training block = 4 weeks

\*\* Physicians pursuing multi-imaging modality fellowships that will achieve level 3 training in another non-invasive imaging specialty require a minimum of 15 training blocks (60 weeks) dedicated exclusively to echocardiography [an additional 9 training blocks (36 weeks) beyond Level 2 requirements].

† Denotes a limited focused examination

**Table 4** Case Volume Requirements for Maintenance of Competence

Technique	Case Volume (per year)
Focused Transthoracic Echocardiography	40
Transthoracic Echocardiography	400
Transesophageal Echocardiography	25
Stress Echocardiography	75
Contrast Echocardiography	10
3D - Echocardiography	20

## Appendix I

### Level I: Training Objectives and Strategies

Role	Objectives	Strategies
Medical Expert	<p>Understand cardiovascular anatomy, physiology and hemodynamics, particularly related to shock, pulmonary embolism, cardiac tamponade, and aortic dissection.</p> <p>Understand the basic physical principles of ultrasound including 2D and Doppler echocardiography.</p> <p>Understand the instrumentation of 2D-echocardiography.</p> <p>Understand the indications, contraindications, strengths, weaknesses and clinical utility of transthoracic and transesophageal echocardiography.</p> <p>Know the normal and abnormal echocardiographic appearance of cardiac structures including the left and right ventricles, aortic and mitral valves, atria, pericardium and aorta.</p> <p>Know the 2D echocardiographic features of left and right ventricular systolic dysfunction, ventricular dilatation, ascending aorta dilatation, inferior vena cava size and degree of collapse, pericardial effusion (large vs. small), cardiac tamponade, and potentially significant aortic stenosis and mitral stenosis.</p> <p>Learn to correlate echocardiographic findings with the findings from other investigations including hemodynamics and pathologic / surgical specimens</p> <p>Learn to perform and interpret (in the clinical context) focused transthoracic echocardiography using 2D-echocardiography from the subcostal, parasternal and apical windows in patients with selected suspected cardiovascular diseases.</p>	<p>The above will be accomplished by direct supervision by sonographers and echocardiographers using patients, heart models, echocardiography texts, echocardiography teaching case libraries, educational audio-visual resources and other imaging modalities.</p>
Communicator	<p>Develop a good patient relationship during the echocardiography exam with appropriate attention to patient comfort and privacy.</p> <p>Interpret the relevant questions to be answered by the echocardiography examination using information from the initial medical evaluation.</p> <p>Develop a written report summarizing all of the salient echocardiographic findings (pertinent positive and negative findings)</p> <p>Communicate the results of the examination to other treating or referring physicians, as well as the patient, when appropriate.</p>	<p>Work closely with the sonographers in order to acquire the skills necessary to perform an examination in an effective and compassionate manner.</p> <p>Interpret echocardiography studies with an echocardiographer to learn how to interpret and report effectively.</p> <p>Prepare sample or practice reports of interpreted echocardiographic studies.</p> <p>Dictate or enter reports of interpreted echocardiographic studies and review them with the supervising echocardiographer.</p>

Role	Objectives	Strategies
Collaborator	<p>Work closely with the staff in the echocardiography laboratory, including sonographers, to assist in the study preparation, performance, and patient discharge from the laboratory.</p> <p>Work with the cardiologists and echocardiographers in an effective, collegial and professional manner.</p> <p>Interact and work with other physicians or allied health care professionals when performing or interpreting the echocardiography examination.</p>	<p>Spend time in the echocardiography laboratory observing the professional interactions between sonographers, echocardiographers and referring physicians.</p> <p>Perform and interpret portable echocardiography studies in the emergency department, intensive care unit, coronary care unit, cardiac surgery intensive care unit, or on the wards.</p>
Manager	<p>Utilize the echocardiography equipment, facilities, personnel and time in an efficient manner.</p> <p>Respect and adhere to the echocardiography laboratory schedule and the patient's need for a timely examination.</p> <p>Understands the appropriate indications, contraindications and clinical utility of various echocardiographic modalities including transthoracic and transesophageal echocardiography.</p>	<p>Works closely with echocardiographers, sonographers and booking staff to appropriately triage patients.</p>
Health Advocate	<p>Understand the role of echocardiography in diagnosing and managing cardiovascular disease.</p> <p>Use information from the echocardiography exam to help patients modify their cardiovascular risk factors.</p> <p>Use echocardiography to help patients understand their cardiovascular disease.</p>	<p>Use information from the echocardiography study in combination with clinical information from the patient to promote cardiovascular health, early diagnosis of disease, appropriate management of the patient's medical condition and more efficient use of health care resources.</p>
Scholar	<p>Recognize and understand knowledge gaps in the technical and interpretive facets of echocardiography for the diagnosis and management of relevant cardiovascular diseases.</p> <p>Critically evaluate the literature on select topics related to echocardiography</p> <p>Participate in rounds or presentations on echocardiography topics or using echocardiography images.</p>	<p>Refer to cardiology and echocardiography textbooks and journals and review relevant topics.</p> <p>Attend cardiology and echocardiography rounds.</p> <p>Attend citywide echocardiography rounds.</p> <p>Prepare and present echocardiography topics at rounds.</p> <p>Review and utilize multimedia resources including teaching case databases and electronic textbooks.</p>

Role	Objectives	Strategies
Professional	<p>Interact with patients coming to the echocardiography laboratory with integrity, honesty and compassion.</p> <p>Work with other physicians and allied healthcare professionals in an appropriate, collegial and professional manner.</p> <p>Understand the limitations of Level I echocardiography training on the physician's technical skills, interpretive skills and knowledge.</p>	<p>Use echocardiographers as mentors.</p> <p>Spend time in the echocardiography laboratory in order to develop appropriate professional and interpersonal skills related to the practice of echocardiography.</p> <p>Contact referring physicians as appropriate to inform them of important echocardiographic findings.</p>



## Level 2 (Basic): Training Objectives and Strategies

Role	Objectives	Strategies
Medical Expert	<p>Understand cardiovascular anatomy, physiology and hemodynamics.</p> <p>Understand the physical principles and instrumentation of ultrasound including, M-mode, 2D and Doppler echocardiography.</p> <p>Acquire knowledge of the Doppler equations used during the echocardiography exam.</p> <p>Understand the indications, contraindications, strengths, weaknesses and clinical utility of transthoracic, transesophageal, and stress echocardiography.</p> <p>Know the normal echocardiographic appearance of cardiac structures including cardiac chambers, valves and major blood vessels.</p> <p>Understand common ultrasound artifacts and the identifying echocardiographic features.</p> <p>Develop familiarity with the abnormal echocardiographic appearance of cardiac structures during disease.</p> <p>Know the 2D and Doppler echocardiography features of left and right ventricular systolic and diastolic dysfunction, cardiomyopathies, valve stenosis or regurgitation, normal and abnormal prosthetic valve function, intracardiac masses, congenital heart disease, pericardial disease, pulmonary artery hypertension, and aortic disease.</p> <p>Learn to correlate echocardiography findings with the findings of other investigations including hemodynamics and pathologic / surgical specimens.</p> <p>Learn to perform and interpret (in the clinical context) comprehensive transthoracic echocardiography examinations (M-Mode, two-dimensional, pulse and colour flow Doppler, continuous wave Doppler, tissue Doppler) in patients with cardiovascular diseases.</p>	<p>The above will be accomplished by direct supervision by sonographers and echocardiographers using patients, heart models, echocardiography texts, educational audio-visual resources and other imaging modalities.</p>

Role	Objectives	Strategies
Communicator	<p>Develop a good patient relationship during the echocardiography exam with appropriate attention to patient comfort and privacy.</p> <p>Interpret the relevant questions to be answered by the echocardiographic examination using available information and the requisition.</p> <p>Develop a comprehensive echocardiography report that summarizes all of the salient positive and negative echocardiography findings.</p> <p>Communicate the results of the examination to the referring physician, as well as the patient, when appropriate.</p>	<p>Work closely with the sonographers in order to acquire the skills necessary to perform an echocardiography examination in an effective and compassionate manner.</p> <p>Read echocardiography studies with an echocardiographer to learn how to interpret and report effectively.</p> <p>Prepare sample or practice reports of interpreted echocardiographic studies.</p> <p>Dictate or enter reports of interpreted echocardiography studies and review them with the supervising echocardiographer.</p>
Collaborator	<p>Work closely with the staff in the echocardiography laboratory, including sonographers, to assist with the study preparation, performance and patient discharge from the laboratory.</p> <p>Work with cardiologists and echocardiographers in an effective, collegial and professional manner.</p> <p>Interact and work with other physicians and allied health care professionals when performing or interpreting the echocardiography exam.</p>	<p>Spend adequate time with the sonographers and echocardiographers.</p> <p>Perform and interpret portable echocardiography studies in the intensive care unit, coronary care unit, cardiac surgery intensive care unit, or on the wards.</p>
Manager	<p>Utilize the echocardiographic equipment, facilities, personnel and time in an efficient manner.</p> <p>Respect and adhere to the laboratory schedule and a patient's need for a timely examination.</p> <p>Understand the appropriate indications, contraindications and clinical utility of the various echocardiographic modalities including transthoracic, transesophageal and stress echocardiography.</p>	<p>Work closely with the echocardiographers, sonographers and booking staff to appropriately triage patients.</p> <p>Discuss with the referring physician the most appropriate echocardiography modality for a patient based on available information and modify the exam as necessary.</p>
Health Advocate	<p>Understand the role of echocardiography in diagnosing and managing cardiovascular disease.</p> <p>Use information from echocardiography to help patients modify their cardiovascular risk factors.</p> <p>Use echocardiography to help patients understand their cardiovascular illness.</p>	<p>Use information from the echocardiography study in combination with clinical information from the patient to promote cardiovascular health, early diagnosis of disease, appropriate management of the patient's medical condition and more efficient use of health care resources.</p>

Role	Objectives	Strategies
Scholar	<p>Recognize and understand knowledge gaps in the technical and interpretive facets of echocardiography for the diagnosis and management of cardiovascular disease.</p> <p>Critically evaluate the literature on topics related to echocardiography</p> <p>Assist with teaching more junior housestaff on the technical and interpretive aspects of echocardiography</p> <p>Actively participate in rounds or presentations on echocardiography topics or utilizing echocardiography images.</p>	<p>Refer to cardiology and echocardiography textbooks and journals to review topics.</p> <p>Attend cardiology and echocardiography rounds.</p> <p>Attend citywide echocardiography rounds.</p> <p>Prepare and present echocardiography topics at rounds.</p> <p>Review and utilize multimedia resources including teaching case databases and electronic textbooks.</p>
Professional	<p>Interact with patients coming to the echocardiography laboratory with integrity, honesty and compassion.</p> <p>Work with other physicians and allied healthcare professionals in an appropriate, collegial and professional manner.</p>	<p>Use echocardiographers as mentors.</p> <p>Spend time in the echocardiography laboratory in order to develop the appropriate professional and interpersonal skills related to the practice of echocardiography.</p> <p>Contact referring physicians as appropriate to inform them of important echocardiographic findings.</p>

### Level 3: Training Objectives and Strategies

Role	Objectives	Strategies
Medical Expert	<p>Understand cardiovascular anatomy, physiology and hemodynamics.</p> <p>Understand the physical principles and instrumentation of ultrasound including M-Mode, 2D and Doppler echocardiography; harmonic imaging; transesophageal echocardiography; stress echocardiography; and contrast echocardiography.</p> <p>Acquire knowledge of the Doppler equations employed in the echocardiography exam.</p> <p>Understand the indications, contraindications, strengths, weaknesses and clinical utility of transthoracic, transesophageal, stress and contrast echocardiography.</p> <p>Know the normal variants and echocardiographic appearance of cardiac structures including cardiac chambers, valves and major blood vessels.</p> <p>Know the normal echocardiographic appearance of cardiac structures including cardiac chambers, valves and major blood vessels.</p> <p>Understand common ultrasound artifacts and the identifying echocardiographic features.</p> <p>Develop familiarity with the abnormal echocardiographic appearance of cardiac structures during disease.</p> <p>Know the 2D and Doppler echocardiography features of left and right ventricular systolic and diastolic dysfunction, cardiomyopathies, valve stenosis and regurgitation, normal and abnormal prosthetic valve function, intracardiac masses, congenital heart disease, pericardial disease, pulmonary artery hypertension, and aortic disease.</p> <p>Learn to correlate echocardiographic findings with the findings of other cardiac diagnostic imaging modalities, hemodynamic studies or surgical / pathological specimens.</p> <p>Learn to perform and interpret (in the clinical context) comprehensive transthoracic (M-Mode, two-dimensional, pulse and colour flow Doppler, continuous wave Doppler, tissue Doppler), transesophageal, stress and contrast echocardiography in patients with cardiovascular diseases.</p> <p>Know and understand new or upcoming imaging technologies and their potential role in patient care.</p> <p>Know the strengths and limitations of the echocardiographic technologies in reference to other imaging or diagnostic tools.</p>	<p>The above will be accomplished by direct supervision by sonographers and echocardiographers using patients, heart models, echocardiography texts, educational audio-visual resources and other imaging modalities.</p>

Role	Objectives	Strategies
Communicator	<p>Develop a good patient relationship during the echocardiography exam with appropriate attention to patient comfort and privacy.</p> <p>Interpret the relevant questions to be answered by the echocardiographic examination using available information and the requisition.</p> <p>Develop a report summarizing all of the salient positive and negative echocardiographic findings.</p> <p>Communicate the results of the examination to the referring physician, as well as the patient, when appropriate.</p> <p>Communicate and discuss best practice guidelines with other colleagues (physicians and sonographers) working in the echocardiography laboratory to ensure their adoption.</p> <p>Communicate and discuss the echocardiography exams and reports with other colleagues (physicians and sonographers) to promote quality assurance.</p> <p>Develop the interpersonal and communication skills required for directorship of an echocardiography laboratory.</p>	<p>Work closely with the sonographers in order to acquire the skills necessary to perform an examination in an effective and compassionate manner.</p> <p>Read echocardiography studies with an echocardiographer to learn how to interpret and report effectively.</p> <p>Dictate reports of interpreted echocardiographic studies and review them with the supervising echocardiographer.</p> <p>Discuss and participate in decision-making regarding management of the echocardiography laboratory.</p>
Collaborator	<p>Work closely with the staff in the echocardiography laboratory, including sonographers, to assist with study preparation, performance, and patient discharge from the laboratory.</p> <p>Work with the cardiologists and other echocardiographers in an effective, collegial and professional manner.</p> <p>Interact and work with other physicians and allied health care professionals when performing or interpreting the echocardiography exam.</p> <p>Participate with other colleagues (physicians and sonographers) working within the echocardiography laboratory to promote, develop, adopt and maintain best practice standards and quality assurance within the echocardiography laboratory.</p>	<p>Spend adequate time with the sonographers and echocardiographers.</p> <p>Perform and interpret portable echocardiographic studies in the intensive care unit, coronary care unit, cardiac surgery intensive care unit, or on the wards.</p> <p>Become familiar with best practice standards of echocardiography and discuss with other colleagues. Participate in the adoption of best practice standards in the echocardiography laboratory.</p> <p>Become familiar with programs to maintain quality assurance in an echocardiography laboratory and participate with colleagues in their adoption.</p>

Role	Objectives	Strategies
Manager	<p>Utilize the echocardiography equipment, facilities, personnel and time in an efficient manner.</p> <p>Respect and adhere to the laboratory schedule and a patient's need for a timely examination.</p> <p>Understand the appropriate indications, contraindications and clinical utility of the various echocardiographic modalities including transthoracic, transesophageal, stress and contrast echocardiography.</p> <p>Communicate and discuss best practice standards of echocardiography and quality assurance with colleagues (physicians and sonographers) working in the echocardiography laboratory to facilitate their adoption and maintenance in the echocardiography laboratory.</p> <p>Incorporate new established techniques into the echocardiography laboratory.</p> <p>Develop the managerial, interpersonal and communication skills required for directorship of an echo laboratory</p>	<p>Work closely with echocardiographers, sonographers and booking staff to appropriately triage patients and manage daily activities of the laboratory.</p> <p>Assess strengths and needs of the laboratory and make appropriate suggestions to improve laboratory function and performance.</p> <p>Become familiar with best practice standards of echocardiography and promote their adoption in the echocardiography laboratory.</p> <p>Become familiar with programs to maintain quality assurance in an echocardiography laboratory and promote their adoption.</p>
Health Advocate	<p>Understand the role of echocardiography in diagnosing and managing cardiovascular disease.</p> <p>Use information from echocardiography to help patients modify their cardiovascular risk factors.</p> <p>Use echocardiography to help patients understand their cardiovascular illness.</p> <p>Understand new and developing techniques and technology in echocardiography and evaluate their potential utility for patient care.</p>	<p>Use information from the echocardiography study in combination with clinical information from the patient to promote cardiovascular health, early diagnosis of disease, appropriate management of the patient's medical condition and more efficient use of health care resources.</p> <p>Read review articles and original investigations in echocardiography journals related to new and future developments in echocardiography.</p>

Role	Objectives	Strategies
Scholar	<p>Understand knowledge gaps in the technical and interpretive aspects of echocardiography for the diagnosis and management of cardiovascular disease.</p> <p>Critically evaluate the literature on topics related to echocardiography</p> <p>Assist with teaching more junior housestaff and non-echocardiographers on the technical and interpretive aspects of echocardiography</p> <p>Participate in rounds or presentations on echocardiography topics or utilizing echocardiography images.</p> <p>Incorporate new and established techniques into the echocardiography laboratory.</p>	<p>Refer to cardiology and echocardiography textbooks and journals to review topics.</p> <p>Read echocardiography journals to be aware of new developments in echocardiography.</p> <p>Attend cardiology and echocardiography rounds.</p> <p>Attend citywide echocardiography rounds.</p> <p>Prepare and present in-depth reviews on echocardiography topics at rounds, journal clubs or sonographer in-services.</p> <p>Review and utilize multimedia resources including teaching case databases and electronic textbooks.</p> <p>Participate in research projects utilizing echocardiography.</p> <p>Attend or present at national or international echocardiography meetings.</p>
Professional	<p>Interact with patients coming to the echocardiography laboratory with integrity, honesty and compassion.</p> <p>Work with other physicians and allied healthcare professionals in an appropriate, collegial and professional manner.</p> <p>Develop maturity required to manage an echocardiography laboratory.</p>	<p>Use senior echocardiographers and the Director of the Echocardiography laboratory as mentors.</p> <p>Spend time in the echocardiography laboratory in order to develop the appropriate professional and interpersonal skills related to the practice of echocardiography.</p> <p>Contact referring physicians as appropriate to inform them of important echocardiographic findings.</p>