

Special Article

Canadian guidelines for training in adult perioperative transesophageal echocardiography *Recommendations of the Cardiovascular Section of the Canadian Anesthesiologists' Society and the Canadian Society of Echocardiography*

[Lignes directrices canadiennes pour la formation en échocardiographie transœsophagienne chez l'adulte

Recommandations de la Section cardiovasculaire de la Société canadienne des anesthésiologistes et de la Société canadienne d'échocardiographie]

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Purpose: To establish Canadian guidelines for training in adult perioperative transesophageal echocardiography (TEE).

Methods: Guidelines were established by the Canadian Perioperative Echocardiography Group with the support of the cardiovascular section of the Canadian Anesthesiologists' Society (CAS) in conjunction with the Canadian Society of Echocardiography.

Guidelines for training in echocardiography by the American Society of Echocardiography, the American College of Cardiology and the Society of Cardiovascular Anesthesiologists were reviewed, modified and expanded to produce the 2003 Quebec expert consensus for training in perioperative echocardiography. The Quebec expert consensus and the 2005 Guidelines for the provision of echocardiography in Canada formed the basis of the Canadian training guidelines in adult perioperative TEE.

Results: Basic, advanced and director levels of expertise were identified. The total number of echocardiographic examina-

tions to achieve each level of expertise remains unchanged from the 2002 American Society of Echocardiography-Society of Cardiovascular Anesthesiologists guidelines. The increased proportion of examinations personally performed at basic and advanced levels, and the level of autonomy at the basic level suggested by the Quebec expert consensus are retained. These examinations can be performed in a perioperative setting and are not limited to intraoperative TEE. Training "on the job", the role of the perioperative transesophageal echocardiography examination, requirements for maintenance of competence, and duration of training are also discussed for each level of training. The components of a TEE report and comprehensive TEE examination are also outlined.

Conclusion: The Canadian guidelines for training in adult perioperative TEE reflect the unique Canadian practice profile in perioperative TEE and address the training requirements to obtain expertise in this field.

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Objectif : Établir des lignes directrices canadiennes pour la formation à l'échocardiographie transœsophagienne (ETO) chez l'adulte.

Méthode : Les lignes directrices ont été établies par le Groupe canadien sur l'échocardiographie périopératoire, appuyé par la section cardiovasculaire de la Société canadienne des anesthésiologistes (SCA) conjointement avec la Société canadienne d'échocardiographie. Nous avons passé en revue, modifié et développé les lignes directrices de l'American Society of Echocardiography, l'American College of Cardiology et la Society of Cardiovascular Anesthesiologists pour en arriver au consensus d'experts du Québec en 2003 sur la formation en échocardiographie périopératoire. Le consensus d'experts du Québec et les lignes directrices de 2005 sur l'utilisation de l'échocardiographie au Canada ont formé la base des lignes directrices de la formation canadiennes en ETO périopératoire chez l'adulte.

Résultats : Les niveaux de compétence élémentaire, avancé et supérieur ont été déterminés. Le nombre total d'examens d'échocardiographie nécessaires pour atteindre chaque niveau de compétence est demeuré inchangé depuis les lignes directrices de 2002 de l'American Society of Echocardiography-Society of Cardiovascular Anesthesiologists. Nous avons conservé le nombre croissant d'examens réalisés personnellement aux niveaux élémentaire et avancé et le degré d'autonomie au niveau élémentaire suggérés par le consensus d'experts québécois. Ces examens peuvent être réalisés dans un contexte périopératoire et ne sont pas limités à l'ETO peropératoire. La formation «en milieu de travail», le rôle de l'examen d'échocardiographie transœsophagienne périopératoire, les exigences du maintien de la compétence et la durée de la formation sont aussi discutées pour chaque niveau de formation. La composante d'un rapport d'ETO et l'examen d'ETO détaillé sont décrits des Guidelines for the Provision of Echocardiography in Canada.

Conclusion : Les lignes directrices canadiennes pour la formation à l'ETO périopératoire chez l'adulte représentent le profil particulier de la pratique canadienne en ETO périopératoire et traitent des exigences nécessaires pour acquérir des compétences dans le domaine.

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Introduction

Transesophageal echocardiography (TEE) is an important monitoring and diagnostic tool in the operating room and in the perioperative period with minimal risk to the patient. The information TEE provides can lead to modifications in both the surgical approach and medical management of the patient. Although echocardiography was first introduced into clinical practice in 1954, it was not until the development of a high resolution TEE probe that the potential role of TEE in the operating room became clear. Since the development of the multiplane probe in 1992, TEE has had an increasing role in anesthesia with established practice guidelines. In the operating room, TEE has become an important diagnostic and monitoring tool. Although the use of intraoperative TEE is increasing, it is important to acknowledge that it is not a substitute for an adequate preoperative echocardiographic assessment in cardiac surgery and in non-cardiac surgery when a preoperative echocardiogram is required. Today, most university and community hospitals in Canada with cardiac surgical programs have the capability of performing intraoperative echocardiography. It is now an integral part of cardiac anesthesiology and residents have expressed heightened interest in learning echocardiography which is now considered an essential aspect of a fellowship in cardiac anesthesia. Moreover, an increasing number of practicing anesthesiologists are requesting training opportunities in perioperative TEE without placing an undue burden on their clinical practice. There are however, no Canadian guidelines for training in perioperative TEE.

In the United States, Aronson *et al.* published a historical perspective on training and certification in

TABLE I ASE/SCA guidelines for training in perioperative echocardiography: 2002

	<i>Basic</i>	<i>Advanced</i> ‡	<i>Director</i> §
Echocardiographic examinations* (<i>n</i>)	150	300	450
Minimum intraoperative TEE examinations (<i>n</i>)†	50	150	300
Total duration of training	NS	NS	NS
Total CME hours (<i>n</i>)	20	50	NS
PTE examination	NS	NS	NS
MOC: CME hours	NS	NS	NS
MOC: # TEE per year (<i>n</i>)	50	50	50

ASE/SCA = American Society of Echocardiography/Society of Cardiovascular Anesthesiologists; TEE = transesophageal echocardiography; CME = continuing medical education; PTE = perioperative transesophageal echocardiography; MOC: maintenance of competence; NS = not specified; *Complete echocardiographic examinations that are interpreted and reported by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. This may include complete transthoracic studies that were not recorded by the trainee. †Comprehensive intraoperative TEE examinations that are performed, interpreted and reported by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. ‡Echocardiographic studies for basic training are included in the total number required for advanced training. §Echocardiographic studies for advanced training are included in the total number required for a director level of expertise.

Adapted from ASE/SCA Task Force Guidelines for Training in Perioperative Echocardiography^{7,8} These recommendations were endorsed by the 2003 American College of Cardiology/American Heart Association clinical competence statement.⁹⁻¹¹

TABLE II ACC/AHA guidelines for training in TTE/TEE: 2003

	<i>Basic</i>	<i>Advanced</i> §	<i>Director</i> ¶
Interpreted TTE examinations* (<i>n</i>)	150	300	750
Performed TTE examinations† (<i>n</i>)	75	150	300
Total duration of training (months)	3	6	12
TEE training‡ (<i>n</i>)	NO	50	
PTE examination	NS	NS	NS
MOC: # of TEE per year (<i>n</i>)		25-50	
MOC: CME hours per year (hr)	5	5	> 5

ACC/AHA = American College of Cardiology/American Heart Association; TTE = transthoracic echocardiography; TEE = transesophageal echocardiography; PTE = perioperative transesophageal echocardiography; MOC: maintenance of competence; CME: continuing medical education; NS = not specified; *Complete TTE examinations that are interpreted by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. †Complete TTE examinations that are performed and interpreted by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. ‡TEE training is limited to trainees with an advanced level of training in TTE. The guidelines recommend the performance of 50 TEE studies including 25 esophageal intubations before the trainee can perform independent TEE studies. §Echocardiographic studies for basic training are included in the total number required for advanced training. ¶Echocardiographic studies for advanced training are included in the total number required for a director level of expertise.

Adapted from the ACC/AHA clinical competence statement on echocardiography.⁹⁻¹¹

perioperative TEE.¹ In 1987, the American Society of Echocardiography published guidelines for optimal physician training in echocardiography.² Three levels of training were identified: level I (basic training), level II (advanced training) and, level III (director of an echocardiography laboratory). These guidelines were revised by the American Society of Echocardiography (ASE) in 1992 for training in TEE.³ The American College of Cardiology (ACC) reaffirmed these recommendations in 1995, but with a more comprehensive echocardiographic assessment that includes Doppler hemodynamic examination for each study performed.⁴ In 1996 a task force by the ASE and Society of Cardiovascular Anesthesiologists (SCA) published

practice guidelines for perioperative TEE, identifying a basic and an advanced level of training (Appendix 1)⁵ and in 1998, the National Board of Echocardiography (NBE) established the first examination in perioperative TEE (PTE).⁶ In 2002 a joint task force by the ASE and the SCA published training requirements in perioperative echocardiography to achieve each level of training (basic, advanced, director); qualifications for training programs and for program directors were also outlined (Table I).^{7,8} The perioperative TEE training requirements of the American Society of Anesthesiologists/Society of Cardiovascular Anesthesiologists (ASA/SCA) task force were endorsed in 2003 by the American College of Cardiology/

TABLE III Canadian guidelines for training in perioperative TEE: 2006

	<i>Basic</i>	<i>Advanced**</i>	<i>Director††</i>
Echocardiographic examinations* (<i>n</i>)	150	300	450
Perioperative TEE† (<i>n</i>)	100	200	300
Total duration of training (months)	3	6	9
PTE examination	Yes	Yes	Yes
Total CME hours (<i>n</i>) (accredited CME hours)†	50 (25)	50 (25)	75 (37.5)
MOC: Total CME hours (<i>n</i>) (accredited CME hours)§	50 (25)	50 (25)	75 (37.5)
MOC: TEE per year (<i>n</i>) (interpreted examinations)¶	50	50	50 (75)

TEE = transesophageal echocardiography; PTE = perioperative transesophageal echocardiography; CME = continuing medical education; MOC = maintenance of competence. *Complete echocardiographic examinations that are interpreted by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. These may include complete transthoracic studies from a database. †Comprehensive perioperative TEE examinations that are performed, interpreted and reported by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise. ‡CME hours to achieve either a basic or advanced level should be completed within a two-year period. The CME hours required for a director level should be completed within a four-year period. §CME hours for MOC at the basic, advanced or director level should be completed within a four-year period. ¶The minimum total number of echocardiographic studies that must be interpreted per year for a director level is indicated in bracket. This number may include the TEE studies for MOC. Note that the duration of training may vary according to the individual, training pathway or training centre and is not as important as completing the required number of echocardiographic examinations and CME hours. **Echocardiographic studies for basic training are included in the total number required for advanced training. ††Echocardiographic studies for advanced training are included in the total number required for a director level of expertise.

American Heart Association (ACC/AHA) Task Force on clinical competence in echocardiography.⁹⁻¹¹ In addition to perioperative training in TEE, the ACC/AHA task force also identified a separate training pathway for TEE that requires advanced training in transthoracic echocardiography (TTE) (Table II). In 2003, a Quebec expert consensus outlined stringent training requirements for a basic, advanced and director level of expertise in perioperative echocardiography for anesthesiologists (Table III).¹² More recently, the Canadian Society of Echocardiography (CSE) and the Canadian Cardiovascular Society (CCS) identified training in TEE as part of a level II training in TTE in the 2005 guidelines for the provision of echocardiography in Canada.¹³ Maintenance of competence for TEE, based on these guidelines, requires physicians to interpret at least 50 TEE and 300 TTE examinations per year. In these guidelines physicians must achieve and maintain expertise in TTE before they are considered qualified to perform TEE. These recommendations were based on the opinion of a panel of experts in the field and included a review of Canadian provincial policies for the performance and interpretation of echocardiographic studies. However, TEE training can also be obtained as part of a perioperative echocardiography pathway as outlined in this document.

Purpose

Guidelines for training in TTE are well established but there are no Canadian training guidelines for physicians who have an echocardiographic practice

that is focused on perioperative TEE. The purpose of this document is to provide a national consensus on training guidelines in adult perioperative TEE, which incorporates different regional viewpoints in both cardiology and anesthesia, to reflect the diverse practice profiles across Canada. It is also important that physicians performing perioperative TEE have an appropriate level of training to ensure patient safety and quality of care. The current consensus acknowledges that there are several valid training pathways to achieve each level of expertise in perioperative echocardiography. The Canadian training guidelines in perioperative TEE only highlight some of the possible training pathways that can be used to facilitate this process. However, the emphasis is on obtaining the expertise in perioperative TEE and not on the specific pathway that is used to achieve this goal.¹⁴⁻¹⁶ For each level of training, the infrastructure of a training program can be individualized to allow the trainee to achieve either a basic, advanced or director level of expertise.

Adherence to the Canadian training guidelines in perioperative TEE does not ensure either credentialing or certification. Certification in perioperative TEE is currently only available in North America via the NBE. Although these guidelines may be used for credentialing purposes, this decision remains hospital based.

The training recommendations in this document are intended for licensed medical practitioners enrolled in, or having completed an accredited residency. They represent a minimum training requirement and physicians are encouraged to exceed the recommendations

outlined in this document. These guidelines do not apply to TTE or pediatric or non-surgical intensive care unit (ICU) patients where the scope of diagnosis may be quite different from that associated with the acute perioperative management of adult surgical patients. However, as the technology in echocardiography evolves and the scope of perioperative applications increases, these guidelines will need further revisions to incorporate these changes. The training guidelines in this document should also be considered as interim until a Canadian examination and certification process is established in perioperative TEE for each level of training.

Methods

A panel of experts was structured to include anesthesiologists and cardiologists from different provinces across Canada to reflect the diverse professional expertise and regional viewpoints. This panel included representatives grouped by province or region of the Canadian Perioperative Group.¹³ Also included were the chair of the 2005 guidelines committee for the provision of echocardiography in Canada and other cardiologists involved in the creation of these guidelines.¹³ The initial working group included four anesthesiologists designated by the PEG with the support of the cardiovascular section of the Canadian Anesthesiologists' Society (CAS) and one cardiologist designated by the CSE.

Training guidelines in adult echocardiography by the ASE in 1987, ACC in 1995 and, ASE and SCA in 2002 (Table I) were reviewed and used as a template for the creation of the 2003 Quebec expert consensus for training in perioperative echocardiography.^{2-4,7,8,12} In 2003, a clinical competence statement on echocardiography by the AHA and ACC in collaboration with the ASE, SCA and the Society of Pediatric Echocardiography was also reviewed.⁹⁻¹¹ The Quebec expert consensus and the 2005 Guidelines for the Provision of Echocardiography in Canada formed the basis of the Canadian training guidelines in adult perioperative TEE (Table III).¹² Once a consensus was achieved, this document was circulated to every member of the PEG and to the executive of the CSE for further review. During the CAS meeting in June 2005, the guidelines were presented and discussed in an open forum at the meeting of the PEG. The document was also distributed to the membership of the CV section of the CAS for comments. Following appropriate revisions, the final document was endorsed by the cardiovascular section of the CAS and the CSE.

I. Training guidelines

Knowledge and skills

The knowledge and skills required to achieve a basic and an advanced level of training have been outlined previously in the report of the joint task force of the ASA and SCA published in 1996.⁵ The recommendations were updated and modified in 2002 by the joint task force of the ASE and SCA on physician training in perioperative echocardiography to include epicardial echocardiography and epivascular echocardiography. The knowledge and skills described in the 2002 ASE/SCA guidelines for the advanced level of training were maintained in the Quebec expert consensus and are also endorsed in the Canadian guidelines on perioperative TEE¹² (Appendix I).^{7,8} However, compared to the 2002 ASE/SCA guidelines, in the Canadian training guidelines on perioperative TEE, the required knowledge and skills at a basic level of training are increased to provide the physician with a level of autonomy in the operating room¹² (Appendix I).^{7,8}

The training requirements to achieve basic, advanced and a director level of expertise are outlined in Table III. The trainee should have a sufficient knowledge base for each level of training and in addition to the required echocardiographic studies, the trainee must complete the requisite continuing medical education (CME) hours commensurate with his/her level of training.

BASIC LEVEL

A trainee with a basic level of expertise has to master the acquisition of all the views of a comprehensive examination as described by the ASE and the SCA.^{16,17} The anesthesiologist with a basic level of training will also have the ability to use intraoperative TEE independently as a monitoring and diagnostic tool at a basic level as outlined in this document (Appendix I).^{7,8,12} Therefore, at a basic level of training the anesthesiologist can monitor and diagnose hemodynamic problems related to preload, ventricular systolic or diastolic dysfunction, myocardial ischemia and valvular dysfunction.⁷⁻¹² Following uncomplicated valve replacement, a trainee with basic training will have the ability to recognize valvular lesions or dysfunction that may be significant and that would require consultation with a physician who has advanced training in perioperative echocardiography.¹² A trainee with basic training will also have the expertise to provide TEE guidance for the positioning of a coronary sinus catheter, intra-aortic balloon pump or other assist devices. However, transesophageal echocardiography diagnosis that will impact significantly on the surgical procedure must be done in consultation with a physician who has advanced training in perioperative TEE.⁷⁻¹²

ADVANCED LEVEL

An advanced level of training is required when TEE diagnosis will have a direct impact on the surgical management of the patient (e.g., mitral valve repair). A physician who has obtained an advanced level of training becomes a consultant in echocardiography and has the skills and knowledge to perform a complete evaluation of more complex adult echocardiographic cases. In addition, a physician with this level of expertise will have a better understanding of the impact of cardiac surgery, assist devices, anesthesia, inotropes and vasoactive drugs on echocardiographic findings. An advanced level of training also provides the ability to participate in the training of other physicians who wish to acquire expertise in perioperative TEE.

DIRECTOR LEVEL OF PERIOPERATIVE TEE

The director of perioperative TEE is predominantly an administrative position conferred by the hospital on an appropriately qualified individual. The intent of this document is to describe the training, knowledge and skills required before an individual is considered to take on this administrative leadership of a perioperative echocardiography service. Although several individuals may attain the qualifications for a director level of expertise, not everyone attaining director qualifications would be called upon to assume the administrative duties of a perioperative echocardiography service. Therefore, in any institution, there would normally be only one physician appointed as director of perioperative TEE and this individual should have the training qualifications outlined in this document.

The responsibilities of a director involve administration of facilities, personnel and equipment in a manner that would optimize the provision of perioperative echocardiography services. Within the department, the director has to ensure quality control on the performance, storage and reporting of echocardiographic studies. The director is also responsible for the appropriate allocation of echocardiographic resources, proper sterilization protocol and maintenance of equipment, and must ensure that teaching is done appropriately with an adequate level of supervision for the trainee. It is also important that a physician who has assumed the responsibility of directorship remains current with developments in perioperative echocardiography. Short courses or visitations of high level facilities are also encouraged to acquire the necessary expertise in the running of a perioperative TEE service.

The administrative responsibilities of the director of perioperative TEE will be predominantly focused on the intraoperative TEE setting. In centres where anesthesiologists may be requested to perform TEE stud-

ies in the ICU or in the preoperative setting, she/he may also be responsible for the quality control of these TEE studies. However, her/his role in the ICU or in the preoperative setting may be limited because full echocardiography coverage requires the use of TTE in addition to TEE.

Duration of training

Guidelines written in 1987 by the ASE and in 1995 by the ACC on training for TTE recommend three months of training for a basic level and six months of training for an advanced level of expertise.^{2,4} More recently, the duration of training was also outlined in the Guidelines for the provision of echocardiography in Canada and in the ACC/AHA clinical competence statement for training in TTE. However, the 2002 ASE/SCA guidelines and the ACC/AHA clinical competence statement on echocardiography did not include duration of training for a basic or advanced level of expertise in perioperative echocardiography.⁷⁻¹¹ The recommended duration of training to achieve either a basic, advanced or director level of expertise is included in the Canadian training guidelines on perioperative echocardiography to facilitate the organization of a focused training process and to provide an estimate of the anticipated training period (Table III). However, the panel acknowledges that the emphasis remains on obtaining the required expertise and not on the specific duration of training.

BASIC LEVEL

A three-month fellowship in perioperative TEE is the minimum recommended training period to achieve a basic level of expertise. This period of time is important to acquire the required expertise. Analysis of the PTE examination also identified three months of training or equivalent with positive performance.⁶ Although a trainee may not be able to spend three consecutive months in echocardiography, the required number of examinations for basic training must be completed within a one-year period.

ADVANCED LEVEL

An advanced level of training can be achieved during a one-year fellowship in cardiac anesthesia with echocardiography training or alternatively during a six-month fellowship in echocardiography. It is also recognized that training may be interrupted or may be performed in parallel with clinical activity (see section II). However, a trainee with a basic level of training who wishes to obtain an advanced level of expertise must still complete the required additional echocardiographic studies and total CME hours within a maximum period

of two years (Table III). However, the emphasis is not on the specific duration of training but on the acquisition of the required knowledge and skills provided that the training period does not exceed the recommended maximum duration of two years. At the end of training, the trainee should obtain a letter of recommendation from either the director of perioperative TEE or from the director of the echocardiography laboratory, stating that the trainee has achieved the expertise for an advanced level of training based on the knowledge and skills defined in the practice guidelines (Appendix 1).

DIRECTOR LEVEL OF PERIOPERATIVE TEE

A trainee who has achieved an advanced level of expertise may complete the required additional echocardiographic studies for a director level of expertise during a subsequent three months of training in perioperative echocardiography (Appendix 3). The panel also recognizes that training may be interrupted or may be performed in parallel with clinical activity (see section II). However, the required additional echocardiographic studies must be completed within a maximum period of two years. As previously mentioned, the emphasis remains on the acquisition of the required knowledge and skills and not on the specific duration of training provided that the echocardiographic studies and CME hours are completed within the maximum allocated time period (Table III).

Number of echocardiographic examinations

Previous guidelines for basic training in 1987 and in 1995 on TTE have required that the trainee interpret 150 examinations including 75 examinations personally performed.^{2,4} In 1992 the ASE identified that 50 TEE examinations including 25 probe insertions would be required for training in TEE in addition to obtaining a level II training as defined in Table I.³ In 2002, at a basic level of expertise, the ASE and SCA guidelines for training in perioperative echocardiography identified 150 complete echocardiographic studies that are interpreted and reported, as the minimum number of examinations required.^{7,8} In these guidelines, the examinations must include at least 50 comprehensive intraoperative TEE studies personally performed, interpreted and reported by the trainee (Table I).^{7,8} At an advanced level of training, the ASE and SCA Task Force identified 300 interpreted and reported complete echocardiographic studies including 150 personally performed comprehensive intraoperative TEE studies, as the minimum number of examinations required (Table I).^{7,8} These recommendations were endorsed in the 2003 ACC/AHA clinical competence statement on echocardiography.⁹⁻¹¹

In the Canadian training guidelines on perioperative TEE an increased number of examinations personally performed under appropriate supervision at both the basic and the advanced level of training is required to facilitate the completion of the intraoperative TEE assessment in a timely fashion. These may include TEE examinations performed in an ICU setting and are not limited to intraoperative TEE evaluations as specified in the 2002 ASE/SCA guidelines.^{7,8} Moreover, the trainee is not required to report the interpreted echocardiographic studies that are not personally performed, but these studies must be reviewed with a physician who has achieved an advanced level of expertise (Table III). Selected comprehensive echocardiographic studies from an existing database can also be used for this purpose.¹² The trainee who obtains his training after 2006 is required to keep a log of all the studies performed.

BASIC LEVEL

During a basic level of training, the trainee is required to interpret a total of 150 complete echocardiographic examinations including at least 100 comprehensive perioperative TEE studies personally performed and interpreted under appropriate supervision (Table III).⁷⁻¹² These studies must include a variety of surgical cases to ensure that the candidate can achieve the skills and knowledge for a basic level of training (Appendix 1).⁷⁻¹² Transthoracic echocardiographic and TEE examinations that are performed during residency training as part of a dedicated rotation in an echocardiography laboratory may also qualify in the current guidelines towards the required number of examinations personally performed for a basic level of training. However, the required number of echocardiographic examinations must be completed within a year.

ADVANCED LEVEL

During an advanced level of training, the trainee is required to interpret a total of 300 complete echocardiographic examinations including at least 200 comprehensive perioperative TEE studies personally performed and interpreted under appropriate supervision (Table III).¹² The echocardiographic studies must be reviewed with a physician who has achieved an advanced level of training. These studies must also include a variety of surgical cases to ensure that the candidate can achieve the skills and knowledge for an advanced level of training.⁷⁻¹² The required additional number of echocardiographic examinations for an advanced level of training must be completed within a two-year period.

DIRECTOR LEVEL OF PERIOPERATIVE TEE

At the director level of expertise, the requirements are similar to those proposed by the ASE and SCA Task Force. The trainee is required to have interpreted at least 450 cumulative complete perioperative echocardiographic examinations and this number must include a minimum of 300 comprehensive perioperative TEE studies personally performed, interpreted and reported.⁷⁻¹² The cardiac centre should have the variety and number of adult cardiac surgical cases to ensure that the trainee has an adequate exposure to the wide scope of perioperative TEE diagnosis. A trainee who has achieved an advanced level of training must complete the required additional number of echocardiographic examinations for a director level of expertise within a two-year period.

Training centres

A minimum of two physicians with advanced training in perioperative TEE should be required before a centre can be recognized for training physicians in perioperative TEE at a basic level.¹² The cardiac centre should be performing on average at least two cardiac surgical cases per day during a regular week schedule.¹² The variety of echocardiographic cases should be sufficient for the trainee to achieve the technical and cognitive skills of basic training (Appendix 1).

A centre may qualify for advanced training if there are at least three physicians with advanced training including at least one who fulfills the requirement for director of perioperative TEE as outlined in this document.¹² Although two anesthesiologists with advanced training may be sufficient to provide advanced training, it is the opinion of the authors that it is important to expose the candidate to a more diversified approach in perioperative TEE. The cardiac centre should have the variety and number of adult cardiac surgical cases to ensure that the trainee has an adequate exposure to the wide scope of perioperative TEE diagnosis.⁷⁻¹² As stated in the recent training guidelines published by the ASE and the SCA, the authors would also like to emphasize the importance of case diversity to ensure that the trainee can use TEE effectively in all clinically established current applications.⁷⁻¹²

Perioperative transesophageal echocardiography examination

The 2003 ACC/AHA clinical competence statement in echocardiography and the 2002 ASE/SCA guidelines in echocardiography do not require a passing score on the PTE examination.⁷⁻¹¹ In the Canadian training guidelines on perioperative echocardiography, the basic and the advanced level of training both require

completion of the PTE examination (Table III). This provides a useful tool to ensure that the trainee has not only completed the required CME hours but that he can also interpret perioperative TEE studies appropriately. In the Canadian guidelines the role and skills of a physician with basic training are increased. Therefore, although the PTE examination may be considered to represent a more advanced level of training it is also included at a basic level of training because it represents a standardized mechanism to ensure that the candidate has acquired the necessary knowledge to perform TEE studies appropriately and autonomously at a basic level.¹² A passing score on the PTE examination is therefore required before a trainee can perform perioperative TEE autonomously at a basic level.

In the advanced level of expertise, the committee recognizes that there are physicians currently performing perioperative TEE independently who have not completed the PTE examination process. It is not the intention of this committee to limit the clinical practice of these physicians who are providing important clinical care. Therefore, the requirement for a passing score on the PTE examination only applies to trainees who will be completing this level of training after 2005. Physicians who have obtained an advanced level of expertise prior to this date are encouraged but not required to participate in the PTE examination process.

A passing score on the PTE examination does not infer that the trainee has achieved the necessary skills in perioperative echocardiography and it should not be considered as a potential substitute for clinical experience in the perioperative setting. It is therefore essential that the trainee also complete the required number of echocardiographic examinations in a tertiary care cardiac centre that has the variety of adult cardiac surgical cases to ensure an adequate exposure to the wide scope of perioperative TEE diagnosis.¹²

Completion of the PTE examination should be done at the end of training but the requirements for a basic or an advanced level of training may still be fulfilled if the trainee obtains a passing score on the PTE examination at a later date provided that she/he maintains the appropriate level of expertise as outlined in the maintenance of competence (MOC) section of this document. In the future, the development of a Canadian examination process in perioperative echocardiography would likely replace the PTE examination in the Canadian training guidelines.

Continuing medical education

The 2003 ACC/AHA clinical competence statement in echocardiography and the 2002 ASE/SCA

guidelines recommend 20 hours of CME for a basic level of expertise and 50 hours for an advanced level of expertise in perioperative echocardiography.⁷⁻¹¹ In the Canadian training guidelines on perioperative echocardiography, the basic and the advanced level of training both require the completion of 50 hours of CME including at least 25 hours of accredited CME. In the authors' opinion, 50 hours of CME represent a minimum for the candidate to achieve a passing score on the PTE examination.¹²

Previous guidelines do not address CME requirements for the level of program director. In the Canadian training guidelines on perioperative echocardiography, the program director is required to complete at least 75 hours of CME over a maximum period of four years, including at least 37.5 hours of accredited CME.

Learning activities that qualify as CME may include conferences, seminars, workshops or videos on TEE including topics ranging from a basic to an advanced level.¹² The required CME hours can be achieved easily by attending the equivalent of a one-week comprehensive echocardiographic course.

Maintenance of competence

The 2003 ACC/AHA clinical competence statement in echocardiography recommends 25-50 TEE examinations per year to maintain adequate expertise in the performance and interpretation of TEE.⁹⁻¹¹ The 2002 ASE/SCA guidelines and the 2003 ACC/AHA statement recommend 50 examinations per year for MOC in perioperative echocardiography.⁷⁻¹¹ It is the opinion of the authors that a minimum of 50 comprehensive TEE examinations per year, performed, interpreted and reported are required to maintain an adequate level of expertise for an individual who has achieved a basic or an advanced level of expertise in perioperative TEE.¹² For MOC at a director level of expertise in perioperative echocardiography, at least 75 comprehensive perioperative echocardiographic examinations must be reviewed on a yearly basis and this number must include at least 50 comprehensive perioperative TEE examinations that are personally performed, interpreted and reported. Ongoing review with other colleagues of difficult or challenging cases is strongly encouraged for all levels of training. In addition, a total of 50 hours of CME, including at least 25 hours of accredited CME, over a four year period is recommended to maintain either a basic or an advanced level of expertise to ensure that the level of knowledge remains current with new developments in echocardiography. The requirements are more stringent for the director of a perioperative TEE who is expected to

complete 75 hours of CME including 37.5 hours of accredited CME over a four-year period to remain current with new developments in echocardiography.

The guidelines for the provision of echocardiography in Canada recommend 12 hours of accredited CME every two years for MOC of a level II training in TTE.¹⁴ This is similar to the recommended 25 hours of accredited CME for the Canadian training guidelines in adult perioperative TEE. The non-accredited CME is a concept that is also included in MOC by the Royal College of Physicians and Surgeons of Canada.

II. Provisions for continuing training in parallel with clinical activity

Dedicated echocardiographic training is recommended for the trainee who wants to achieve a basic level of expertise. Once a trainee has achieved a basic level of training there are several pathways that can be used to obtain an advanced level of expertise. Although the completion of an advanced level of training via a fellowship training program is preferred, the committee recognizes that it is also possible to achieve this level of expertise in parallel with clinical practice ("on the job" training) once a trainee has completed a basic level of training defined in the current guidelines.^{12,14-16} Therefore, a trainee with a basic level of expertise may fulfill the requirements for an advanced level of training, in parallel with clinical practice, by completing the required CME hours and echocardiographic studies. These echocardiographic studies must be performed and interpreted under the supervision of a physician with an advanced level of training. The supervising advanced level echocardiographer should be immediately available and be involved in an ongoing fashion. During training, the trainee should progressively acquire more independence and should receive periodic evaluations by the supervising echocardiographer. The advanced level of training that is obtained in parallel with clinical activities must be accomplished over a maximum period of two years. The cardiac centre should have the variety and requisite number of adult cardiac surgical cases to ensure that the trainee has an adequate exposure to the wide scope of perioperative TEE diagnosis that will allow the trainee to achieve an advanced level of training. At the end of training, the trainee should obtain a letter of recommendation from either the director of perioperative TEE or from the director of the echocardiography laboratory, stating that the trainee has achieved the expertise for an advanced level of training based on the knowledge and skills defined in the practice guidelines (Appendix 1).

A physician with an advanced level of expertise

could fulfill the training criteria for a director level of expertise outlined in Table III in parallel with clinical activities if she/he practices in a tertiary cardiac centre that has the appropriate infrastructure and case load. An individual who has achieved an advanced level of expertise has already demonstrated the ability to perform independent TEE studies at an advanced level. Therefore, the required additional CME hours and echocardiographic studies can be completed independently if the trainee practices in a tertiary care cardiac centre that has the variety of adult cardiac surgical cases to ensure an adequate exposure to the wide scope of perioperative TEE diagnosis.¹² However, it is recommended that at least 10% of these additional TEE cases be reviewed with another physician who has achieved an advanced level of training to ensure quality of care in the acquisition and interpretation of TEE studies. The additional required TEE cases and CME hours must be completed over a maximum period of two years. The trainee should also be able to provide documentation of his echocardiographic studies and required CME hours. Short courses or visitations of high level facilities are also encouraged to acquire the necessary expertise in the running of a perioperative TEE laboratory. This alternate avenue for achieving a director level of expertise will avoid the loss of anesthesia coverage and the financial burden associated with obtaining training in a different centre.¹²

III. Grandfathering of established practitioners

The committee recognizes that there are highly qualified practitioners actively engaged in perioperative TEE whose training did not follow the guidelines outlined in this document but who nonetheless have learned the techniques in other ways and have attained a high level of competence. It is not the intention of this document to prevent such individuals from practicing and providing important clinical care. It is hoped that this document will provide hospitals and regulatory committees general guidelines by which such nonstandard training can be evaluated.

IV. The role of TTE

The authors consider that although training in TTE is not required to learn TEE, the trainee should be encouraged to spend time in an academic echocardiography laboratory.

There may be significant added value to learning TTE during training in perioperative echocardiography for several reasons: 1) a trainee can obtain a high volume experience in a relatively short period of time, 2) a broad spectrum of pathology will be encountered, 3) a better understanding will be gained regarding

TABLE IV Contraindications to transesophageal echocardiography probe insertion

- Patient refusal
- Esophageal or gastric pathology that would predispose to perforation
- Respiratory distress in the non-intubated patient
- Cervical spine instability
- Severe coagulopathy

the indications, limitations and technical difficulties of TTE studies, 4) the echocardiography windows are more varied and require more spatial conceptualization for understanding, 5) an ongoing relationship with cardiology is important. Although the views and technical skills are different in TTE, the principles of echocardiography are similar and can usually be applied to TEE.

Transthoracic echocardiography training may also be useful for performing intraoperative epivascular echocardiography since manipulation of the epivascular probe has more similarities to TTE than TEE. Although epivascular echocardiography is an important diagnostic tool in the evaluation of aortic pathology, the epivascular echocardiographic studies performed by the trainee are not included in the recommended number of echocardiographic examinations (Table III). The decision to include TTE and TEE training in the cardiology echocardiography laboratory and the allocated proportion of training will depend on regional expertise and set-up. The knowledge and skills to achieve each level of training have been defined previously and the onus remains on each training centre to ensure that the candidate has achieved the necessary expertise.

V. The TEE examination

Potential complications of TEE should be explained to the patient, including a 1% risk of minor complications and a 0.01% risk of major complications.¹⁸ The risk of esophageal perforation may be higher than quoted in the literature, and in the presence of relative contraindications to TEE probe insertion, caution is advised. Contraindications to TEE probe insertion are described in Table IV.

Current guidelines do not require standard antibiotic prophylaxis prior to TEE.¹³ The documentation of a complete examination with adequate images should be obtained for each patient so that if consultation is later required, the necessary information will be available. In dealing with specific clinical situations,

additional non-standard views may be required. In critically ill patients, a targeted TEE examination is appropriate and should be structured to obtain the data which is essential to answer the specific questions of the referring physicians. A complete TEE study should include all the standard views from multiple planes including views of all cardiac structures as well as appropriate use of Doppler (Appendix 2).^{13,17,19}

VI. The intraoperative echocardiography report

In order to facilitate clinical care, the findings of the intraoperative echocardiographic examination must be transmitted to referring physicians and perioperative medical teams in an effective manner. The content of the report should provide clinically relevant, useful and timely information. The intraoperative echocardiography report should include all of the appropriate demographic and patient information to facilitate future retrieval and review of the examination. The report should openly acknowledge to the medical team any study limitations secondary to equipment, technical problems, image quality, time constraints and pathology complexity. The views of a basic exam should be obtained and stored for off-line analysis if later required. Failure to acquire the views of a basic exam should be reported as an incomplete examination.

The intraoperative echocardiographic report outlined in Appendix 3 of this document was adapted from the 2005 "guidelines for the provision of echocardiography in Canada" to reflect the intraoperative aspect of the examination which should include a pre-intervention and a post-intervention assessment. The pre-intervention report should reflect the echocardiographic indication(s) for the procedure and should include an evaluation of the structure and function of the anatomical components outlined in Appendix 3. It should represent all relevant quantitative and qualitative information derived from the examination. It should also compare the echocardiographic findings to the results of previous examinations and report findings not previously reported, in particular if these findings alter the course of patient care. The post-intervention report should include an assessment of the success of the procedure. It should also include any changes in right ventricular function, left ventricular function and valvular function, in addition to any new abnormalities that are identified during a brief but comprehensive post-surgical assessment.

A comprehensive echocardiographic evaluation of the structure and function of the anatomic components outlined in Appendices 3 and 4¹³ is encouraged, however, the intraoperative time available for a TEE study during cardiac surgery may be limited and pre-

clude the performance of all the echocardiographic measurements included in this document. In patients undergoing coronary artery bypass grafting, the focus may be on the evaluation of ventricular systolic and diastolic function. In patients who are undergoing cardiac surgery other than coronary artery bypass grafting, the focus should be on a comprehensive qualitative and/or quantitative assessment of the cardiac pathology that requires surgical intervention. A qualitative assessment of the function and structure of the other anatomic components outlined in Appendices 3 and 4 may be sufficient for a complete examination, provided that the intraoperative findings are consistent with the preoperative TTE assessment. Discrepancies with the preoperative TTE or new findings that require a change in surgical management must be documented with a comprehensive echocardiographic evaluation and appropriate quantitative measurements or analysis.

The final report must be in writing and part of the permanent patient record. The echocardiographic report can be generated by a physician with basic training in perioperative echocardiography as defined in the Canadian guidelines for training in perioperative echocardiography, but must be reviewed with a physician who has achieved an advanced level of training when echocardiographic findings are not clear, or if there is uncertainty in the echocardiographic qualitative or quantitative assessment.

The preliminary report

Echocardiography provides the ability to quickly derive valuable information regarding the hemodynamic status of critically ill patients. Physicians who have achieved a basic level of training (or higher) in perioperative echocardiography as defined in the Canadian Guidelines for training in Perioperative Echocardiography, are capable of recognizing a wide range of pathology and should be able to communicate echocardiographic findings directly with the cardiac surgeon in the operating room. However, findings that will impact on the surgical procedure should be done in consultation with a physician who has achieved an advanced level of training in echocardiography. Any clinical decisions based on preliminary observations remain the responsibility of the attending cardiac surgeon.

Conclusions

Perioperative TEE is a powerful monitoring and diagnostic tool. However, misinterpretation of TEE examinations can have catastrophic implications for the patient. With patient safety and quality of care in

mind, and as the availability and use of TEE increases, it is imperative that physicians obtain the necessary expertise and appropriate level of training prior to their routine performance of examinations. The Quebec expert consensus and the 2005 Guidelines for the Provision of Echocardiography in Canada formed the basis of the Canadian training guidelines in adult perioperative TEE. The increased training requirements at a basic and advanced level, outlined in the Quebec expert consensus on perioperative echocardiography, were endorsed in the Canadian training guidelines on perioperative TEE. Although the total number of interpreted echocardiographic examinations is the same as those specified in both the 2003 ACC/AHA guidelines and the 2002 ASE/SCA guidelines, the number of echocardiographic examination personally performed has been increased to ensure proficiency in the use of TEE while providing anesthesia care to the patient. In addition, as recommended in the Quebec expert consensus, successful completion of the PTE examination is required in the Canadian training guidelines on perioperative TEE. Both the role and the training requirements of a physician with basic training are increased as compared to those proposed by the 2002 ASE/SCA task force, to provide anesthesiologists with autonomy in the use of TEE at a basic level of training. Therefore, with these guidelines in place, the anesthesiologist with basic training will not only be able to perform a complete independent TEE examination during non-complex adult cardiac surgical procedures, but also, while ensuring proper anesthetic care, be able to identify findings requiring more advanced echocardiographic evaluation.

Finally, the physician with an advanced level of training will have the expertise to perform a complete echocardiographic evaluation in complex adult cardiac surgical cases while understanding the impact of anesthesia, cardiac surgery, assist devices and hemodynamic changes associated with the use of inotropes or vasoactive drugs on echocardiographic findings. The physician with advanced training will also have the expertise to participate in decisions that may impact on the surgical management of the patient. However, the panel acknowledges that this document outlines minimum training requirements and trainees are encouraged to exceed these guidelines. Moreover, consultation is strongly encouraged in the interpretation and management of complex echocardiographic cases.

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

Technical skills

1. Ability to operate ultrasonography including the primary controls affecting the quality of the displayed data.
2. Ability to insert a TEE probe safely in the anesthetized, tracheally intubated patient.
3. Ability to perform a comprehensive TEE examination and differentiate normal from markedly abnormal cardiac structures and function.
4. Ability to recognize marked changes in segmental ventricular contraction indicative of myocardial ischemia or infarction.
5. Ability to recognize marked changes in global ventricular filling and ejection.
6. Ability to recognize air embolization.

APPENDIX 1 Recommended training objectives for basic and advanced perioperative transesophageal echocardiography (TEE)

Basic training

Cognitive skills

7. *Ability to identify native and prosthetic valvular lesions or dysfunctions that would require consultation with a physician having an advanced level of training* (ability to recognize gross valvular lesions and dysfunctions).
8. *Ability to detect intracardiac masses and thrombus* (ability to recognize large intracardiac masses and thrombi).
9. *Ability to detect pericardial effusions* (ability to detect large pericardial effusions).
10. Ability to recognize common echocardiographic artifacts.
11. Ability to communicate echocardiographic results effectively to healthcare professionals, the medical record, and patients.
12. Ability to recognize complications of perioperative echocardiography.

Advanced training

Cognitive skills

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

Technical skills

1. All the technical skills defined under basic training.
2. Ability to acquire or direct the acquisition of all necessary echocardiographic data, including epicardial and epiaortic imaging.

3. Ability to recognize subtle changes in segmental ventricular contraction indicative of myocardial ischemia or infarction.
4. Ability to quantify systolic and diastolic ventricular function and to estimate other relevant hemodynamic parameters.
5. Ability to quantify normal and abnormal native and prosthetic valvular function.
6. Ability to assess the appropriateness of cardiac surgical plans.
7. Ability to identify inadequacies in cardiac surgical interventions and the underlying reasons for the inadequacies.
8. Ability to aid in clinical decision making in the operating room.

Reproduced with permission from the American Society of Echocardiography and Society of Cardiovascular Anesthesiologists Task Force Guidelines for Training in Perioperative Echocardiography 2002 published by Lippincott, Williams & Wilkins, and Elsevier.^{7,8} The modifications are indicated in italics and are limited to statements 7, 8 and 9 of the technical skills for Basic training with the original statement in parenthesis.

APPENDIX 2 Standard views of a comprehensive transesophageal echocardiography (TEE) examination

A complete TEE study should include *all the* standard views from multiple planes including views of all cardiac structures as well as appropriate use of Doppler.

1. Standard 4 chamber (0°-20°), 2 chamber (80°-100°) and long axis (120°-160°) views
2. Aortic valve short (30°-60°) and long axis (120°-160°) views
3. Bicaval view of atrial septum (80°-110°)
4. Images of the mitral valve from multiple planes
 - a. 4 chamber (0°-20°)
 - b. commissural (60°-70°)
 - c. 2 chamber (80°-100°)
 - d. long axis (120°-160°)
5. Images of the tricuspid valve from multiple planes
 - a. 4 chamber (0°-20°)
 - b. right ventricle inflow-outflow (60°-90°)
 - c. modified bicaval (110°-160°)
6. Longitudinal views of the ascending aorta and pulmonary valves

7. Imaging of atrial appendices
8. Identification of pulmonary veins
9. Appropriate use of saline or other contrast agents in the setting of evaluation for interatrial shunt or abnormal venous drainage
10. Transgastric short and long axis view for left ventricular function as well as appropriate angulated views for assessment of valves and prostheses. Specifically:
 - a. basal short (0°-20°)
 - b. mid short (0°-20°)
 - c. 2 chamber (80°-100°)
 - d. long axis (90°-120°)
 - e. right ventricle inflow (100-120°)
 - f. deep transgastric (0°-20° with antelexion)
11. *Main pulmonary artery and bifurcation (0°)*
12. Aorta (including ascending, arch and descending thoracic portions).

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APPENDIX 3 Components of an intraoperative echocardiography report

Basic components of an intraoperative transesophageal echocardiography report should include the following

- Patient identification
- Patient location
- Patient height, weight, body surface area, heart rate and rhythm
- The indication for the study (*e.g., surgical procedure*)

General study information including:

- Study date
- Referring physician identification
- Interpreting physician(s) identification
- Media location (*e.g., disk or tape number etc*)
- Location where study was performed (*e.g., OR, PACU, ER, ICU*)
- Sonographer identification
- Type of study (*e.g., transesophageal echocardiography*)
- Study technical quality (*e.g., teaching quality, good, fair, poor, incomplete*)

Pre-intervention report:

Evaluation of the structure and function of the following anatomic components of the examination: (the

minimum evaluation for each, and the implied meaning of a “normal” report is detailed in Appendix 4).

- Left ventricle
- Right ventricle
- Left atrium
- Left atrial appendage
- Right atrium
- Aortic valve
- Mitral valve
- Tricuspid valve
- Pulmonic valve
- Aorta
- Pulmonary artery
- Interventricular septum
- Interatrial septum
- Pulmonary veins
- Pericardium

Specific evaluation directed at the presenting problem and detected significant pathology

Post-intervention report:

Echocardiographic assessment directed at the surgical intervention

New abnormalities in the structure or function of the anatomic components outlined in the pre-intervention report.

Conclusions and summary

- Overall interpretation/summary of findings
- Assessment of presenting issue
- Relevant comparisons to prior studies or reports as available
- Study limitations
- Recommendations regarding alternative or additional investigations and consultation where appropriate

The above constitutes a basic examination. Specific indications or pathology require further targeted imaging and/or hemodynamic assessment. A full review of the specific data required for evaluation of all possible pathologies is beyond the scope of this review and the reader is referred to one of the many excellent comprehensive texts available. OR = operating room; PACU = post-anesthesia care unit; ER = emergency room; ICU = intensive care unit.

Adapted from the Guidelines for the Provision of Echocardiography in Canada published by Pulsus Group Inc. with permission from the CCS and Pulsus Group Inc.¹³ Modifications are indicated in italics.

APPENDIX 4 The meaning of “normal”

For each of the anatomic and functional components of the report, a minimum of information is expected and should be implied in the designation of “normal”. These include the following:

Left ventricle

- chamber size
- wall thickness
- systolic function
- diastolic function

Right ventricle

- chamber size
- wall thickness
- systolic function

Left atrium

- normal size
- absence of masses

Left atrial appendage

- absence of masses

Right atrium

- normal size
- absence of masses
- normal caval connections

Aortic valve

- normal morphology
- no significant stenosis
- no significant regurgitation

Mitral valve

- normal leaflet morphology
- normal chordal morphology
- normal leaflet coaptation
- no significant stenosis
- no significant regurgitation

Tricuspid valve

- normal leaflet morphology
- normal leaflet coaptation
- no significant stenosis
- no significant regurgitation

Pulmonic valve

- normal leaflet morphology
- no significant stenosis
- no significant regurgitation

Aorta

- normal annular dimension
- normal sinus of valsalva structure and size
- normal ascending aortic dimension
- normal arch dimensions
- normal proximal descending aorta

Pulmonary artery

- normal main pulmonary artery dimension

Interventricular septum

- normal thickness

no defect

Interatrial septum

- normal structure
- no defects or shunt flow

Pulmonary veins

- all four pulmonary veins identified
- pulmonary venous drainage in left atrium

Pericardium

- absence of significant effusion
- normal thickness

It is recognized that echocardiography is sensitive to various technologic limitations and the acquisition of a full set of interpretable data may not be possible for all patients. It is therefore important that such limitations be clearly stated within the report, in order to avoid the assumption of normality by the referring physician. Statements such as “imaging was suboptimal or impossible” or “reliable interpretation not possible” should be used where appropriate.

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