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

François Béique MD FRCPC¹, Mohamed Ali MD FRCPC², Mark Hynes MD FRCPC³, Scott MacKenzie MD FRCPC⁴, André Denault MD FRCPC^{5,6}, André Martineau MD FRCPC⁷, Charles MacAdams MD FRCPC⁸, Corey Sawchuk MD FRCPC⁹, Kristine Hirsch MD FRCPC¹⁰, Martin Lampa MD FRCPC¹¹, Patricia Murphy MD FRCPC¹², Georges Honos MD FRCPC¹³, Bradley Munt MD FRCPC¹⁴, Anthony Sanfilippo MD FRCPC¹⁵, Peter Duke MD FRCPC¹⁶

F Béique, M Ali, M Hynes, et al. 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. Can J Cardiol 2006;22(12):1015-1027.

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 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 examinations to achieve each level of expertise remains unchanged from the 2002 American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists guidelines. The increased proportion of examinations personally performed at basic and advanced levels, as well as the level of autonomy at the basic level suggested by the Quebec expert consensus are retained. These examinations may be performed in a perioperative setting and are not limited to intraoperative TEE. Training 'on-the-job', the role of the perioperative TEE examination, the requirements for maintenance of competence and the 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.

Key Words: Echocardiography, Perioperative, Standards of practice, Training guidelines, Training standards, Transesophageal echocardiography

¹Department of Anesthesia, Sir Mortimer B Davis Jewish General Hospital, McGill University, Montreal, Quebec; ²Department of Anesthesia and Surgery, Kingston General Hospital, Queen's University, Kingston; ³Department of Anesthesia and Critical Care Medicine, Ottawa Heart Institute, University of Ottawa, Ottawa, Ontario; ⁴Departments of Anesthesia and Medicine, St Boniface General Hospital, University of Manitoba, Winnipeg, Manitoba; ⁵Department of Anesthesiology; ⁶Department of Medicine, Critical Care Division, Montreal Heart Institute, University of Montreal, Montreal; ⁷Department of Anesthesia, Quebec Heart Institute/Laval Hospital, Laval University, Quebec City, Quebec; ⁸Department of Anesthesia, Foothills Medical Centre, University of Calgary, Calgary, Alberta; ⁹Department of Anesthesia, McMaster University, Hamilton, Ontario; ¹⁰Department of Anesthesia, Queen Elizabeth II Health Sciences Centre, Dalhousie University, Halifax, Nova Scotia; ¹¹Department of Anesthesia, Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia; ¹²Department of Anesthesia, Toronto General Hospital, University of Toronto, Toronto, Ontario; ¹³Department of Medicine, Division of Cardiology, Sir Mortimer B Davis Jewish General Hospital, McGill University, Montreal, Quebec; ¹⁴Department of Medicine, Division of Cardiology, St Paul's Hospital and Providence Health Care, University of British Columbia, Vancouver, British Columbia; ¹⁵Department of Medicine, Kingston General Hospital Queen's University, Kingston, Ontario; ¹⁶Departments of Anesthesia and Surgery, Health Sciences Centre, University of Manitoba, Winnipeg, Manitoba

Correspondence: Dr François Béique, Sir Mortimer B Davis Jewish General Hospital, 3755 chemin de la Côte Ste-Catherine, Montreal, Quebec H3T 1E2. Telephone 514-340-8222 ext 5701, fax 514-340-8108, e-mail fbeique@ana.jgh.mcgill.ca

Received for publication December 20, 2005. Accepted May 2, 2006

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

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'examen 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'examen réalisés personnellement aux niveaux élémentaire et avancé et le degré d'autonomie au niveau élémentaire suggérés par le consensus d'experts québécois. La formation « sur place », 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.

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.

EXECUTIVE SUMMARY

The Canadian guidelines for training in adult perioperative transesophageal echocardiography (TEE) include basic, advanced and director levels of expertise. For each level of training, the knowledge, skills and training requirements are clearly outlined in the present document. To ensure quality of care, successful completion of the perioperative TEE examination is required for those physicians who completed their training after 2005 before they can perform perioperative TEE autonomously at the basic, advanced or director levels of expertise. The guidelines also address grandfathering of established practitioners, training centre requirements, the role of transthoracic echocardiography (TTE), training in parallel with clinical activity, the components of a TEE report and a comprehensive TEE examination. Although several training pathways are proposed, the emphasis remains on obtaining the required expertise, and not on the specific pathway that is used to achieve this goal.

At the basic level of training, the trainee must review and interpret a minimum of 150 supervised echocardiographic examinations within a maximum period of one year. This number must include at least 100 comprehensive perioperative TEE examinations that are personally performed, interpreted and reported by the trainee under appropriate supervision. The trainee must also complete 50 h of continuing medical education (CME), including 25 h of accredited CME within a maximum period of two years. A trainee with basic training may perform a complete perioperative TEE examination autonomously, but echocardiographic findings that will significantly impact the surgical procedure must be done in consultation with a physician who has achieved an advanced level of training in perioperative TEE.

At the advanced level, trainees are required to review and interpret 300 echocardiographic examinations, including at least 200 comprehensive perioperative TEE examinations that are performed, interpreted and reported personally by the trainee under appropriate supervision within a maximum period of two years. Trainees must also complete 50 h of CME, including 25 h of accredited CME during their training. A physician who has successfully completed the advanced level of training qualifies as a consultant echocardiographer, with skills and knowledge to perform complex

adult echocardiographic examinations and render opinions that may affect surgical decisions.

The director level of expertise requires the trainee to review and interpret an additional 150 echocardiographic examinations, including at least 100 comprehensive perioperative TEE examinations that are personally performed, interpreted and reported within a maximum period of two years. A total of 75 h of CME, including 37.5 h of accredited CME, must also be completed within a four-year period. The director level of expertise is predominantly associated with administrative responsibility for the operation of a perioperative TEE service, and the training criteria outlined in the following document indicate the minimum requirements before an individual may be considered eligible for the directorship of this position.

Maintenance of competence (MOC) for the basic and advanced levels of training include the performance of 50 comprehensive perioperative TEE examinations per year and the completion of 50 h of CME within four years, including 25 h of accredited CME. At the director level of expertise, at least 75 comprehensive perioperative echocardiographic examinations must be reviewed on a yearly basis, and this number must include the performance of 50 perioperative TEE examinations. MOC for this level also requires the completion of 75 h of CME every four years, including 37.5 h of accredited CME.

These guidelines represent the minimum training requirements, and trainees are encouraged to exceed these guidelines. Consultation is also strongly encouraged in the interpretation and management of complex echocardiographic cases.

INTRODUCTION

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 the 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 increasingly popular role in anesthesia, with established practice guidelines. In the operating room, TEE has

TABLE 1

The American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists guidelines for training in perioperative echocardiography (2002)

	Basic	Advanced*	Director†
Echocardiographic examinations‡, n	150	300	450
Minimum intraoperative TEE examinations§, n	50	150	300
Total duration of training	NS	NS	NS
Total CME hours	20	50	NS
Perioperative TEE examination	NS	NS	NS
MOC: CME hours	NS	NS	NS
MOC: number of TEE per year	50	50	50

*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; ‡Includes 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 transesophageal echocardiographic (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. These recommendations were endorsed by the 2003 American College of Cardiology/American Heart Association clinical competence statement (9-11). CME Continuing medical education; MOC Maintenance of competence; NS Not specified. Adapted from references 7 and 8

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 or noncardiac 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 and Thys (1) published a historical perspective on training and certification in perioperative TEE. In 1987, the American Society of Echocardiography (ASE) published guidelines (2) for optimal physician training in echocardiography. 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 ASE in 1992 (3) for training in TEE. The American College of Cardiology (ACC) reaffirmed these recommendations in 1995 (4), but with a more comprehensive echocardiographic assessment that included a Doppler hemodynamic examination for each study performed. In 1996, a task force of the ASE and the Society of Cardiovascular Anesthesiologists (SCA) published practice guidelines (5) for perioperative TEE, identifying a basic and an advanced level of training (Appendix 1), and in 1998, the National Board of Echocardiography (6) established the first examination in perioperative TEE. In 2002, a joint task force of the ASE and the SCA published training requirements (7,8) in perioperative

TABLE 2

The American College of Cardiology/American Heart Association guidelines for training in transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) (2003)

	Basic	Advanced*	Director†
Interpreted TTE examinations‡, n	150	300	750
Performed TTE examinations§, n	75	150	300
Total duration of training, months	3	6	12
TEE training¶, n	NA	50	NS
Perioperative TEE examination	NS	NS	NS
MOC: number of TEE per year	NA	25-50	NS
MOC: CME hours per year	5	5	>5

*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; ‡Complete TTE examinations interpreted by the trainee under the supervision of a physician who has achieved an advanced or director level of expertise; §Complete TTE examinations 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. CME Continuing medical education; MOC Maintenance of competence; NA Not available; NS Not specified. Adapted from references 9-11

echocardiography to achieve each level of training (basic, advanced and director); qualifications for training programs and for program directors were also outlined (Table 1). The perioperative TEE training requirements of the American Society of Anesthesiologists and the SCA task force were endorsed in 2003 by the ACC and the 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 required advanced training in TTE (Table 2). In 2003, a Quebec expert consensus (12) outlined stringent training requirements for a basic, advanced and director level of expertise in perioperative echocardiography for anesthesiologists (Table 3). More recently, the Canadian Society of Echocardiography (CSE) and the Canadian Cardiovascular Society (13) identified training in TEE as part of the level II TTE training in the 2005 guidelines for the provision of echocardiography in Canada. MOC 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. The 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 may also be obtained as part of a perioperative echocardiography pathway as outlined in the present 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 the present document is to provide a national consensus on training guidelines in adult perioperative

TABLE 3
Canadian guidelines for training in perioperative transesophageal echocardiography (TEE) (2006)

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

*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; ‡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 parentheses. 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. CME Continuing medical education; MOC Maintenance of competence

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 may be used to facilitate this process. However, the emphasis is on obtaining the expertise in perioperative TEE, and not on the specific pathway 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 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 National Board of Echocardiography. Although the guidelines may be used for credentialing purposes, this decision remains hospital-based.

The training recommendations in the present 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 the document. These guidelines do not apply to TTE or pediatric or nonsurgical intensive care unit (ICU) patients, for whom 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, the guidelines will need further revisions to incorporate these changes. The training guidelines in the present 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, the ACC in 1995, and the ASE and the SCA in 2002 (Table 1) 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 the AHA and the 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 (12) in adult perioperative TEE (Table 3). 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 cardiovascular 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 the basic and advanced levels of training were outlined previously in the report of the joint task force of the American Society of Anesthesiologists and the SCA published in 1996 (5). The recommendations were updated and modified in 2002 by the joint task force of the ASE and the SCA on physician training in perioperative echocardiography to include epicardial echocardiography and epivascular echocardiography. The knowledge and skills described in the 2002 the 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 TEE (12) (Appendix 1) (7,8). However, compared with the 2002 ASE/SCA guidelines, in the Canadian training guidelines on perioperative TEE, the required knowledge and skills at the basic level of training are increased to provide the physician with a level of autonomy in the operating room (12) (Appendix 1) (7,8).

The training requirements to achieve basic, advanced and director levels of expertise are outlined in Table 3. 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 CME hours commensurate with the 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 the present document (Appendix 1) (7,8,12). Therefore, at a basic level of training, the anesthesiologist may 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, a TEE diagnosis that will significantly impact the surgical procedure must be made in consultation with a physician who has advanced training in perioperative TEE (7-12).

Advanced level: An advanced level of training is required when a TEE diagnosis will have a direct impact on the surgical management of the patient (eg, 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 a physician the ability to participate in the training of other physicians who wish to acquire expertise in perioperative TEE.

Director level: The director of perioperative TEE is predominantly an administrative position conferred by the hospital on an appropriately qualified individual. The intent of the present document is to describe the training, knowledge and skills required before an individual is considered to take on the 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 on 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 the present 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 and storage of echocardiographic

equipment and on 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 studies in the ICU or in the preoperative setting, the director may also be responsible for the quality control of these TEE studies. However, the role of the director in the ICU or 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 (2) and in 1995 by the ACC (4) on training for TTE recommended three months of training for a basic level and six months of training for an advanced level of expertise. 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 2003 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 the basic, advanced and director levels of expertise is included in the Canadian training guidelines on perioperative echocardiography to facilitate the organization of a focused training process and provide an estimate of the anticipated training period (Table 3). 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 perioperative TEE 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 may be achieved during a one-year fellowship in cardiac anesthesia with echocardiography training or during a six-month fellowship in echocardiography. It is also recognized that training may be interrupted or performed in parallel with clinical activity (see section II, 'Provisions for continuing training in parallel with clinical activity'). 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 3). However, the emphasis is not on the specific duration of training, but rather 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 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: A trainee who has achieved an advanced level of expertise may complete the required additional echocardiographic studies for a director level of expertise during the subsequent three months of training in perioperative echocardiography (Appendix 1). The panel also recognizes that training may be interrupted or performed in parallel with clinical activity (see section II). However, the additional required 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 3).

Number of echocardiographic examinations

Previous guidelines for basic training in 1987 (2) and 1995 (4) on TTE required that the trainee interpret 150 examinations, including 75 examinations that are personally performed. In 1992, the ASE indicated that 50 TEE examinations, including 25 probe insertions, would be required for training in TEE, in addition to obtaining level II training as defined in Table 1 (3). In 2002, the ASE and the SCA guidelines for training in perioperative echocardiography identified 150 complete echocardiographic studies, which are interpreted and reported at a basic level of expertise, as the minimum number of examinations required at a basic level of expertise (7,8). According to these guidelines, the examinations must include at least 50 comprehensive intraoperative TEE studies that are personally performed, interpreted and reported by the trainee (Table 1) (7,8). At an advanced level of training, the ASE and the 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 1) (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 advanced levels 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 they 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 3). Selected comprehensive echocardiographic studies from an existing

database may also be used for this purpose (12). Trainees who obtain the training after 2006 are required to keep a log of all the studies performed.

Basic level: During the 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 3) (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). TTE and TEE examinations performed during residency training, as part of a dedicated rotation in an echocardiography laboratory, may also qualify in the current guidelines toward the required number of examinations personally performed for a basic level of training. However, the required number of echocardiographic examinations must be completed within one 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 3) (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: At the director level of expertise, the requirements are similar to those proposed by the ASE and the 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 adequate exposure to the wide scope of perioperative TEE diagnoses. A trainee who has achieved the advanced level of training must complete the required additional number of echocardiographic examinations within a two-year period to obtain the director level of expertise.

Training centres

A minimum of two physicians with advanced training in perioperative TEE should be required before a centre is 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 the present document (12). Although two anesthesiologists with advanced training may be sufficient to provide advanced training, it is the opinion of the authors of the present paper 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 adequate exposure to the wide scope of perioperative TEE diagnoses (7-12). As stated in the recent training guidelines published by the ASE and the SCA, the authors also emphasize the importance of case diversity to ensure that the trainee can use TEE effectively in all clinically established current applications (7-12).

Perioperative TEE 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 perioperative TEE examination (7-11). In the Canadian training guidelines on perioperative echocardiography, the basic and the advanced levels of training both require completion of the perioperative TEE examination (Table 3). This provides a useful tool to ensure that trainees have not only completed the required CME hours, but that they 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 perioperative TEE examination may be considered to represent a more advanced level of training, it is also included at the 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 perioperative TEE examination is therefore required before a trainee may perform perioperative TEE autonomously at a basic level.

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

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

Completion of the perioperative TEE examination should be performed 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 perioperative TEE examination at a later date, provided that the trainee maintains the appropriate level of expertise as outlined in the MOC section of the present document. In the future, the development of a Canadian examination process in perioperative echocardiography would likely replace the perioperative TEE examination in the Canadian training guidelines.

CME

The 2003 ACC/AHA clinical competence statement in echocardiography and the 2002 ASE/SCA guidelines recommend 20 h of CME for a basic level of expertise and 50 h of CME for an advanced level of expertise in perioperative echocardiography (7-11). In the Canadian training guidelines on perioperative echocardiography, the basic and advanced levels of training both require the completion of 50 h of CME, including at least 25 h of accredited CME. In the opinion of the authors of the present paper, 50 h of CME is the minimum for the candidate to achieve a passing score on the perioperative TEE 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 h of CME over a maximum period of four years, including at least 37.5 h of accredited CME.

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

MOC

The 2003 ACC/AHA clinical competence statement in echocardiography recommends 25 to 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 of the present paper that a minimum of 50 comprehensive TEE examinations per year, personally performed, interpreted and reported, is 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 the 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 h of CME over a four-year period, including at least 25 h of accredited CME, 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 h of CME, including 37.5 h 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 h of accredited CME every two years for MOC of a level II training in TTE (14). This is similar to the recommended 25 h of accredited CME for the Canadian training guidelines in adult perioperative TEE. Nonaccredited CME is a concept that is also included in MOC by the Royal College of Physicians and Surgeons of Canada.

TABLE 4
Contraindications to transesophageal echocardiographic probe insertion

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

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 the basic level of training, there are several pathways 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 as defined in the current guidelines (12,14-16). Therefore, a trainee with the basic level of expertise may fulfill the requirements for the 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 involved in an ongoing fashion. During training, the trainee should progressively acquire more independence and 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 diagnoses 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 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).

Physicians with an advanced level of expertise could fulfill the training criteria for the director level of expertise outlined in Table 3 in parallel with clinical activities if they practice 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 may be completed independently if the trainee practices in a tertiary care cardiac centre that has the variety of adult cardiac surgical cases to ensure adequate exposure to the wide scope of perioperative TEE diagnoses (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. Trainees should also be able to provide documentation of their echocardiographic studies and required CME hours. Short courses or visitations of high-level facilities are also encouraged to acquire the necessary expertise in the operation of a perioperative TEE laboratory. This alternate avenue for achieving the 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 the present document, but who nonetheless have learned the techniques in other ways and attained a high level of competence. It is not the intention of the present document to prevent such individuals from practising and providing important clinical care. It is hoped that the present document will provide hospitals and regulatory committees general guidelines by which such nonstandard training may be evaluated.

IV. THE ROLE OF TTE

The authors of the present paper recognize 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: a trainee can obtain a high volume experience in a relatively short period of time; a broad spectrum of pathology will be encountered; a better understanding will be gained regarding the indications, limitations and technical difficulties of TTE studies; the echocardiography windows are more varied and require more spatial conceptualization for understanding; and 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.

TTE training may also be useful for performing intraoperative epivascular echocardiography because 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 3). 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 setup. The knowledge and skills to achieve each level of training were previously defined, 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, including a 1% risk of minor complications and a 0.01% risk of major complications, should be explained to the patient (18). The risk of esophageal perforation may be higher than quoted in literature, and in the presence of relative contraindications to TEE probe insertion, caution is advised. Contraindications to TEE probe insertion are described in Table 4.

Current guidelines do not require standard antibiotic prophylaxis before 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 nonstandard views may be required. In critically ill patients, a targeted TEE examination is appropriate and should be structured to obtain the data, which are 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 echocardiography (Appendix 2) (13,17,19).

VI. THE INTRAOPERATIVE ECHOCARDIOGRAPHY REPORT

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 appropriate demographic and patient information to facilitate the 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 examination should be obtained and stored for offline analysis, if later required. Failure to acquire the views of a basic examination should be reported as an incomplete examination.

The intraoperative echocardiographic report outlined in Appendix 3 of the present 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 preintervention and postintervention assessments. The preintervention report should reflect the echocardiographic indication(s) for the procedure, and 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 with the results of previous examinations and findings not previously reported, particularly if these findings alter the course of patient care. The postintervention 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 identified during a brief but comprehensive postsurgical assessment.

A comprehensive echocardiographic evaluation of the structure and function of the anatomic components outlined in Appendixes 3 and 4 (13) is encouraged, however, the intraoperative time available for a TEE study during cardiac surgery may be limited and may preclude the performance of all the echocardiographic measurements included in the present document. In patients undergoing coronary artery bypass grafting surgery, 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 Appendixes 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 must be a part of the permanent patient record. The echocardiography report may be generated by a physician with basic training in perioperative echocardiography as defined in the Canadian guidelines for training in perioperative echocardiography, but it must be reviewed with a physician who has achieved the 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 pathologies and should be able to communicate echocardiographic findings directly with the cardiac surgeon in the operating room. However, findings that will impact 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 before 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 the basic and advanced levels, 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 that specified in both the 2003 ACC/AHA and the 2002 ASE/SCA guidelines, the required number of echocardiographic examinations 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 perioperative TEE 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 compared with

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 noncomplex adult cardiac surgical procedures, but also be able to identify findings requiring more advanced echocardiographic evaluation while ensuring proper anesthetic care.

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 the surgical management of the patient. However, the panel acknowledges that the present 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.

APPENDIX 1

Recommended training objectives for basic and advanced levels of perioperative transesophageal echocardiography

Basic training

Cognitive skills

1. Knowledge of the physical principles of echocardiographic image formation and blood velocity measurement.
2. Knowledge of the operation of ultrasonography equipment, including all controls that affect the quality of data displayed.
3. Knowledge of 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 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 equipment, including the primary controls affecting the quality of the displayed data.
2. Ability to insert a transesophageal echocardiographic probe safely in an anesthetized, tracheally intubated patient.

APPENDIX 1 – CONTINUED

Recommended training objectives for basic and advanced levels of perioperative transesophageal echocardiography

3. Ability to perform a comprehensive transesophageal echocardiographic examination, and differentiate normal from markedly abnormal cardiac structures and function.
4. Ability to recognize marked changes in segmental ventricular contraction indicative of myocardial ischemia or infarction.
5. Ability to recognize marked changes in global ventricular filling and ejection.
6. Ability to recognize air embolization.
7. *Ability to identify native and prosthetic valvular lesions or dysfunctions that would require consultation with a physician who has 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 health care professionals and patients, as well as on a medical record.
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, this knowledge must be detailed).
5. Detailed knowledge of all other diseases of the heart and great vessels relevant in the perioperative period (if pediatric practice is planned, this knowledge may be more general).
6. Detailed knowledge of the techniques, advantages, disadvantages and potential complications of commonly used cardiac surgical procedures for the 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 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.

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 parentheses. Reproduced with permission from references 7 and 8

APPENDIX 2**Standard views of a comprehensive transesophageal echocardiographic examination**

A complete transesophageal echocardiographic study should include *all the* standard views from multiple planes, including views of all cardiac structures, as well as the appropriate use of Doppler echocardiography:

1. Standard four-chamber (0°–20°), two-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 the atrial septum (80°–110°);
4. Images of the mitral valve from multiple planes:
 - a. four-chamber (0°–20°);
 - b. commissural (60°–70°);
 - c. two-chamber (80°–100°); and
 - d. long-axis (120°–160°).
5. Images of the tricuspid valve from multiple planes:
 - a. four-chamber (0°–20°);
 - b. right ventricular inflow-outflow (60°–90°); and
 - c. modified bicaval (110°–160°).
6. Longitudinal views of the ascending aorta and pulmonary valves;
7. Imaging of atrial appendages;
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 views 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. two-chamber (80°–100°);
 - d. long-axis (90°–120°);
 - e. right ventricular inflow (100°–120°); and
 - f. deep transgastric (0°–20° with antelexion).
11. *Main pulmonary artery and bifurcation (0°); and*
12. *Aorta (including the ascending, arch and descending thoracic portions).*

Reproduced from reference 13 (modifications are indicated in italics)

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 (*eg, surgical procedure*); and
- General study information, including:
 - study date;
 - referring physician identification;
 - interpreting physician(s) identification;
 - media location (*eg, disk or tape number, etc*);
 - location where study was performed (*eg, operating room, postanesthesia care unit, emergency room, intensive care unit*);
 - sonographer identification;
 - type of study (*eg, transesophageal echocardiography*); and
 - study technical quality (*eg, teaching quality, good, fair, poor, incomplete*).

APPENDIX 3 – CONTINUED**Components of an intraoperative echocardiography report**

Preintervention report:

- Evaluation of the structure and function of the following anatomical 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; and
 - pericardium.
- Specific evaluation directed at the presenting problem and detected significant pathology.

Postintervention report:

- *Echocardiographic assessment directed at the surgical intervention.*
- *New abnormalities in the structure or function of the anatomic components outlined in the preintervention report.*

Conclusions and summary:

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

The above constitutes a basic examination. Specific indications or pathologies 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 the present review, and the reader is referred to one of the many excellent comprehensive texts available. Adapted from the reference 13 (modifications are indicated in italics)

APPENDIX 4**The meaning of 'normal'**

For each anatomical and functional component of the report, a minimum of information is expected and should be implied in the designation of 'normal'. This includes the following:

- Left ventricle
 - chamber size;
 - wall thickness;
 - systolic function; and
 - diastolic function.
- Right ventricle
 - chamber size;
 - wall thickness; and
 - systolic function.

Continued on page 1026

APPENDIX 4 – CONTINUED

The meaning of 'normal'

- Left atrium
 - normal size; and
 - absence of masses.
- Left atrial appendage
 - absence of masses.
- Right atrium
 - normal size;
 - absence of masses; and
 - normal caval connections.
- Aortic valve
 - normal morphology;
 - no significant stenosis; and
 - no significant regurgitation.
- Mitral valve
 - normal leaflet morphology;
 - normal chordal morphology;
 - normal leaflet coaptation;
 - no significant stenosis; and
 - no significant regurgitation.
- Tricuspid valve
 - normal leaflet morphology;
 - normal leaflet coaptation;
 - no significant stenosis; and
 - no significant regurgitation.
- Pulmonic valve
 - normal leaflet morphology;
 - no significant stenosis; and
 - no significant regurgitation.
- Aorta
 - normal annular dimension;
 - normal sinus of valsalva structure and size;
 - normal ascending aortic dimension;
 - normal arch dimensions; and
 - normal proximal descending aorta.
- Pulmonary artery
 - normal main pulmonary artery dimension.
- Interventricular septum
 - normal thickness; and
 - no defect.
- Interatrial septum
 - normal structure; and
 - no defects or shunt flow.
- Pulmonary veins
 - all four pulmonary veins identified; and
 - pulmonary venous drainage in left atrium.
- Pericardium
 - absence of significant effusion; and
 - normal thickness.

It is recognized that echocardiography is sensitive to various technological 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 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. Reproduced from reference 13 (modifications are indicated in italics)

REFERENCES

1. Aronson S, Thys DM. Training and certification in perioperative transesophageal echocardiography: A historical perspective. *Anesth Analg* 2001;93:1422-7.
2. Pearlman AS, Gardin JM, Martin RP, et al. Guidelines for optimal physician training in echocardiography. Recommendations of the American Society of Echocardiography Committee for Physician Training in Echocardiography. *Am J Cardiol* 1987;60:158-63.
3. Pearlman AS, Gardin JM, Martin RP, et al. Guidelines for physician training in transesophageal echocardiography: Recommendations of the American Society of Echocardiography Committee for Physician Training in Echocardiography. *J Am Soc Echocardiogr* 1992;5:187-94.
4. Stewart WJ, Aurigemma GP, Bierman FZ, et al. Guidelines for training in adult cardiovascular medicine. Core Cardiology Training Symposium (COCATS). Task Force 4: Training in echocardiography. *J Am Coll Cardiol* 1995;25:16-9.
5. Thys DM, Abel M, Bollen BA, et al. Practice guidelines for perioperative transesophageal echocardiography. A report by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography. *Anesthesiology* 1996;84:986-1006.
6. Aronson S, Butler A, Subhiyah R, et al. Development and analysis of a new certifying examination in perioperative transesophageal echocardiography. *Anesth Analg* 2002;95:1476-82.
7. Cahalan MK, Abel M, Goldman M, et al. American Society of Echocardiography and Society of Cardiovascular Anesthesiologists Task Force guidelines for training in perioperative echocardiography. *Anesth Analg* 2002;94:1384-8.
8. Cahalan MK, Stewart W, Pearlman A, et al. American Society of Echocardiography and Society of Cardiovascular Anesthesiologists Task Force guidelines for training in perioperative echocardiography. *J Am Soc Echocardiogr* 2002;15:647-52.
9. Quinones MA, Douglas PS, Foster E, et al. American College of Cardiology/American Heart Association clinical competence statement on echocardiography. A report of the American College of Cardiology/American Heart Association/American College of Physicians – American Society of Internal Medicine Task Force on Clinical Competence. *Circulation* 2003;107:1068-89.
10. Quinones MA, Douglas PS, Foster E, et al. ACC/AHA clinical competence statement on echocardiography. A report of the American College of Cardiology/American Heart Association/American College of Physicians – American Society of Internal Medicine Task Force on Clinical Competence. *J Am Coll Cardiol* 2003;41:687-708.
11. Quinones MA, Douglas PS, Foster E, et al. ACC/AHA clinical competence statement on echocardiography. A report of the American College of Cardiology/American Heart Association/American College of Physicians – American Society of Internal Medicine Task Force on Clinical Competence. *J Am Soc Echocardiogr* 2003;16:379-402.
12. Béique FA, Denault AY, Martineau A, et al. Expert consensus for training in perioperative echocardiography in the province of Quebec. *Can J Anesth* 2003;50:699-706.
13. Sanfilippo A, Bewick D, Chan KL, et al. Guidelines for the provision of echocardiography in Canada: Recommendations of a joint Canadian Cardiovascular Society/Canadian Society of Echocardiography Consensus Panel. *Can J Cardiol* 2005;21:763-80.
14. Thys DM. Clinical competence in echocardiography. *Anesth Analg* 2003;97:313-22.

15. Savage RM, Licina MG, Koch CG, et al. Educational program for intraoperative transesophageal echocardiography. *Anesth Analg* 1995;81:399-403.
16. Cahalan MK, Foster E. Training in transesophageal echocardiography: In the lab or on the job? (Edit). *Anesth Analg* 1995;81:217-8.
17. Shanewise JS, Cheung AT, Aronson S, et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: Recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. *Anesth Analg* 1999;89:870-84.
18. Kallmeyer IJ, Collard CD, Fox JA, et al. The safety of intraoperative transesophageal echocardiography: A case series of 7200 cardiac surgical patients. *Anesth Analg* 2001;92:1126-30.
19. Shanewise JS, Cheung AT, Aronson S, et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: Recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. *J Am Soc Echocardiogr* 1999;12:884-900.

This article was published concurrently in the *Canadian Journal of Anesthesia* (Can J Anesth 2006;53:1044-60).