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COMMENTARY

Essential training steps to achieving competency in the basic intraoperative transesophageal echocardiography examination for Chinese anesthesiologists

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Abstract **Guidelines for the intraoperative transesophageal echocardiography (TEE) examination have defined a detailed standard for medical professionals, particularly anesthesiologists, on how a TEE exam should proceed. Over the years, TEE has gained substantial popularity and emerged as a preferred monitoring modality to aid in perioperative management and decision making during hemodynamic instability situations or critical care settings. TEE training pathways and practice guidelines have been well established in western countries and many regions of the world. However, TEE training and practice information for anesthesiologists are lacking in China. As innovative technologies develop, other educational models have emerged to aid in obtaining competency in basic TEE exam. Hence, establishing a consensus on the ideal TEE training approach for anesthesiologists in China is urgently needed. Developing an effective curriculum that can be incorporated into an anesthesiology resident's overall training is also necessary to provide knowledge and skills toward competency in basic TEE exam. With evolving medical system reforms and increasing demands for intraoperative hemodynamic monitoring to accommodate surgical innovations, anesthesiology professionals are increasingly obliged to perform intraoperative TEE exams in their current and future practices. To overcome obstacles and achieve significant progress in using the TEE modality to help in intraoperative management and surgical decision making, publishing basic TEE training guidelines for China's anesthesiologists is an important endeavor.**

Keywords transesophageal echocardiography; guidelines; training; competency

Training and practice guidelines for TEE in the United States

In 1999, the American Society of Echocardiography (ASE) and the Society of Cardiovascular Anesthesiologists (SCA) jointly published the first guidelines for performing a comprehensive perioperative transesophageal echocardiography (PTE) examination [1]. This historical documentation defined a detailed standard for medical professionals, particularly anesthesiologists, on how a complete multi-plane, intraoperative transesophageal echocardiography (TEE) examination should proceed. It also laid out a framework whereby academic institutions could develop their own pathways for training anesthesia providers, residents, or fellows to become competent echocardiographers within a clinical practice. In the article, the task force outlined 20 fundamental echo views to be used as references for each individual to capture cardiac structures and evaluate baseline cardiac functions. These guidelines were subsequently revised in 2002 [2]. The updated guidelines further delineated the training process for the PTE exam, including prerequisite echocardiographic knowledge and skills, training components and duration, and appropriate training environment and supervision. Over the years, TEE has gained substantial popularity and emerged as a preferred monitoring modality to aid perioperative management or decision making during hemodynamic instability situations or critical care

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settings [3, 4]. In 2010, the American Society of Anesthesiologists formed a task force with the SCA and adapted and further updated the existing recommendations. This group published practice guidelines for perioperative TEE exams that could assist physicians in determining the appropriate application of TEE. These guidelines also supported using the PTE exam to improve the quality of a surgical patient's care [5]. Recommendations were designed for advanced TEE clinicians who routinely use such modalities to guide appropriate diagnoses and to form treatment decisions for cardiac diseases. The task force provided scientific supporting evidence and summarized sensitivity, specificity, and predictive values of PTE exam use.

Over the last few years, growing interest in using TEE as a basic tool to help a physician's perioperative management based on TEE-derived monitoring information has emerged. This new development prompted the ASE and SCA to publish yet another basic perioperative TEE exam recommendation [6]. This expert consensus statement was tailored to the performance of a focused or goal-directed TEE exam. The limited application of the basic PTE exam was intended for non-diagnostic monitoring within the customary practice of anesthesiology. Therefore, basic PTE training is primarily focused on intraoperative monitoring, whereas advanced training targets specific diagnoses [7]. The individual who trains through the basic TEE pathway would not be required to possess the same degree of knowledge and skills as advanced PTE diplomats but must still be expected to use the fundamental knowledge and skills that could facilitate intraoperative surgical intervention and medical management, as with any other proven clinical monitoring method. The basic TEE exam consensus statement also suggests that focusing the basic PTE examination on 11 of the most relevant views, instead of 20, can provide adequate information for diagnosing certain etiologies of hemodynamic instability in surgical patients. In their statement, the task force emphasized, "The individual patient characteristics, anatomic variations, pathologic features, or time constraints imposed on performing the basic PTE examination may limit the ability to perform every aspect of the examination and, furthermore, that there may be other entirely acceptable approaches and views of an intraoperative examination, provided they obtain similar information in a safe manner" [6].

Training and practice guidelines for TEE outside the United States

In addition to the United States, other continents and nations have worked extensively with their professional societies and authorized organizations to develop their own TEE training pathways and practice guidelines. The Canadian Society of Anesthesiologists launched its training guidelines for the adult PTE exam in 2006 [8]. These guidelines reflect the unique Canadian practice profile in perioperative TEE and address the training requirements for obtaining expertise in this field. Canada's basic TEE training holds criteria similar to the ASE/SCA published guidelines. In summary, at the basic level of training, the trainee must review and interpret a minimum of 150 echo exams, 100 of which must be personally performed, interpreted, and reported by the trainee under appropriate supervision. The trainee is also required to complete 50 h of TEE-related continuing medical education (CME), including 25 h of accredited CME within the past two years. Different from the American guidelines, Canadian training also requires three months of dedicated TEE training time. In addition, to maintain each individual competency for basic TEE operational skills, all physicians must perform at least 50 comprehensive PTE exams per year [8]. Basic TEE accreditation in Europe was established in 2005 [7,9], and the accreditation process consists of two parts [10]. The theoretical knowledge component is assessed through a computer-based written exam, while the practical skill component requires all candidates to submit for approval a clinical case log of 125 PTE exams performed personally in a 12-month period; of these, 15 cases are selected randomly and evaluated by the examiners. In Australia and New Zealand, although no formal accreditation process is practiced, the Australian and New Zealand College of Anaesthetists have issued guidelines for the training and practice of the PTE exam [11]. Competency in the PTE exam is defined as the equivalent of 50 full-time days over a minimum period of 10 weeks to a maximum of two years. The trainee is expected to perform and report on 50 complete PTE exams under appropriate supervision, 50 unsupervised exams, and at least 100 additional supervised reviews. Australian and New Zealand College of Anaesthetists guidelines also include a web-based distance educational program that provides a spectrum TEE case reviews for anesthesiology professionals around the world [12]. Other Asian countries and regions that have developed individual TEE education and training guidelines include Japan, Singapore, and Taiwan of China [13].

Other educational models to obtain competency on the basic echo examination

As innovative technologies develop, other educational models have emerged to aid in obtaining competency in the basic echo exam. Education is the most important tool to assist in changing the anesthesiology community's perspective of TEE use in daily clinical practice. Other subspecialty programs have developed bedside training models to provide individual trainees with a rapid method

of achieving knowledge and skills toward competency in the goal-directed basic clinical ultrasound exam (Table 1). Examples include heart scan, FOCUS, FATE, FEEL, FEAR, and BLEEP, which allow a sequence of basic exams and are limited in scope for the interpretation of cardiovascular pathology [4,12]. The American Society of Anesthesiologists and SCA have teamed up to develop a similar introductory CME TEE course focused on basic TEE knowledge and skills, which is offered four times a year across the United States [14]. No consensus on the ideal training approach or "standardized protocol" for achieving competency on the PTE exam has yet been presented. However, many anesthesiologists find that conducting a basic PTE exam is sufficient to meet the expectation of routine practice [15]. The American College of Emergency Physicians and ASE recommend a two- or three-day course to cover all 11 applications of clinical ultrasound, with only 6–8 h of hands-on skill maneuvers and no standardized assessment [7]. Only 3–4 h of didactics allocated to cardiac ultrasound is deemed sufficient, with only 2–4 h of echo equipment manipulation exercises. Several other programs, including a trauma surgery fellowship and the American College of Chest Physicians, have proposed a similar bedside echo training curriculum, offering a 3-day course followed by a supplemental online educational portfolio to meet their proposed competency certification [16].

Standardizing the basic TEE training curriculum

Based on the successes of other academic institutions, an effective curriculum can be incorporated into an anesthesiology resident's overall training to provide skills toward competency in basic TEE exam [4]. Australia's success shows that educational initiatives can change perceptions in clinical practice. The University of Melbourne has conducted distance educational courses since 2004, and these courses continue to flourish and evolve. The university recently collaborated with the SCA to provide online access to professional development courses for anesthesiologists worldwide [12]. The University of Florida has shared its educational objectives and training experience with Chinese anesthesiologists in recent years, thereby developing a stepwise practical approach for residents and anesthesia providers to obtain competency in basic TEE [4]. All interested trainees are required to secure a designated TEE rotation for a minimum two-week (80-hour) block. The TEE training curriculum mandates all trainees to review fundamental knowledge about TEE prior to performing a TEE exam on any patient. Supervising attending physicians are responsible for teaching safe probe insertion, image acquisition, and interpretation, as well as how to care for the TEE machine. All TEE examination reports are co-signed by the supervising TEE-certified anesthesiologist. Additional learning resources, such as TEE simulation practice and web-based educational access, are provided.

All trainees must review TEE programs and reading materials before they can perform a TEE exam on a patient. A biweekly didactic TEE lecture series and periodic hands-on transthoracic echocardiography workshops are arranged to supplement the TEE training. In addition, trainees participate with a TEE-certified anesthesiologist in monthly TEE case review sessions that cover a spectrum of complex cardiac cases and review a minimum of 15 specific types of TEE cases archived in the TEE imaging library. This case library augments the echo graphic knowledge required to make accurate diagnoses of cardiac pathology and hemodynamic instability during daily anesthesia practice.

West China Medical Center of Sichuan University, highlighting the importance of visual technology in anesthesia practice, recently launched visual technology-orientated training courses and conferences [17]. Recognizing the importance of TEE in clinical practice and the lagging knowledge and work force in the field of

Table 1 Comparison of training models in obtaining competency on basic ultrasound (US)/TEE skills

Modules	Training period	Cases proposed	TEE course	Hands on	Special setup
Canadian Anesthesiology	3 months	150 cases	50 designated CME hours	100 personally performed cases	Continue to perform TEE at 50 case/year
Europe	Over 1 year	125 cases/12 months	Computer-written exam	125 personally performed cases	Audit 15 cases evaluated by the examiners
Australia and New Zealand	10 weeks to 2 years	50 cases supervised; 50 cases unsupervised	Online course	100 personally performed cases	Supervised review of 100 cases
ACEP*		11 applications of clinical ultrasound	2- to 3-day course	6–8 h of skill maneuvers	3–4 h of didactic for cardiac US
ACCP#		Complete online learning module	3-day course	Complete online portfolio	Pass assessment exam

*ACEP, American College of Emergency Physicians; #ACCP, American College of Chest Physicians.

anesthesiology in China, West China Medical Center established China's first TEE training center for anesthesiologists and partnered with West Science Academy in Sichuan Province to develop a TEE simulation module (VRsim) [18]. This state-of-the-art simulation program is a highly sophisticated and efficient alternative pathway that can teach trainees how to perform a TEE exam, although TEE training with simulation is limited in the sense that it may not provide adequate detail spectrum information to meet the necessary training expectations. The evolving TEE simulation-training model may potentially become an effective educational pathway that can replace traditional training methods wherein trainees must practice their skills by performing repeated TEE exams on the same patient [19]. In addition to attending a scheduled TEE lecture series, all trainees have abundant time to practice TEE skills at the simulation laboratory. This training program is developed under a unique paradigm comprising 4 different phases taking place over a total of 3 months [18]: phase 1, mandatory TEE lectures; phase 2, simulation training; phase 3, assessment with simulator; and phase 4, clinical training in the operating room. All trainees undergo this vigorous, systemic training program, which includes a uniquely designed curriculum, designated operating room TEE exam time, a broad spectrum of case coverage, and standard TEE reports, and all graduates study a minimum of 100 cases during their three-month training. Upon successful completion of the program, trainees are issued a competency evaluation booklet and certification. This program has achieved significant progress, producing not only a skilled TEE anesthesiologist workforce but also trained TEE professional educators who have established similar TEE training centers in their respective medical institutions in different regions of China.

Developing TEE training guidelines for Chinese anesthesiologists

Despite growing enthusiasm and efforts to incorporate clinical ultrasound into anesthesia practice, China continues to face an uphill battle in formalizing TEE training and practice in the anesthesiology subspecialty. Many issues in the current system hinder expected progress. One of the traditional conceptual agreements in hospital policy is that TEE requires expert skills and must be performed by cardiologists; however, published TEE training guidelines are lacking, and the requirements within each institution are inconsistent for achieving competency for a basic TEE exam. The resulting deficiency in TEE knowledge and skills for anesthesiologists means that many of these practitioners perform intraoperative TEE exams with only minimal training. With the combination of evolving medical system reforms, increased demands for intraoperative hemodynamic monitoring to accommodate surgical innovations, and acute and unpredictable operating room settings, anesthesiology professionals are increasingly obliged to perform intraoperative TEE exams in their current and future practices. To ensure cultural change, China must incorporate new TEE technology into the anesthesiology subspecialty practice, which requires support from hospital administrators and surgical colleagues; the Chinese Society of Anesthesiologists must also lead in the development of training guidelines and encourage anesthesiologists to accept responsibility for taking over TEE exam duties in the operating room.

In 2012, the Chinese PTE Exam Training and Practice Guideline Task Force Committee was formed. This committee consisted of skilled TEE professionals from different regions of China. The goals of this task force are to seek resources, establish infrastructure, and develop the education platform, training, practice, and competency assessment of TEE guidelines for Chinese anesthesiologists. Over the last few years, after working diligently with a group of advanced TEE-certified CT anesthesiologists in the United States, the committee members have achieved some progress toward developing Chinese basic TEE training and practice guidelines. These proposed training requirements (Table 2) are based on other guidelines but also establish unique criteria in achieving competency in

Table 2 Proposed basic TEE training requirements for Chinese anesthesiologists

Training requirement	Expectation
Training duration	3 months
Training center	Qualified and designated center
TEE specific course	20 equivalent CME hours
Total number of cases evaluated	150 cases*
Personal performance with supervision (acquisition, interpretation, and reporting)	50 cases
Pre- or postoperative basic TEE exam with report	50 cases (include 10 cases each for coronary artery disease, valvular disease, cardiomyopathy, or congestive heart failure cases)
TEE classic case review with qualified echocardiographic expert	50 cases ranging from spectrum of cardiac pathologies

*Total number of cases required during the training period.

basic TEE knowledge and skills for Chinese anesthesiologists [6,20]. To reach this goal, the guidelines must include, but are not limited to, defining the following aspects: (1) the basic TEE view, along with acquisition techniques and an abbreviated basic PTE exam sequence for hemodynamic monitoring; (2) prerequisite basic TEE knowledge and skills; (3) training requirements, including the number of cases and the duration of training; (4) supplemental training courses (CME hours and online educational platforms); and (5) the TEE training curriculum and alternative pathways to obtain the necessary competency for the basic TEE exam. The task force's primary responsibility is to provide appropriate recommendations for the TEE skill competency evaluation process. Guidelines must be attainable by anesthesiology professionals during their clinical practice and must present objective criteria to assess competency and obtain PTE proficiency.

Conclusions

Despite great efforts to advance the use of clinical ultrasound in the anesthesiology subspecialty in China, TEE training and practice for anesthesiologists require further development. Many obstacles must be overcome before significant progress can be made toward using the TEE modality to help in intraoperative management and surgical decision making. Publishing basic TEE training guidelines for China's anesthesiologists will solidify this process and help to bring China closer in line with medical best practices.

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Compliance with ethics guidelines

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