Introduction

Echocardiography was introduced in the operating room in the 1970s, with its initial applications involving epicardial echocardiography (EE). The use of transesophageal echocardiography (TEE) during surgery was first described in 1980 and did not become commonplace until high-frequency transducers and color Doppler imaging became available in the mid-1980s. The improved quality of the acoustic image enabled anesthesiologists and surgeons to use TEE intraoperatively to diagnose myocardial ischemia, confirm the adequacy of valve reconstruction and other surgical repairs, determine the cause of hemodynamic disorders and other intraoperative complications, and provide diagnostic information that could not be obtained preoperatively. Real-time access to this information has enabled surgeons to correct inadequate repairs before patients leave the operating room, has reduced the need for reoperation, and has facilitated the prevention and early treatment of perioperative complications.

Clinical Use

Intraoperative TEE has numerous clinical uses, many of which are discussed on this course.

The most authoritative recent work on the value of intraoperative echocardiography comes from the consensus group of the American College of Cardiology, American Heart Association and American Society of Echocardiography on the indications for perioperative TOE during cardiac surgery.(1,2,3) The authors have identified 706 publications that have contributed to the evidence base on intraoperative TOE. After due analysis, they have identified evidence as follows;

Class 1 evidence - Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
1. Evaluation of acute, persistent, and life-threatening hemodynamic disturbances in which ventricular function and its determinants are uncertain and have not responded to treatment.
2. Surgical repair of valvular lesions, hypertrophic obstructive cardiomyopathy, and aortic dissection with possible aortic valve involvement.
3. Evaluation of complex valve replacements requiring homografts or coronary reimplantation, such as the Ross procedure.
4. Surgical repair of most congenital heart lesions that require cardiopulmonary bypass.
5. Surgical intervention for endocarditis when preoperative testing was inadequate or extension to perivalvular tissue is suspected.
6. Placement of intracardiac devices and monitoring of their position during port-access and other cardiac surgical interventions.
7. Evaluation of pericardial window procedures in patients with posterior or loculated pericardial effusions.

Class IIa evidence – The weight of evidence/opinion is in favour of usefulness/efficacy
1. Surgical procedures in patients at increased risk of myocardial ischemia, myocardial infarction, or hemodynamic disturbances.
2. Evaluation of valve replacement, aortic atheromatous disease, the Maze procedure, cardiac aneurysm repair, removal of cardiac tumors, intracardiac thrombectomy, and pulmonary embolectomy.
3. Detection of air emboli during cardiotomy, heart transplant operations, and upright neurosurgical procedures.

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.
1. Evaluation of suspected cardiac trauma, repair of acute thoracic aortic dissection without valvular involvement, and anastomotic sites during heart and/or lung transplantation.
2. Evaluation of regional myocardial function during and after off-pump coronary artery bypass graft procedures.
3. Evaluation of pericardiectomy, pericardial effusions, and pericardial surgery.
4. Evaluation of myocardial perfusion, coronary anatomy, or graft patency.
5. Dobutamine stress testing to detect inducible demand ischemia or to predict functional changes after myocardial revascularization.
6. Assessment of residual duct flow after interruption of patent ductus arteriosus.

Class III: Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful.
1. Surgical repair of uncomplicated secundum atrial septal defect.

Given that some of the conditions considered are pathophysiological states (i.e. risk of ischemia and/or myocardial infarction) rather than anatomic diagnoses, the 10 indications contained within Class I and Class IIa level evidence actually cover the majority of cardiac surgery in adults. Therefore we can conclude that the most prestigious consensus authority has recommended that intraoperative TOE is useful and effective for almost all of cardiac surgery.

Echocardiography in critical care has also been found to be extremely valuable, and in their pivotal consensus statement Cheitlin et al note that “numerous applications (of echocardiography) to conditions discussed elsewhere in these guidelines also apply to the hemodynamically unstable patient who is evaluated in the critical care unit.” Echocardiography in critical care may be performed both for diagnostic reasons or to monitor the short term effects of treatment, in a similar manner to use in the operating room. One substantial review identified 19 studies with over 1000 patients in whom echocardiography in the critical care unit was shown to have a positive impact on outcome. (4)
In a large recent study involving 255 ICU patients, who were initially being monitored using conventional techniques, the authors found that the extra information provided by echocardiography resulted in a significant management change in 32% of patients. In 67% of those who were hypotensive, the echocardiography findings revealed the cause and led to a management change with an improvement in blood pressure, in 31% of cases.(5)

Costachescu et al. demonstrated a much higher degree of agreement between observers, and therefore improved diagnostic certainty, when using echocardiography compared with conventional haemodynamic monitoring in critically ill patients, and also found the extra echocardiographic information to have been valuable in 34% of patients and “essential” in a further 34%. (6) These themes are repeated by other authors.(7-12). A recent editorial in Critical Care Medicine has emphasised the value of echocardiography in the ICU, whilst also stressing the value of proper training and cardiological support. (13)

**Training and Accreditation**

Early recommendations for general guidelines were of limited use for perioperative echocardiographers. (14,15) The clinical competencies required for the effective practice of perioperative transesophageal echo have been reviewed and recently published.(16) These recommendations are extensive and give the practitioner the opportunity to check his/her progress against the skills required. Proof of competence usually requires passing an assessment or examination. A number exist; some are institutional, others national. The two main international assessments are those run by the National Board of Echocardiography (NBE) in association with the Society of Cardiovascular Anaesthesiologists (SCA) in North America (17) and the exam run by the European Society of Cardiology in association with the European Association of Echocardiography (EAE) and the European Association of Cardiothoracic Anaesthesiologists.(18) The American exam has been running since 1995 and performance of the exam has been reviewed.(19) The European exam was first held in 2005 and no authoritative performance data are available yet.

**Perioperative TEE; Is there a cost benefit?**

There have been studies in both cardiac surgery and critical care suggesting that echocardiography can lead to improved patient outcomes. Although these may translate into financial cost benefits, sometimes they may not. Sometimes the correct management is more expensive, not less, and the important gain lies in the quality of patient care rather than the cost. However, poor patient care is undeniably costly, in terms of patients quality of life, extended periods in the ITU, late re-operations and litigation.

**Conclusion**

Perioperative TEE is now firmly established in the area of adult cardiac surgery. Equipment costs are falling, and technology is improving. As practice standards become more widely accepted it is likely that perioperative TEE skills will be a standard requirement for future cardiac anaesthesiologists.
References
6. Costachescu et al. (Crit Care Med 2002;30:1214-23)
17. www.echoboards.org/pte/exam.html ; www.scahq.org
18. www.eacta.org ; ( follow « TEE accreditation « path)