

Transthoracic Echocardiography (TTE) for Non-Cardiac Anaesthetists

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The title of this talk is appropriately TTE for the non-cardiac anaesthetist as it is really the non-cardiac anaesthetist who will use TTE in their practice more than the cardiac anaesthetist. You are more likely to have a patient who has not had appropriate investigations front up on your list. Your cases will usually have less invasive monitoring, possibly increasing the need for TTE.

There is a growing importance of ultrasound in peri-operative and acute care medicine, which strongly suggests that anaesthetists should be proficient users of ultrasound technology in areas beyond regional anaesthesia and central vascular access¹.

Use of echocardiography by non-cardiologists has grown exponentially over the past decade. This is especially so in the critical care specialties such as emergency medicine, intensive care and anaesthesia. There are a number of reasons for this:

1. More ready availability of portable, or at least easily moveable machines, with capability of high quality imaging.
2. Appreciation of the limitations of clinical examination and even invasive monitoring, while TTE is a powerful non-invasive tool able to rapidly provide important reliable information for the diagnosis of a variety of cardiovascular conditions.
3. Embracing the concept of a limited TTE. Unlike formal cardiology-based TTE, a limited TTE is often more appropriate in the peri-operative period to address a particular question and can usually be performed in under 10 minutes. Many studies have shown that clinicians can be trained to qualitatively determine left and right ventricular function and size, detect pericardial effusions, assess volume status, and identify clinically relevant valvular defects in a relatively short period of didactic and hands-on-training.
4. The increasing age of our patients and hence their cardiovascular co-morbidities.

A variety of acronyms / terms have been coined by different organisations to describe limited TTE examinations, e.g. HeartScan (Haemodynamic Echocardiography Assessment In Real Time), FADE (Fast Assessment Diagnostic Echocardiography), RUSH (rapid ultrasound in Shock), FATE (Focus Assessed Transthoracic Echo), Goal directed TTE, Focused TTE.

Learning and gaining experience in TTE

Anaesthetists are now trained in the use of ultrasound equipment for vascular access, regional nerve blocks and more. Hence they are already familiar with the physical principles behind ultrasound imaging and how to use the main features of the equipment.

Anaesthetists are trained (and examined) in cardiac and vascular physiology.

You are 3/4 of the way there!

There are many avenues for training in TTE for critical care specialists:

- Formal on-line university courses such as the Graduate Certificate in Clinical Ultrasound (GCertCU) from the University of Melbourne (www.heartweb.com.au) or Generalist Medical Echocardiography Course from the University of Otago (<http://www.otago.ac.nz/courses/papers/index.html?papercode=GENA717>).
- Short duration hands-on training courses - these are regularly offered by many institutions or groups such as:
Australian Institute of Ultrasound (http://www.aiu.edu.au/programs_and_courses/),
Ultrasound Training Solutions (<http://www.ultrasoundtraining.com.au/courses>),
Cardiac Skills Australia (<http://www.cardiacskillsaustralia.com.au/workshops>)
iHeartScan courses (www.heartweb.com.au)
Alfred Hospital ICU (Melbourne) , Nepean Hospital ICU (NSW) and more.
- Some hospital departments and course convenors have purchased high fidelity ultrasound simulators (suitable for transthoracic and transoesophageal ultrasound practice).
- Experienced Colleagues - the beauty of TTE is its safety and non-invasiveness. I have yet to meet a patient or male colleague who would be unwilling to be scanned. Hence the only limitation to gaining experience (perhaps after doing a short hands-on workshop) is machine availability and ideally (but not essentially) some local expertise.
- Arrange via your local cardiology department to spend some time with one of their sonographers (usually very skilled and excellent teachers).
- Some excellent websites. In particular I would very highly recommend the Toronto General Hospital Department of Anesthesia virtual TTE (http://pie.med.utoronto.ca/tte/TTE_content/standardViews.html) and TOE websites (<http://pie.med.utoronto.ca/TEE/>).

The College of Anaesthetists has a professional document: "Guidelines on Training and Practice of Perioperative Cardiac Ultrasound in Adults (PS 46)" relating to this area of anaesthetic practice (including transoesophageal echocardiography). Guidelines have also been published and training pathways proposed by emergency physicians and intensivists.

Indications for Limited TTE

Brian Cowie published our experience at St. Vincent's of a peri-operative TTE service for non-cardiac surgery run by anaesthetists². We performed 170 studies in 3 years (2007-2010). 74% were performed in the pre-anaesthesia room, 13% in the operating room, 12% in the post-anaesthesia care room and 1% in ICU. Images of adequate quality to answer the clinical question were obtained in 167 out of 170 (98%) patients.

The indications were as follows:

Indication	Number (%)
Murmur detected / valve disease suspected	98 (58%)
Haemodynamic instability	37 (22%)
Ventricular function assessment	17 (10%)
Dyspnoea/hypoxia	6 (4%)
Poor functional capacity	3 (2%)
Other	9 (5%)

Some change in patient management resulting from the focused study occurred in 140 out of 170 (82%) patients (see table below)

Changes in management following peri-operative TTE	Number (proportion)
Invasive monitoring avoided	45 (24%)
Referred for formal cardiology TTE	34 (20%)
No management change	30 (18%)
Fluid bolus administered	25 (15%)
Invasive monitoring placed	22 (13%)
Change in anaesthesia technique	20 (12%)
Vasoactive drug administered	12 (7%)
Postoperative recovery location altered	12 (7%)
Procedure cancelled	7 (4%)
Fluid restriction prescribed	3 (2%)
Vasoactive drugs ceased	3 (2%)

Clinical examination is unreliable for assessment of the nature and severity of valvular pathology. This is especially important in the case of severe aortic stenosis which exposes patients to high peri-operative risks, has significant implications for peri-operative management, is increasingly common in our elderly population and is often relatively asymptomatic.

A prompt limited TTE is especially indicated for diagnosis of persistent hypotension in the face of apparently adequate fluid therapy / vasopressors. Unlike clinical examination and invasive monitoring, TTE will rapidly and reliably differentiate hypovolemia from poor left and right ventricular function and detect uncommon problems such as pericardial effusions or severe valvular disease.

Most information is obtained from parasternal, apical and subxiphoid views (see attached slides). Any one of these windows often provides enough images to make the clinical diagnosis, which is fortunate in case one window does not provide satisfactory imaging.

It is nearly always worth trying to perform a TTE before going to transoesophageal echocardiography (TOE) - even in ICU post cardiac surgery. TOE is invasive with Australian data suggesting a 1 in 1000 incidence of gastro-oesophageal injury and 1 in 5000 risk of death³. The caveat is that one should rapidly progress to a TOE if images are poor or any doubt remains regarding the diagnosis and the patient is deteriorating.

Doppler examination

Many limited TTE courses and protocols do not involve the use of spectral Doppler. I believe that Doppler should be part of a limited TTE study because:

- of the importance of assessing the severity of aortic stenosis by measuring velocities and gradients across the valve
- of the importance of estimation of right ventricular systolic pressure, as pulmonary hypertension is associated with increased peri-operative risks and is often minimally symptomatic
- it enables measurement of cardiac output
- learning it is readily achievable⁴

Limitations

Equipment availability - although this is becoming less of an issue. The higher end machines often provide better images (in challenging patients) and more reliable and sensitive Doppler. However, the small machines are improving and are nearly always sufficient to provide the diagnosis.

Patient positioning and access. The ideal position is for the patient to be turned half way to their left side, but this is often impossible - especially intra-operatively. However, in my experience, satisfactory imaging from at least one window is nearly always possible with the patient supine. The other problem intra-operatively may be access to the chest in the patient covered by drapes and Bair huggers.

Some patients have very poor acoustic windows and it is impossible to obtain useful images from any view. This is not always predictable from their body habitus.

Unlike TOE, the probe cannot be held in position continuously, hence TTE cannot act a continuous monitor.

Last, but definitely not least, there is always the risk of misdiagnosis from misinterpretation of the images or the inability to visualise an important pathology. The clinician must be aware of their limitations and when in any doubt, a second opinion from a more experienced colleague should be sought. A focused study or limited echocardiography does not replace a formal transthoracic echocardiogram in difficult cases or ones which will require on-going cardiac management.

References

1. Davinder Ramsingh, John Christian Fox, and William C. Wilson. Perioperative Point-of-Care Ultrasonography: An Emerging Technology to Be Embraced by Anesthesiologists. *Anesthesia and Analgesia* 2015; 120: 990-2.
2. B. Cowie. Three years' experience of focused cardiovascular ultrasound in the peri-operative period. *Anaesthesia*, 2011; 66: 268-273
3. Piercy M, McNicol I, Dinh DT, Story DA, Smith JA. Major complications related to the use of transesophageal echocardiography in cardiac surgery. *J Cardiothorac Vasc Anesth* 2009; 23: 62-65.
4. Cowie BS, Kluger R. Evaluation of systolic murmurs using transthoracic echocardiography by anaesthetic trainees. *Anaesthesia*. 2011; 66: 785-90.