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Focused transoesophageal TOE (f TOE): A new accreditation pathway

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Abstract

The concept of a focused ultrasound study to identify sources of haemodynamic instability has revolutionized patient care. Point-of-care ultrasound (POCUS) using transthoracic scanning protocols, such as FUSIC Heart, has empowered non-cardiologists to rapidly identify and treat the major causes of haemodynamic instability. There are, however, circumstances when a transoesphageal, rather than transthoracic approach, may be preferrable. Due to the close anatomical proximity between the oesophagus, stomach and heart, a transoesphageal echocardiogram (TOE) can potentially overcome many of the limitations encountered in patients with poor transthoracic ultrasound windows. These are typically patients with severe obesity, chest wall injuries, inability to lie in the left lateral decubitus position and those receiving high levels of positive airway pressure. In 2022, to provide all acute care practitioners with the opportunity to acquire competency in focused TOE, the Intensive Care Society (ICS) and Association of Anaesthetists (AA) launched a new accreditation pathway, known as Focused Transoesophageal Echo (fTOE). The aim of fTOE is to provide the practitioner with the necessary information to identify the aetiology of haemodynamic instability. Focused TOE can be taught in a shorter period of time than comprehensive and teaching programmes are achievable with support from cardiothoracic anaesthetists, intensivists and cardiologists. Registration for fTOE accreditation requires registration via the ICS website. Learning material include theoretical modules, clinical cases and multiple-choice questions. Fifty fTOE examinations are required for the logbook, and these must cover a range of pathology, including ventricular dysfunction, pericardial effusion, tamponade, pleural effusion and low preload. The final practical assessment may be undertaken when the supervisors deem the candidate's knowledge and skills consistent with that required for independent practice. After the practitioner has been accredited in fTOE, they must maintain knowledge and competence through relevant continuing medical education. Accreditation in fTOE represents a joint venture between the ICS and AA and is endorsed by Association of Cardiothoracic Anaesthesia and Critical care (ACTACC). The process is led by TOE experts, and represents a valuable expansion in the armamentarium of acute care practitioners to assess haemodynamically unstable patients.

Keywords

Focused, transoesophageal, echocardiography, intensive care, intraoperative

An introduction to fTOE in the perioperative and critical care population

The concept of a focused (as opposed to comprehensive) echocardiogram to identify haemodynamic instability has revolutionized patient care. Point-of-care ultrasound (POCUS) using transthoracic scanning protocols, such as FATE[1] and FUSIC Heart,[2] has empowered non-cardiologists – especially anaesthetists and intensivists – to rapidly assess cardiovascular status and treat the major causes of haemodynamic instability.

Traditionally, transoesophageal echocardiography (TOE) has been performed by practitioners with advanced (so-called 'level 2') skills; their backgrounds were mainly in cardiology, cardiac anaesthesia and, less commonly, intensive care. However, the challenge remains that patients with haemodynamic instability are encountered

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in locations, such as the emergency department, intensive care unit and in non-cardiac theatres, where level 2 TOE practitioners are not always immediately available. While FUSIC heart (or similar) is usually the first port of call, there are circumstances when a transoesphageal, rather than transthoracic approach, may be preferable.

Indications and rationale for perioperative/critical care focused TOE

Firstly, due to the close anatomical proximity between the oesophagus, stomach and heart, TOE can potentially overcome many of the limitations encountered in patients with poor transthoracic echocardiography (TTE) windows. These are typically patients with severe obesity, chest wall injuries, inability to lie in the left lateral decubitus position and those who require mechanical ventilation. In such patients, TOE can be preferrable as higher resolution images can typically be acquired of atrial structures, the great vessels, the atrioventricular valves and aortic root. Both ventricles can also be clearly visualized from the oesophagus, and stomach in the so-called transgastric views. TOE is therefore strongly indicated when there is life-threatening haemodynamic instability and the cause cannot be identified by TTE.[3] Secondly, as the TOE probe can be left in situ, it can track changes in ventricular filling and function over time and is therefore a good cardiovascular monitor.

TOE is increasingly used with diagnostic and therapeutic impact in ICU,[4] where competence in TOE is regarded as an important component of advanced critical care echo.[5] TOE has even been used in ICU to inform the recruitment strategy in patients with acute respiratory distress syndrome (ARDS) by comparing lung echogenicity (deaeration) at low and high PEEP.[6]

As the operator can stand well away from most surgical fields, TOE can be employed as an intra-operative tool to guide and inform decision-making, and is a standard of care in cardiac surgery. Non-cardiac surgical patients most likely to benefit from intra-operative TOE are patients undergoing major surgery, associated with blood loss or large fluid shifts, with concurrent severe cardiovascular disease, such as coronary artery disease, severe valvular heart disease, severely impaired left ventricular (LV) or right ventricular (RV) function and severe pulmonary hypertension.[7] TOE is commonly used during lung and liver transplantation. Recipients often have comorbidities (including cirrhotic cardiomyopathy, characterized by a poor ventricular response to stressors) and commonly display cardiovascular instability, especially at time of reperfusion, due to intracardiac air embolism, thrombosis, severe RV dysfunction, regional wall motion abnormalities (RWMAs) and previously undiagnosed LV outflow tract (LVOT) obstruction.[8] TOE may be used in neurosurgery associated with high risk of venous air embolism.[7]

TOE is valuable in patients during and after cardiac arrest, both intra-operatively[9] and in ED,[10] to identify causes and assess efficacy of chest compression during cardiopulmonary resuscitation without hampering resuscitation efforts.[11]

Development of focused TOE training

While having many benefits, TOE has inherent risks. Therefore, it is essential that prospective TOE practitioners undergo appropriate training and acquire suitable experience, knowledge and skills to practice TOE as safely as possible. Level 2 training takes approximately 2 years to complete and requires a logbook of 125 cases, which is challenging to achieve for most practitioners outside of a dedicated TOE-orientated fellowship. Therefore, clamour by acute care practitioners (outside of cardiology/cardiac anaesthesia) to gain focused TOE skills has grown, as has the demand for a fTOE accreditation pathway to support this process.

In 2013, the American Society of Echocardiography and the Society of Cardiovascular Anaesthesiologists proposed a training and certification pathway for basic peri-operative TOE.[12] The intention was to use basic peri-operative TOE as a haemodynamic monitor. Although there is clearly a diagnostic element during haemodynamic emergencies, the aforementioned pathway is restricted to anaesthetists only and emphasizes the need to seek expert advice when unexpected pathology is encountered.

In 2022, to provide all acute care practitioners with the opportunity to acquire competency in focused TOE, the Intensive Care Society (ICS) and Association of Anaesthetists commissioned a fTOE accreditation committee to create a new accreditation pathway, known as Focused Transoesophageal Echo (fTOE). The fTOE pathway was endorsed by the Association of Cardiothoracic Anaesthetists and Critical Care, who, jointly with the British Society of Echocardiography, established level 2 accreditation in TOE.

fTOE views and technique

The aim of fTOE is to provide the practitioner with the necessary information to identify the aetiology of haemodynamic instability. The fTOE accreditation committee identified the number of views considered to be adequate to recognize the most common and serious sources of haemodynamic instability. The consensus was to recommend eight essential views (Table 1) with the probe in either the midoesophageal (ME) position, 30–40 cm from the teeth, or transgastric (TG) position, 40–45 cm from the teeth. The essential views are the ME four chamber, ME two chamber, ME long-axis (LAX), ME bicaval, ME RV inflow-outflow, ME ascending aorta LAX, ME descending aortic short axis (SAX) and TG mid-papillary SAX views. The ME views provide most of the information needed for a focused exam, while the TG view is often used to complete the assessment for preload status and as a continuous monitor of ventricular filling and function (Table 2).

Table 1. Recommended fTOE views.

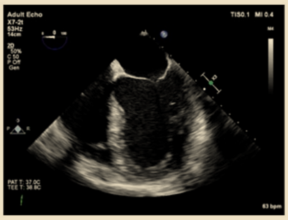
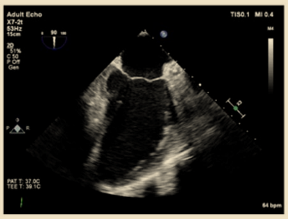
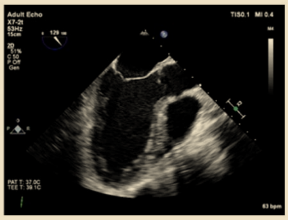
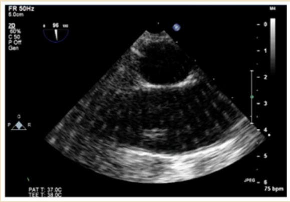
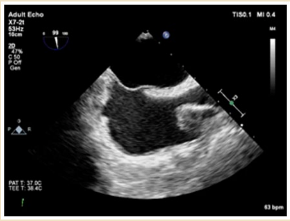
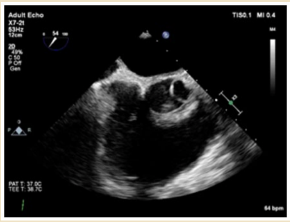
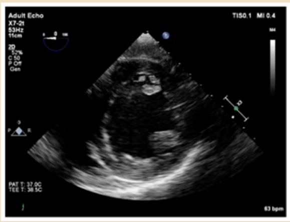
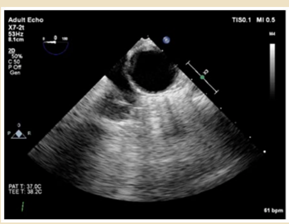
Views	Angle		Modality	Description
1. ME four chamber view	0°–10°		2D and CFD across mitral (MV) and tricuspid (TV) valves	LV and RV function, RWMA, septal dyssynchrony, gross mitral and tricuspid valve pathology, pericardial effusion, atrial septal defects.
2. ME two-chamber view	80°–100°		2D and CFD across MV	LV function, RWMA, gross mitral valve pathology, thrombus in left atrial appendage.
3. ME LAX	120°–140°		2D and CFD across AV	LV function, RWMA, gross mitral and aortic valve pathology, systolic anterior motion (SAM) and LVOT obstruction.
4. ME Ascending Aorta LAX	90°–110°		2D	Significant aortic root dilation (>5cm), aortic dissection (intimal flap, intramural haematoma).
5. ME Bicaval	90°–110°		2D	Cannula placement/position, pacing wires position.
6. ME RV Inflow-Outflow	50°–70°		2D and CFD across TV	RV function, gross tricuspid valve disease, PA catheter position.
7. TG SAX	0°–20°		2D	LV function and filling including measurements, RWMA, pericardial fluid, septal position.
8. Descending Aorta SAX	0°–10°		2D	Aortic dissection, mobile atheroma, intra-aortic balloon pump position, left pleural effusion.

Table 2. Clinical applications of fTOE.

Area of application		Indications	Most useful fTOE views
Critical Care	Suboptimal TTE images (Severe obesity, chest trauma, subcutaneous emphysema, mechanical ventilation)	LV dysfunction and RWMA	ME 4C, ME 2C, ME LAX, TG SAX
		RV dysfunction	ME 4C, ME LAX, ME RV Inflow-Outflow, TG SAX
		Low preload and fluid responsiveness	ME 4C, ME Bicaval,
		Gross valvular pathology	ME 4C, ME 2C, ME LAX, ME RV Inflow-outflow
Peri-operative	Major hepatobiliary surgery and liver transplantation	LV dysfunction and RWMA	ME 4C, ME 2C, ME LAX, TG SAX
		Severe RV dysfunction	ME 4C, ME LAX, ME RV Inflow-Outflow, TG SAX
		Thrombosis and clot	ME 4C, ME 2C, ME LAX, ME RV inflow-outflow, ME Asc Aortic LAX
		Air embolism	ME 4C, ME LAX, ME Bicaval, ME RV inflow-outflow
		LVOT obstruction	ME LAX
	Non-cardiac surgery	Risk of major blood loss or fluid shift	ME 4CV, ME 2C, ME LAX, ME Inflow-outflow, TG SAX, ME Desc Ao SAX
		Known severe coronary disease	ME 4CV, ME 2C, ME LAX, ME Inflow-outflow, TG SAX
		Known valvular disease	ME 4C, ME 2C, ME LAX, ME RV Inflow-outflow
		Severely impaired LV or RV function	ME 4C, ME 2C, ME LAX, ME RV Inflow-Outflow, TG SAX
		Severe Pulmonary hypertension	ME 4C, ME LAX, ME RV inflow-Outflow, ME TG SAX
Emergency department and Cardiac arrest	Blunt thoracic trauma	Pericardial effusion, contusion Great vessels (Intimal flap, aortic regurgitation or intramural haematoma)	ME LAX, ME Asc Ao LAX, Desc Ao SAX
	Identify reversible causes of cardiac arrest	Tamponade, Acute PE, Severe Hypovolaemia or hemorrhagic shock, pneumothorax, acute coronary syndrome	ME 4C, TG SAX
	Efficacy of chest compression		ME 4C, ME LAX
	ECMO-CPR	Guidewires insertion, Venous cannula check	ME Bicaval, Desc Ao SAX

Risks of TOE and how to minimize them

Potential disadvantages of TOE include high initial cost, probe fragility and need for meticulous decontamination. However, the most important is the risk of injury (Table 3) and all TOE practitioners must weigh its potential benefits against this.

Sites of injury follow the route of the probe from the mouth to the stomach, and include almost all of the anatomical structures in between.[13] The mechanism of injury is typically the probe tip exerting force on structures in the GI tract during probe insertion or manipulation. Underlying disease may increase the susceptibility of patients to injury during the procedure.

TOE is contra-indicated in the presence of a perforated viscus, significant oesophageal disease (e.g. stricture), recent upper gastro-intestinal surgery or bleeding.[13] TOE may be safely used in patients undergoing liver transplantation, even with known varices, however, the risks may outweigh the potential benefits, particularly if there has been recent bleeding of banding of varices.[15] Several studies testify to its impact on peri-operative decision making.[7]

To mitigate the risk of injury in fTOE, we have set out clear safety criteria. Before probe insertion, patients must have: (a) a definitive airway in situ, (b) a clear indication for focused echocardiography, (c) an inadequate attempt at focused transthoracic study and (d) consent or assent according to local policy. fTOE should only be performed by practitioners who are accredited in fTOE or otherwise supervised by someone with level 2 skills in TOE and experience in different clinical environments, including echocardiography department, interventional cardiology, cardiac theatres and intensive care. During probe insertion, learners must be directly supervised by an expert until they are deemed competent to do so. And after probe insertion, all images obtained during training should be reviewed by an expert in a clinically meaningful timeframe, so that all subjects benefit from the clinical insight that fTOE provides.

Measures to aid probe insertion and reduce the likelihood of injury include: insertion under direct vision, using plenty of lubricant on the probe and limiting undue force during insertion, probe manipulation and flexion of the probe tip. Video laryngoscope allows excellent visualization of the structures posterior to the laryngeal inlet, thereby enhancing the success rate of probe

Table 3. Incidence of common and important complications.[13]

Injury	Incidence
Damage to lips	1 in 8
Damage to teeth	1 in 1000
Sore throat	1 in 12
Swallowing dysfunction	1 in 25
Oropharyngeal mucosal injury	1 in 500
Larynx (vocal cord injury, airway compression)	Unknown
Oesophageal perforation and GI bleed	1 in 1250[14]
Dental injury	1 in 3000
Death	1 in 3000

insertion and reducing the incidence of injury to surrounding structures.[16]

It is also important that the operator does not become task fixated on what is a complex procedure, from a technical and cognitive perspective and lose sight of the potentially unstable patient.

fTOE versus comprehensive TOE

It must be reiterated that fTOE is a limited exam and is not intended to replace comprehensive TOE. A comprehensive TOE encompasses up to 28 views[17] and involves detailed imaging of intracardiac structures and great vessels using 2D and the full range of Doppler modalities including colour flow, pulsed-wave (PW) Doppler, continuous-wave (CW) Doppler, tissue Doppler and 3D echo, which fall beyond the scope and syllabus of fTOE. Comprehensive TOE is the standard of care in cardiac surgery, and should be used during all open-heart procedures and operations on the thoracic aorta. It should also be considered for all CABGs. The comprehensive TOE syllabus covers the full range of acute and chronic conditions, as well as assessment of ventricular and valvular function.

By contrast, fTOE has deliberately limited scope aimed at identifying patients who have or may develop critical cardiac conditions, such as low preload, cardiac tamponade, acute left and right heart dysfunction. If gross valvular heart disease is seen during fTOE, a referral for comprehensive TTE or TOE is usually merited. fTOE is comprised of only eight 2D views; colour flow Doppler is only used for qualitative assessment and to confirm a 2D impression of gross valvular abnormalities. The operator should be familiar with colour flow Doppler optimization, including box position, box size, scale and baseline settings. The fTOE curriculum does not include PW or CW Doppler as these modalities have many pitfalls and require considerable experience to perform correctly. The findings in fTOE are usually binary in nature – for example, whether or not there are signs of low preload, significantly impaired LV function or pericardial effusion. Every fTOE must be stored on the hospital echo database and a written report completed.

fTOE pathology assessment

Global and regional left ventricular function

Determination of global LV systolic function is one of the most common applications of fTOE and it is based on qualitative and visual estimation, supported by simple 2D measurement. Severe RWMAs should also be noted. The views used to assess the LV function are the ME four chamber, ME two chamber, ME LAX and TG SAX views. In the first three views, the cone-shaped left ventricle is visualized side-on (so-called ‘long-axis’) from different scanning angles, contraction and thickening of the LV walls are assessed; in the last, a cross sectional or end-on (so-called ‘short-axis’) view of the left ventricle is seen. The TG SAX is an excellent view to make chamber measurements and temporal comparisons of LV size and function.

Right ventricular function

Assessment of RV function is equally important in hypotensive patients, and is based on size, shape and visual estimation of reduction in fractional area change. The relevant views are the ME four chamber, ME LAX and ME RV inflow-outflow and TG Mid SAX. Patients presenting for liver transplantation with pulmonary hypertension are at increased risk for RV dysfunction secondary to the acute changes in pulmonary pressures associated with volume shifts and acid-base disturbances during transplantation. fTOE in this population also allows rapid assessment of cardiac status. It is important to assess for RV strain in ARDS and lung injury.

Low preload

The hallmarks of low preload (caused by hypovolaemia or vasodilatation) are a small end-diastolic LV cavity, kissing papillary muscles in systole, hyperdynamic contractility and pseudohypertrophy. fTOE can track real-time increases in cavity size in response to fluid challenges or vasopressors. Furthermore, a highly collapsible superior vena cava, as measured in the ME bicaval view during mechanical ventilation, is highly predictive of fluid responsiveness.[18]

Pericardial effusion and thoracic trauma

Echocardiography plays an integral part in the evaluation of trauma involving the thoracic cavity. Rapid diagnosis and intervention are crucial to improving patient outcomes. fTOE offers a rapid, accurate diagnosis of pericardial effusions, traumatic aortic injuries and cardiac contusions. Blunt or penetrating thoracic trauma (including iatrogenic injury during invasive procedures) can result in the accumulation of a pericardial effusion. If the effusion accumulates rapidly, haemodynamic instability may ensue. fTOE can identify the presence of an intimal flap, intramural haematoma, aortic valvular regurgitation

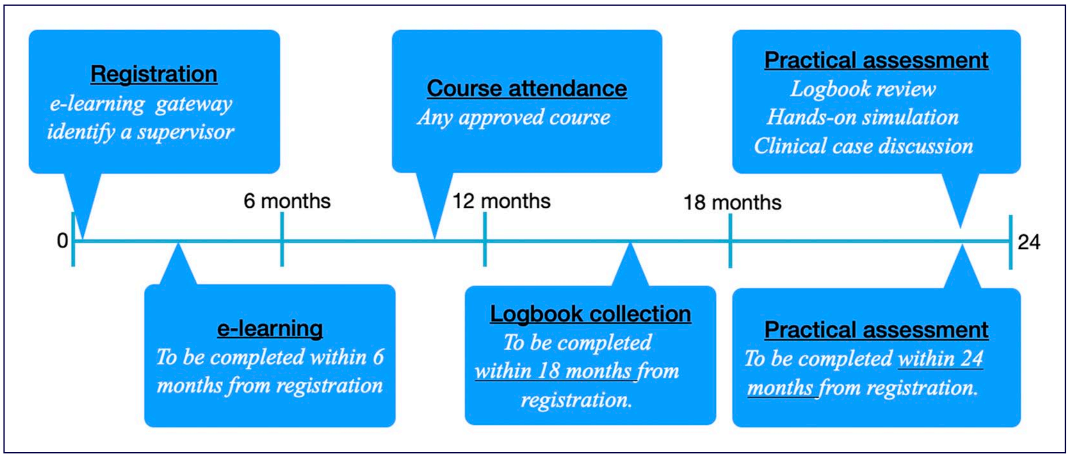


Figure 1. fTOE accreditation pathway.

and signs of a free rupture, and help to expedite treatment and medical management where appropriate.

Aortic dissection

Although Computed Tomography (CT) is the investigation of choice for diagnosing aortic dissection, fTOE is capable of providing an accurate diagnosis within minutes and can be used as the initial modality in the emergency setting. Features that can be seen on TOE include aortic dilatation, an intimal dissection flap, a pericardial effusion and aortic regurgitation.

Pulmonary embolism

Although TOE is not the gold standard for this diagnosis, it compares well with CT when the embolus is acute and central. Echocardiographic findings consistent with acute pulmonary embolism include signs of RV dysfunction (e.g. dilation and hypokinesis) and characteristic RWMAs of the RV free wall with preserved apical contraction (McConnell's sign).

Gross valvular pathology

Significant valvular pathology can usually be recognized in 2D: calcified leaflets, restricted in movement, result in severe stenosis, while leaflet prolapse can lead to lack of coaptation causing severe regurgitation. This is important as severe valvular heart disease can be a source of haemodynamic instability and/or pulmonary oedema, and patients with such pathology may respond differently to vasoactive drugs and fluid. Evidence of significant pathology should merit request for a comprehensive diagnostic echocardiogram.

fTOE training and assessment pathway

Because of its limited scope, fTOE can be taught in a shorter period of time than comprehensive TOE. The benchmark for acquiring basic echocardiography skills varies between 20 and 50 studies[2,19,20] and can be significantly augmented with the use of simulators.[10,20] Teaching programmes are achievable with support from cardiothoracic anaesthetists, intensivists and cardiologists.

The fTOE accreditation committee recognizes that access to training may be challenging initially in non-cardiac centres, where equipment and expertise are limited. We recommend that prospective candidates working in district general hospitals and such tertiary centres establish links with local TOE services and/or regional cardio-thoracic centres. Such networks already exist. We envisage that, under these circumstances, a secondment may be required to support initial hands-on and simulator-based training.

However, once accredited, fTOE providers in non-cardiac centres will be able to cascade learning to others, allowing it to scale up, just as FUSIC Heart training and accreditation has done since it was launched in 2012.

An outline of the training pathway can be seen in Figure 1. Registration for fTOE accreditation is via the ICS website; e-learning can then be accessed via the ICS learning portal. Learning material includes theoretical modules, clinical cases and multiple-choice questions. The modules must be completed prior to commencing mentored practice and logbook collection. A suitable supervisor can be contacted via the ICS fTOE homepage. The supervisor will be responsible for hands-on training, reviewing the scans, overseeing the logbook and recommendation for sign off after the final assessment. Completion of fTOE training will be by a centralized assessment, run by the Association of Anaesthetists. Eligibility as a fTOE supervisor requires level 2 TOE accreditation by the British Society of Echocardiography or European Association of Cardiovascular Imaging, or the ability to demonstrate equivalent knowledge and regular use of TOE by application to the fTOE accreditation committee.

Fifty fTOE examinations are required for the logbook, and these must cover a range of pathology, including ventricular dysfunction, pericardial effusion, tamponade, pleural effusion and low preload. Additionally, no more than half of the logbook studies should be ‘normal’. Candidates in possession of a certificate of completion in FUSIC Heart, FUSIC HD or BSE Level 1 require 30 fTOE cases. The logbook must be completed within 24 months from registration and represent no longer than a 12 month period from first to last scan. The first 20 studies must be directly supervised, after which the supervisor can sign off the candidate for distant supervision and independent probe insertion. Any study performed under distant supervision should be promptly reviewed by a recognized supervisor within a clinically meaningful timescale, which enables the subject to benefit from expert opinion. The final practical assessment may be undertaken when the supervisors deem the candidate’s knowledge and skills consistent with that required for independent practice. After the practitioner has been accredited in fTOE, they must maintain knowledge and competence through relevant continuing medical education. Undertaking regular audit and peer-review of performed fTOE is an excellent way to maintain quality assurance.

We believe that the proposed fTOE training and accreditation strikes the right balance between safety and accessibility. However, we plan to keep our processes under strict review and will make changes accordingly. Some details may change with time, but its central tenets will not.

Conclusion

Accreditation in fTOE represents a joint venture between the Intensive Care Society and Association of Anaesthetists, and is endorsed by the Association of Cardiothoracic Anaesthetists and Critical Care. The process is led by TOE experts and represents a valuable expansion in the armamentarium of acute care practitioners to assess haemodynamically unstable patients. While fTOE in invasive, its risks are mitigated by careful patient selection and clinical supervision, which are all built into the design of training and service delivery. We hope that fTOE will enable more patients to benefit from the insights that POCUS can bring. Comprehensive details, including how to perform a fTOE examination, can be found on the ICS website.

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Supplemental material

Supplemental material for this article is available online.

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