



## POINT OF CARE TRANSTHORACIC ECHOCARDIOGRAPHY

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**ABSTRACT** Transthoracic echocardiography (TTE) is mandatory for any clinical suspicion of MS. Transthoracic echocardiography is one of the most commonly performed cardiac investigations. Transthoracic echocardiography (TTE) has established its role for diagnosis and management in cardiology and is used by various other specialities in medicine, but it is not routinely practised by anaesthesiologists in the perioperative period including the pre-admission clinic/outpatient clinic.

**KEYWORDS :** Point of care, transthoracic echocardiography

**INTRODUCTION**

Transthoracic echocardiography (TTE) is mandatory for any clinical suspicion of MS. Given the decreased awareness toward MS in Western countries and the difficulties of auscultatory diagnosis, MS may only be diagnosed when TTE is performed to establish the cause of unexplained dyspnea or thromboembolic event. Point of care (POC) transthoracic echocardiography (TTE) is a limited bedside investigation done and interpreted by a physician. TTE is traditionally owned, dominated and practised by cardiologists. However, the role of echocardiography (echo) has now extended to other specialities including anaesthesia, critical care and emergency medicine including pre-hospital setting.[1,2,3]

**Handheld ultrasound devices**

Over the past decade, handheld ultrasound devices are available from various manufacturers for clinical use. The utility and clinical applications of POC-TTE have been widely used in elective and emergency situations.[4] It has proven potential in clinical application for rapid assessment and diagnosis of cardiac function.[5] The American Society of Echocardiography (ASE) task force document gives an overview of handheld ultrasound devices, their utility, application and level of training in detail. These devices are miniature forms of traditional ultrasound machines with capability to display two-dimensional and colour echo and are affordable with comparable clarity.[6]

**Clinical Application Pre-operative period**

The pre-operative utility of POC TTE extends from patient's admission to discharge including the pre-anaesthetic clinic.

Primary variables and the physical examination have repeatedly proven insufficient and inaccurate for haemodynamic evaluation and assessment of occult diseases in healthy patients and in high-risk and critically ill patients. Besides a detailed bedside clinical history and physical examination, POC TTE will be complementary and valuable in the pre-operative setting.[3]

TTE has been demonstrated to be an adjunct tool for detailed pre-operative evaluation of the cardiovascular status and rapid assessment in critically ill or rapidly deteriorating patients.[3]

The operating theatre is a unique environment of changing physiological milieu with dramatic, acute and unstable situations.[1-7] Utilising this tool in a timely manner can help in troubleshooting the causes of tachycardia, hypotension and hypoxia when time and situation demand. This modality not only helps in the diagnosis but can also help in monitoring the therapeutic intervention by the patients' clinical response and to titrate the therapy appropriately.

**Routine intra-operative transthoracic echocardiography monitoring**

Real-time routine perioperative TTE in non-cardiac surgery could be ideal, as history and monitoring may not provide the answer to an underlying cardiovascular status in the haemodynamically stable patients. TTE before anaesthesia or even in elective outpatient pre-admission anaesthetic clinics can help clinician in actual decision-

making at the critical time for appropriate management.[7-10] With limited teaching and education, non-cardiologist physicians and medical students' performance was found to have good accuracy and agreement with cardiologists' clinical accuracy after addition of TTE.[11-12]

An algorithm-based approach for hypotension in post-operative period can help to identify the true causes of hypotension.[13-14] Causes of hypotension after any surgery are likely due to vasodilatation secondary to anaesthetics or other medications, or intra-operative hypovolaemia.

POC TTE is helpful to differentiate the above causes in diagnosis and management immediately after surgery in the post-anaesthesia care unit.

POC TTE can be a useful and excellent adjunct to TOE, as it can be done at the bedside and has advantage in interrogating right heart structures and *in situations* where TOE is contraindicated. It can be used during weaning studies as well as in patients undergoing extracorporeal membrane oxygenation and in anticoagulated patients.[15]

Procedures related to intracardiac devices, pacing wires, prosthetic valves and pacemakers are potential sources of traumatic pericardial effusion and haemodynamic compromise in the post-operative period. However, TTE can be helpful in diagnosing these conditions very quickly and assist in pericardiocentesis, particularly in angiography suites, cardiac catheterisation and electrophysiology laboratory where patients are likely to be anticoagulated with heparin and/or have active antiplatelet agents on board. These locations may be unfamiliar or hostile and remote locations with limited resources and help. Although TTE and TOE are within the cardiologist's domain and expertise, the anaesthetist with echo skills can enhance rapid diagnosis and treatment.

**Point of care transthoracic echocardiography in trauma and resuscitation**

Focused TTE ultrasound is currently recommended by ASE and American College of Emergency Physicians (ACEP) in cardiac arrest situation without interruption of standard advanced cardiac life support algorithm. It helps to differentiate between pseudo- and true pulseless electrical activity (PEA) by diagnosing potentially treatable causes, namely, cardiac tamponade, tension pneumothorax and pulmonary embolism. Echo has been used to confirm the diagnosis of pseudo-PEA and shown to have a better outcome than true PEA in out of hospital cardiac arrest patients.[16]

Rapid and accurate diagnosis is vital, particularly during the 'golden hour' of trauma resuscitation. Critical care experts and emergency physicians are using POC TTE for the diagnosis of haemodynamic instability, hypoxia and reversible causes of peri-arrest situations such as pulmonary embolism and cardiac tamponade. Focused assessment with sonography in trauma (FAST) examination can diagnose poor cardiac contractility, penetrating chest injuries, cardiac contusions and tamponade. Now, FAST scan is an important integral part of advanced

life support (advanced trauma life support) algorithm. POC TTE can be very helpful to diagnose the causes of hypotension and shock in addition to facilitate lifesaving procedure and interventions.[16,17,18]

### Education and training opportunities

Various short courses and hands-on workshop opportunities are available for non-cardiology specialists to learn TTE in India and abroad. These post-graduate courses are available for certification, accreditation and reaccreditation. Haemodynamic echo assessment in real-time (HEART) scan is conducted by University of Melbourne, Australia.[19] This comprehensive on-line educational resource is offering certificate courses, diploma and master degree which is available at physician's doorstep through distance education, that one can study at their own pace, time and location. In India, Perioperative and Intensive Care Echocardiography and Ultrasonography foundation also has similar type of collaboration with USabcd Organisation (Denmark) and conducts basic echo workshop, Focus Assessed Transthoracic Echo (FATE) course with online e-reading material, complimented with simulator and hands-on human model workshop.[20,21] Indian Academy of Echocardiography[22] and World Interactive Network Focused on Critical Ultrasound[23] also have extensive e-learning, pre-reading materials, courses, workshops, conferences, certification and fellowships programmes.

### Society guidelines and endorsement

International Liaison Committee on Focused Cardiac Ultrasound (FoCUS) for the International Conference on FoCUS has released extensive international evidence-based recommendations for FoCUS in 2014 and emphasises extensively on clinical application, teaching, benefits, education and certification principles.[24] Emergency physician training in echo for trauma patients, FAST[25] and FOCUS[24] is endorsed by ASE and American College of Emergency Physicians in their position statement.[26] There are various

endorsements and emphasis for the inclusion of echo training and teaching curriculum by the critical care colleges, namely, American College of Critical Care, European College of Critical Care and Australian and New Zealand College of Anaesthetists. [24,25,26,27,28] The position statement and guidelines emphasise on acquisition of images and interpretation of a certain number of cases. From an Indian doctors' clinical practise perspective, statutory permissions as per Pre-Conception and Pre-Natal Diagnostic Techniques Act 1994 should be obtained by an individual/organisation for the use of ultrasound of any use in any format. In this scenario, a radiologist or a cardiologist's opinion, in writing or that of a certified echocardiographer, only will stand in a court of law.

### Available Point Of Care Transthoracic Echocardiography Protocols

In our opinion and training, HEART scan [29] and FATE[30] protocol can be easily merged with routine as well as emergency clinical anaesthesia practice. Peri-arrest algorithms and protocols are meant for life-threatening crisis situations and need different thinking, approach and training and cannot be generalised in elective situations. Currently, there is no evidence for recommendations for a fixed number of clinical cases and clinical hours for POC clinical ultrasound and/or echo.

### Limitations and Solutions

Currently, cost and lack of availability of this technology in remote and regional locations, particularly in third world countries may be limiting factors in its use in routine practice. In addition, unavailability of teaching expertise, courses, workshops and accredited university degrees are main concerns for lack of training and standards. Incorrect diagnosis or misdiagnosis is possible and can cause more patient harm than benefit. Rigorous standards and presence of credentialing authority/licensing body are keys to maintain standards and meet medicolegal requirements. Reporting in standard format and cross-checking by experts from time to time will keep authentication and comparing with other imaging modalities for confirmation of diagnosis will avoid wrong diagnosis and helps in better patient management. Peer review, group discussion, continuous medical education, speciality conferences and maintaining a logbook will keep echocardiographer knowledge and skill up-to-date and also helps in maintenance of continuous professional development (CPD). This paradigm shift of POC assessment by non-cardiologist physician will improve the competency in managing complex patients. With the rapid development of technology and miniaturisation to handheld form of ultrasound machines, affordability and access is a reality in near future. Accuracy of POC TTE in the hands of novice is comparable with expert and has a positive impact on clinical situations.[7,8,9,10,11] It is also equally important to refer the findings of the patients appropriately

and in timely fashion for long-term management and follow-up with cardiologists. Authors also acknowledge the huge task and responsibility of teaching and education of already practising anaesthetists. Unfortunately, current evidence is based on all retrospective data, experts' opinion, consensus and case studies and prospective randomised studies would better assess its usefulness in routine practice.[30,31]

### ULTRASOUND EDUCATION AND TRAINING

To improve ultrasound teaching and training, there is a need to incorporate an ultrasound curriculum within anaesthesia training from the foundation years.[31,32] Simulation can also be helpful for clinician certification and recertification process.[33,34]

CPD is mandatory and highly warranted. There should be departmental resource manual for the guidelines and mandatory policies related to available equipment,

expected performance and annual skill level assessment.[35]

### REFERENCES

1. Faris JG, Veltman MG, Roysse CF. Limited transthoracic echocardiography assessment in anaesthesia and critical care. *Best Pract Res Clin Anaesthesiol*. 2009;23:285-98.
2. Jorgensen MR, Botker MT, Juhl-Olsen P, Frederiksen CA, Sloth E. Point-of-care ultrasonography. *OA Crit Care*. 2013;1:8.
3. Cowie B. Focused cardiovascular ultrasound performed by anesthetists during the perioperative period: Feasible and alters patient management. *J Cardiothorac Vasc Anesth*. 2009;23:450-6.
4. Mehta M, Jacobson T, Peters D, Le E, Chadderdon S, Allen AJ, et al. Handheld ultrasound versus physical examination in patients referred for transthoracic echocardiography for a suspected cardiac condition. *JACC Cardiovasc Imaging*. 2014;7:983-90.
5. Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S, et al. Focused cardiac ultrasound in the emergent setting: A consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *J Am Soc Echocardiogr*. 2010;23:1225-30.
6. Seward JB, Douglas PS, Erbel R, Kerber RE, Kronzon I, Rakowski H, et al. Hand-carried cardiac ultrasound (HCU) device: Recommendations regarding new technology. A report from the echocardiography task force on new technology of the nomenclature and standards committee of the American Society of Echocardiography. *J Am Soc Echocardiogr*. 2002;15:369-73.
7. Cho DH, Park SM, Kim MN, Kim SA, Lim H, Shim WJ. Presence of preoperative diastolic dysfunction predicts postoperative pulmonary edema and cardiovascular complications in patients undergoing noncardiac surgery. *Echocardiography*. 2014;31:42-9.
8. Hoole SP, Falter F. Evaluation of hypoxic patients with transesophageal echocardiography. *Crit Care Med*. 2007;35(8 Suppl):S408-13.
9. Kobal SL, Trento L, Baharami S, Tolstrup K, Naqvi TZ, Cercek B, et al. Comparison of effectiveness of hand-carried ultrasound to bedside cardiovascular physical examination. *Am J Cardiol*. 2005;96:1002-6.
10. Cauty DJ, Roysse CF. Audit of anaesthetist-performed echocardiography on perioperative management decisions for non-cardiac surgery. *Br J Anaesth*. 2009;103:352-8.
11. Brennan JM, Blair JE, Goonewardena S, Ronan A, Shah D, Vasaiwala S, et al. A comparison by medicine residents of physical examination versus hand-carried ultrasound for estimation of right atrial pressure. *Am J Cardiol*. 2007;99:1614-6.
12. Martin LD, Howell EE, Ziegelstein RC, Martire C, Whiting-O'Keefe QE, Shapiro EP, et al. Hand-carried ultrasound performed by hospitalists: Does it improve the cardiac physical examination? *Am J Med*. 2009;122:35-41.
13. Marum S, Price S. The use of echocardiography in the critically ill; the role of FADE (Fast Assessment Diagnostic Echocardiography) training. *Curr Cardiol Rev*. 2011;7:197-200.
14. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid ultrasound in SHock in the evaluation of the critically ill. *Emerg Med Clin North Am*. 2010;28:29-56.
15. Platts DG, Sedgwick JF, Burstow DJ, Mullany DV, Fraser JF. The role of echocardiography in the management of patients supported by extracorporeal membrane oxygenation. *J Am Soc Echocardiogr*. 2012;25:131-41.
16. Prosen G, Krizmaric M, Završnik J, Grmec S. Impact of modified treatment in echocardiographically confirmed pseudo-pulseless electrical activity in out-of-hospital cardiac arrest patients with constant end-tidal carbon dioxide pressure during compression pauses. *J Int Med Res*. 2010;38:1458-67.
17. Blaiwas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. *Acad Emerg Med*.
18. Greenstein YY, Martin TJ, Rolnitzky L, Felner K, Kaufman B. Goal-directed transthoracic echocardiography during advanced cardiac life support: A pilot study using simulation to assess ability. *Simul Healthc*. 2015;10:193-9.
19. The Ultrasound Education Group (UEG), University of Melbourne; HEART Scan Resources. [Last updated on 2011 Jun 08]. Available from: <http://www.heartweb.com>.
20. Perioperative and Intensive Care Echocardiography and Ultrasonography (PICEU) Foundation; FATE Scan Resources. Available from: <http://www.piceufoundation.com/>
21. Ultrasound Airway Breathing Circulation Dolor Organisation; FATE Scan Resources. Available from: <http://www.piceufoundation.com/>
22. Indian Academy of Echocardiography. Available from: <http://www.piceufoundation.com/>
23. World Interactive Network Focused on Critical Ultrasound (WINFOCUS) [Last accessed on 2016 Aug 5]. Available from: <http://www.piceufoundation.com/>
24. Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S, et al. American Society of Echocardiography consensus statement; focused cardiac ultrasound in the emergent setting: A consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *J Am Soc Echocardiogr*. 2010;23:1225-30.
25. Scalea TM, Rodriguez A, Chiu WC, Brennen FD, Fallon WF, Jr, Kato K, et al. Focused assessment with sonography for trauma (FAST): Results from an international consensus conference. *J Trauma*. 1999;46:466-72.
26. American College of Emergency Physicians; Emergency Ultrasound Imaging Compendium. 2006. [Last accessed on 2009 Nov 01]. Available from: <https://www.acep.org/Clinical---Practice-Management/Ultrasound>.
27. Neskovic AN, Edvardsen T, Galderisi M, Garbi M, Gullace G, Jurcut R, et al. Focused cardiac ultrasound: The European Association of Cardiovascular Imaging viewpoint. *Eur Heart J Cardiovasc Imaging*. 2014;15:956-60.
28. Australian and New Zealand College of Anaesthetists (ANZCA). ANZCA Guidelines on Training and Practice of Perioperative Cardiac Ultrasound in Adults. PS 46.

- Available from:<http://www.piceufoundation.com/>
29. Roysse CF. Ultrasound-guided haemodynamic state assessment. *Best Pract Res Clin Anaesthesiol.* 2009;23:273–83.
  30. Focus Assessed Transthoracic Echo (FATE) Scan and Protocol Resources. [Last accessed on 2016 June 3]. Available from: <http://www.piceufoundation.com/>
  31. Mosier JM, Malo J, Stolz LA, Bloom JW, Reyes NA, Snyder LS, et al. Critical care ultrasound training: A survey of US fellowship directors. *J Crit Care.* 2014;29:645–9.
  32. Expert Round Table on echocardiography in ICU. International consensus statement on training standards for advanced critical care echocardiography. *Intensive Care Med.* 2014;40:654–66
  33. Matyal R, Bose R, Warraich H, Shahul S, Ratcliff S, Panzica P, et al. Transthoracic echocardiographic simulator: Normal and the abnormal. *J Cardiothorac Vasc Anesth.* 2011;25:177–81.
  34. Neelankavil J, Howard-Quijano K, Hsieh TC, Ramsingh D, Scovotti JC, Chua JH, et al. Transthoracic echocardiography simulation is an efficient method to train anesthesiologists in basic transthoracic echocardiography skills. *Anesth Analg.* 2012;115:1042–51.
  35. Shilleutt SK, Brakke TR, Thomas WR, Thomas RP, Lisco SJ. The development of a perioperative echocardiography consult service: The Nebraska experience. *J Cardiothorac Vasc Anaesth.* 2015;29:777–84.