

Advancing, strengthening and reshaping obstetric critical care with Point-of-Care Ultrasound (POCUS)

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Lalit Mehdiratta, Nishant Kumar¹, Sukhminder Jit Singh Bajwa²

Department of Anaesthesiology, Critical Care and Emergency Medicine, Narmada Trauma Centre, Bhopal, Madhya Pradesh, ¹Department of Anaesthesiology, Lady Hardinge Medical College and Associated Hospitals, New Delhi, ²Department of Anaesthesiology and Intensive Care, Gian Sagar Medical College and Hospital, Banur, Patiala, Punjab, India

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Address for correspondence: Dr. Lalit Mehdiratta, Anaesthesiology, Critical Care and Emergency Medicine, Narmada Trauma Centre, Bhopal - 462 016, Madhya Pradesh, India.
E-mail: lalitmehdiratta9@gmail.com

It has been hypothesised since the early 18th century by Spallanzani that sound beyond the reach of human ears is used by bats to navigate.^[1] As with most other discoveries, this was first put to use for military purposes by the United States navy during the world wars. The first medical use came much later in the second half of the 20th century when Ian Donald used it for medical purposes in obstetrics and gynaecology. The first ultrasonography (USG) machines were developed in the 1950s, whereas limited, experimental use began not earlier than the 60s. It was in the 1970s that USG started being widely used for various clinical specialities, mainly as a diagnostic tool.^[2]

It was the three 'Princes of Serendip' – La Grange, Abramowitz and Kestenbaum who introduced this technique to anaesthesiology by performing USG-guided supraclavicular blocks in complicated patients^[1] with improved success rates and a decrease in complications in the late 70s and early 80s.

However, the main inroads in anaesthesiology have been made in the last one decade only. With the turn of the century, the application of USG expanded from the routine regional blocks and central venous catheterisation to perioperative and critical care.^[3]

Apart from the usual and new blocks for limb surgeries being performed under vision,^[4-9] with the diminishing size of the machine and better resolution, a whole

armamentarium of fascial plane blocks and surrogate central neuraxial blocks such as paravertebral^[10-12] and erector spinae plane blocks^[13-17] are now available to the anaesthesiologists. Spinal,^[18,19] epidural^[20-22] and even caudal blocks^[23] can now be performed under vision, especially in paediatrics.

In addition to that, the chest wall (pectoralis,^[15-17] serratus anterior plane blocks^[24,25]) and abdominal wall^[26] (transversus abdominis,^[27-29] quadratus lumborum,^[30,31] rectus sheath blocks) plane blocks are now being routinely performed.

The application of USG in chronic pain cannot be over-emphasised. Chest radiogram and fluoroscopy, which have been the mainstay of diagnosis and therapeutics, have now been largely replaced by USG.

Recent studies have suggested the use of preoperative USG to ascertain residual gastric volume^[32-34] in patients at high risk for aspiration. The conventional airway examination in the anticipated difficult airways and obese can be objectively assessed using USG with measurements of the tongue thickness, the submandibular space and even the vocal cord status.^[35-41]

Choosing an appropriately sized endotracheal tube and passing an endotracheal tube through the vocal cords detected by the end-tidal carbon dioxide is now

done under direct real time visualisation.^[42-46] Difficult venous and arterial cannulation, insertion of peripheral or central catheters are no longer dependent on the 'feel' of the vessel.^[47-52]

Postoperative stridor, airway oedema, vocal cord movements, and epiglottic and tracheal anatomy can be directly visualised and are of importance in airway and neck procedures. Front of neck access is now no longer a blind procedure. Percutaneous tracheostomy under USG guidance is now the point of care in the intensive care unit (ICU) and emergency departments.^[53]

Transoesophageal echocardiography is a boon to patients undergoing cardiac surgery or high-risk cardiac patients undergoing noncardiac surgery in diagnosing various cardiac derangements and specific embolism intraoperatively.^[54] Focussed cardiac ultrasound and comprehensive transthoracic cardiac ultrasound for preoperative assessment of suspected abnormalities in cardiac function (e.g., valvular heart disease, left ventricular dysfunction) or volume status provides valuable information.^[55]

Point-of-Care ultrasound (POCUS) is the bedside utilisation of ultrasound in real-time to aid in the early diagnosis and treatment of patients. It is now considered as an extension of the physical examination and serves as a diagnostic adjunct to the treating physician. Unlike conventional ultrasound, it is a rapid, limited study performed at the bedside for a specific diagnosis or therapeutic outcome. POCUS is currently highly utilised by emergency physicians in North America.^[56] Nevertheless, its application in the perioperative period is fast-increasing. A number of narrative reviews on the application of POCUS perioperatively have been recently published and all of them have portrayed that it has diverse clinical utility and great potential.^[57,58] A recent editorial in the Indian Journal of Anaesthesia (IJA) has highlighted the need to adopt modern strategies to improve the quality of perioperative care.^[59] The use of POCUS in the perioperative setting can be a welcome move in this direction.

With its ability to provide a peek in the body cavities and vessels, USG including POCUS is now an integral part of the management of critically ill patients in the emergency department and critical care unit as a valuable diagnostic and monitoring tool. Starting from the cranium, transcranial doppler (vascular sufficiency, cerebral perfusion pressure, vasospasm), optic nerve

sheath diameter (intracranial pressure) and brain parenchyma status (midline shift) can be ascertained.^[60]

Examination of the lung, which was primarily dependent on chest radiogram and computed tomography scan, has yielded way to bedside diagnosis and therapeutics by USG. Pneumonia, pneumothorax, pulmonary oedema, effusion and even extravascular lung water (EVLW) can be picked up by USG. Assessment of diaphragmatic function has further reduced the incidence of failure to wean from mechanical ventilation.^[54]

Volume status can additionally be inferred from the examination of the vena cava and fluid therapy monitored.^[54] A study in this issue is based on the prediction of postinduction hypotension in young adults using ultrasound-derived inferior vena cava parameters.^[61] The utility of focussed assessment with sonography in trauma (FAST) and inpatients with abdominal distension and shock cannot be overemphasised.^[54]

POCUS is now the new kid on the block in obstetric critical care. A recent review concluded that POCUS can play an essential role in aspiration risk assessment, airway management, neuraxial anaesthesia, cardiorespiratory diagnosis and decision-making during pregnancy.^[62] Another recently conducted observational study in critically ill parturients admitted in a resource-limited obstetric high dependency unit concluded that out of the 166 enrolled parturients, 34% presented with respiratory distress, 21% had atleast one pulmonary complication detectable by lung ultrasonography and the incidence was higher in those with respiratory distress. The pulmonary complications that were seen included fluid overload, acute respiratory distress syndrome, pleural effusion, pneumonia and atelectasis. The physiological changes of pregnancy, preeclampsia, and puerperal cardiomyopathy predispose parturients to pulmonary oedema. The use of nifedipine, magnesium sulphate, acute kidney injury related to preeclampsia and iatrogenic fluid overload contribute to pulmonary congestion in the critically ill obstetric patient. Early detection of this congestion to guide fluid administration can prove useful in their clinical management.^[63] This issue of the IJA has a systematic review and meta-analysis, wherein the authors have evaluated the role and ability of POCUS in the assessment of volume status and early detection of lung oedema in parturients with severe preeclampsia (SPE).

The review concludes that POCUS can be a useful tool in the clinical management of the parturient with SPE to identify and grade the presence of EVLW before it clinically manifests, that is, lung ultrasound can detect subclinical pulmonary oedema and provide a window to the treating physician to prevent further deterioration.^[64] POCUS in the hypertensive pregnant patient has some more applications. Measurement of the optic nerve sheath diameter provides a surrogate to intracranial pressure management. In a convulsing patient, transcranial doppler and optic nerve sheath diameter monitoring can prevent further complications.^[64] An interesting application of POCUS in the preclamptic parturient is depicted in another clinical communication published in this issue of the IJA. This communication cites a case of a preeclamptic parturient on magnesium sulphate who got sedated with loss of sensorium. Ultrasound imaging of the abdomen and pelvis in the ICU helped in the diagnosis in this case by depicting kidney abnormalities to be the cause of delayed excretion of magnesium. The resultant magnesium toxicity had led to altered sensorium.^[65]

Despite the shackles of the Pre-Conception and Pre-Natal Diagnostic Techniques (PNDT) act,^[66] USG remains an invaluable tool in the armamentarium of the anaesthesiologists. With the newer compact, single, all-purpose probes (Butterfly, V-Scan), which can be connected to the smart phone or a tablet, it would not be wrong to say that the time is not far when USG would be the new stethoscope! Smartphone-based POCUS has been recently found to be reliable to detect free fluid in the abdominal cavity, the foetal heart-beat, foetal presentation and the assessment of gestational age in the parturient.^[67] This smartphone may be used to detect and estimate the presence of EVLW to guide fluid management in the parturient in the days to come. Nevertheless, POCUS in obstetric critical care has its own share of concerns including barriers like the availability of portable and robust USG equipment for POCUS and the lack of confidence amongst intensivists and obstetricians in doing POCUS. The technique of imaging and the interpretation of the images require training and experience. Several authors, researchers and bodies have recommended the incorporation of ultrasound training in the teaching curriculum of undergraduate medical students and postgraduate students in Obstetrics and Gynaecology and Anaesthesiology.^[68]

Most of the literature on POCUS in obstetric critical care is based on observational studies. It is said that

the reporting of observational studies is often of insufficient quality and this hampers the assessment of the strengths and weaknesses of the study. Furthermore, it is a fact that the quality and reliability of evidence generated from a systematic review are dependent on the quality of the studies that are included in the review.^[69] Nonetheless, all the seven studies included in the systematic review published in this issue are observational studies. At this point, it is imperative to note that the design, implementation and reporting of observational studies require methodological and clinical expertise and reporting skills to minimise bias.^[70] Nevertheless, high quality observational studies/randomised controlled trials need to be published on this novel topic of the use of POCUS in obstetric critical care including preeclampsia. Ultrasound is the new 'Brahmastra' (powerful tool) of the anaesthesiologist and POCUS is the obstetric intensivist's new wand that is revolutionising and strengthening obstetric critical care and improving maternal outcomes. POCUS is currently without doubt the new lamp in the labour room and the obstetric critical care unit.

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