

The use of ultrasound in ICU: the new stethoscope of intensive care physicians

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Balaji Ramamurthy

Sandwell and West Birmingham Hospital, United Kingdom

Correspondence: Balaji Ramamurthy, Sandwell and West Birmingham Hospital, hallam st, west bromwich B714HJ United Kingdom, Tel +4407961656175, Email drbala001983@gmail.com**Received:** April 23, 2022 | **Published:** April 29, 2022

Introduction

Bedside ultrasound has become a valuable tool for physicians working in critical care environments to obtain immediate clinical information, improve patient safety, increase efficiency, and decrease complications. ICU physicians are using innovative ways to use ultrasound in the ICU as it mitigates the risk involved in transferring the sick patients out of safe environment of ICU and avoids delays. Ultrasonography is increasingly being looked upon as extension of clinical examination to find quick care in sick ICU patients.

Discussion

There are several applications of use of ultrasonography in the intensive care unit:

Lungs: can be used to identify various lung pathologies such as pleural effusion, interstitial syndrome, pneumothorax, consolidation including evaluation of alveolar recruitment and positive end-expiratory pressure induced lung re-aeration, during mechanical ventilation, in more severe hypoxemic patients; evaluating volume load

Cardiac: ultrasonography has been used for assessment of ventricular function, for measurement of cardiac output, for assessment of hypovolemia, valve pathologies among many other use. Inferior vena cava measurements for variations with respiratory cycle is another method to assess fluid responsiveness however it's a static parameter.

In cardiopulmonary resuscitation, it is used to identify the cause and detect mechanical activity during the resuscitation.

Abdomen: FAST (focussed assessment with sonography in ultrasound) scan was developed to aid in the diagnosis of blood/free fluid in the abdomen in patients who had suffered blunt trauma with the primary aim to rapidly direct appropriate operative interventions in unstable patients. In this issue, Argandona et al.¹ describe the use of FAST and E-FAST in trauma patients. They describe the techniques of doing FAST ultrasound by the bedside and share the proposal for an algorithm, diagnosis and treatment of abdominal trauma that will be very useful in the Emergency and Intensive Care service. Indeed, FAST is more sensitive and specific than clinical examination, US FAST has been shown to have a sensitivity of 86% to 99% and a specificity of 90% to 99% for detecting hemoperitoneum and is part of the ATLS (American trauma life support) and European (STOP bleeding) initial recommendation for treating trauma patients.

Measurement of intracranial pressure using optic nerve sheath diameter:

In this issue, Kadapa S² talks about use of neuromonitoring in patients with acute liver failure using ONSD and near infrared spectroscopy. Indeed, Toscano et al.³ showed that ONSD using ultrasonography in ICU is a reliable marker of intracranial hypertension, ONSD is determined by measuring the diameter from the inner-edge

to inner-edge of the optic nerve sheath at 3 mm behind the globe, using the optic disc as a reference point. Each of three or more such measurements using horizontal and vertical transbulbar approaches are averaged to calculate a final value of ONSD. The cut-off value for ONSD, measured 3 mm posterior to the globe, correlating with elevated ICP (ICP >20 mmHg) ranges from 4.8 to 6.0 mm. Tayal et al. conducted a prospective, double-blind study in 55 patients and found that an ONSD of 5.0 mm or more correlated with CT findings suggestive of raised ICP. Using 4.5 mm as the cut-off for normal, Tamburrelli et al.⁴ found a sensitivity of echocardiography to identify an ICP >15 mmHg of 88% and a specificity of 90%. Previous studies have demonstrated that ONSD can be used as a non-invasive indicator of raised ICP.

Other uses of ultrasound in ICU: for obtaining vascular access, for assisting in procedures such as abdominal paracentesis, detection of deep venous thrombosis, assessing tracheal rings prior to percutaneous tracheostomy, detection of Et tube after intubation.

However the use of ultrasound in intensive care is not without limitations. First is patient limited such as presence of bandages, obesity, subcutaneous emphysema which can seriously limit the potential use of ultrasound, second is that there can be significant subjective variations.

One of the effective ways to utilise ultrasound in ICU is to develop protocols for the systematic use of ultrasound to arrive at logical conclusion of the patients condition. We have seen the use of ultrasonography for individual organ systems however use of protocols help in global assessment of the rapidly deteriorating patient. Blue protocol⁵ which had diagnostic accuracy of 90.5% was devised following an observational study in France in patients with respiratory failure. The BLUE-protocol can be done within 3 minutes which allows quick diagnosis of acute respiratory failure.

Another protocol used The RUSH protocol (2010) is a rapid evaluation of cardiac function, key vascular structures, and likely sources of hypotension, widely used in emergency medicine to deal with patients in shock. Pontet⁶ tried to study the impact of point of care

ultrasound (POCUS) Systematic application of POCUS may decrease utilization of conventional diagnostic imaging resources and time of mechanical ventilation, and facilitate meticulous intravenous fluid administration in critically ill patients during the first week of stay in the ICU with 22% accuracy rate. Manno et al.⁷ proposed that septic patients may be the most favoured subgroup of patients receiving a POCUS protocol the ICU sound protocol because of the myriad of information and therapies that can be tailored to each individual patient. A population of 125 consecutive critically ill patients admitted in a general ICU were included within 12 h from admission. ICU-sound protocol they used led to more accurate admission diagnosis in 25.6% to 24.9%.⁸

Conclusion

There are varied application of POCUS in the ICU and it is an valuable extension of clinical examination to the ICU physician and important part of his/her armamentarium. It is important that ICU physicians undertake necessary training to develop these skills. It is more effective to use protocols in ICU for systematic application of ultrasonography for diagnosis in the ICU.

Acknowledgments

None.

Conflicts of Interest

None.

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