

# Bedside ultrasound and echocardiography by the pediatric intensivist: An evolving tool and a feasible option in a pediatric ICU

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Bedside ultrasound (BUS) and echocardiography are the evolving tools for pediatric intensivists, which are currently being used in many pediatric intensive care units to evaluate several disease processes, assist in procedural interventions, assess the complications related to those procedures, and perform an accurate and comprehensive assessment of a critically ill child at the bedside.<sup>[1,2]</sup> Transthoracic echocardiography has been used in adult patients to assess the volume status in the emergency room, though somewhat less commonly, in pediatric patients.<sup>[3]</sup>

In this issue of *Indian Journal of Critical Care Medicine*, Ranjit and Kissoon have shown (in a retrospective analysis) the clinical utility of bedside echocardiography to guide further fluid and/or inotropic therapy in children with a clinical picture of septic shock (warm or cold) and variable pulse pressures unresponsive to 60 ml/kg fluid boluses and inotropic support.

While inherent problems of retrospective analysis exist in the interpretation of results of this study, it does emphasize a significant point in pediatric sepsis. Presently there is much oversimplification of pediatric sepsis guidelines recommending a choice of a particular inotrope or vasopressor combination solely based on cold shock or warm shock in conjunction with a low or normal blood pressure. Significant volume deficit and myocardial dysfunction may exist or coexist in many of those patients difficult to assess due to a variable clinical and hemodynamic state. Many of those patients may still need more fluids or have a coexisting myocardial

dysfunction as suggested by bedside echocardiography, that could indicate optimal choice of inotropes and vasopressors alone or in combination.

The assessment of volume status in the pediatric intensive care unit can be a challenge, especially in the edematous child. Echocardiography showing left ventricular chamber with complete collapse or obliteration of the left ventricular cavity guides management in a way that is markedly different from that in a patient with a left ventricular cavity that is clearly dilated and poorly functioning. The assessment of inferior vena cava diameter and its collapse during inspiration has been used to determine the volume status.<sup>[3]</sup> Rapid Ultrasound in Shock (RUSH) examination has been used to uncover the etiology and initiate early goal-directed therapy for adult patients in shock in the emergency department.<sup>[4]</sup>

The analysis of respiratory variation in stroke volume has received the largest level of evidence, but cannot be used in the presence of spontaneous breathing activity, cardiac arrhythmias, increased intraabdominal pressure, low tidal volume, or low lung compliance.<sup>[5]</sup>

As a word of caution, inferior vena cava measurements during mechanical ventilation are less reliable because of

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the caval dilation that frequently occurs in this situation. However, a collapsed inferior vena cava will reliably exclude elevated right atrial pressures, even in septic patients.<sup>[5]</sup> In the present study, authors have used this as a criterion to assess volume status.

In a nationwide survey from 128 pediatric intensive care units in North America, Lambert and colleagues suggested that BUS may be underutilized in many important clinical situations such as assessment of volume status, pneumothorax, and during cardiac arrest. Only 27% of responders of this survey were using BUS for these types of indications.<sup>[1]</sup> Most were using it for obtaining vascular access. Only 20% (18/90) of responders who reported current use of BUS had received formal training in performing BUS.

In the current study, bedside echocardiogram was performed by an echocardiography technician or a cardiologist; however, it may be much more practical to perform a BUS or a limited echocardiogram (the RUSH exam) by a trained intensivist titrating fluid therapy or inotropic/vasopressor support.

A number of university-or private sector-based ultrasound (US) courses focusing on the pediatric patient are evolving, including an annual fundamental US course conducted by the Society of Critical Care Medicine and the Indian Society of Critical Care Medicine (ISCCM).

Most importantly, the issue that has not been addressed yet is the existence of many road blocks for using BUS and bedside echocardiography in critically ill children. These include the resistance posed by radiology services in allowing non-radiologist intensivists to perform US reliably without due accreditation. Furthermore, many cardiologists disagree with limited focused emergency echocardiography, not to mention the difficulties associated with billing and potential medicolegal liability.

Nevertheless, I believe that BUS and echocardiography

are important and rapidly evolving tools for pediatric intensivists (already well established for obtaining vascular access) for rapid assessment of volume status and myocardial function, detecting pericardial effusions, pleural effusions, and other pulmonary problems such as pneumothorax or atelectasis.

Ongoing empirical evidence, training, and experience are necessary to demonstrate the benefits in children with septic shock. Without proper training and expertise, however, the use of bedside echocardiography may be misleading resulting in diagnostic and procedural mistakes.

It is, therefore, important that formal training in such courses of BUS and limited echocardiography be obtained by the intensivist, keeping in mind the following limitations: learning curve needed for the technique, inter-observer variability, interpretation in the presence of confounding factors such as spontaneously breathing versus mechanically ventilated patients, raised intraabdominal pressure, low tidal volumes, and low lung compliance.

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