ICU Echocardiography

Should We Use It in a Heart Beat?

Ask, and it shall be given you; seek, and ye shall find; knock, and it shall be opened unto you.

Matthew 7:7

In the current issue of CHEST (see page 1370), the report by Bossone and colleagues revealed a high incidence (36%) of occult cardiac abnormalities utilizing blinded comprehensive two-dimensional transthoracic echocardiography (TTE) and Doppler echocardiographic evaluation in 500 consecutive patients admitted to the University of Michigan medical ICU for noncardiac reasons. All of the TTE studies were obtained within 18 h of ICU admission. Approximately 14% of patients had two or more cardiac abnormalities identified. Only patients with a finding of pulmonary hypertension on TTE had a longer length of ICU stay, but there was no difference in mortality between patients with a positive finding on TTE and those with normal study findings. Patients with sepsis or liver failure as an ICU admitting diagnosis had a lower incidence of TTE findings, while patients with neurologic or hypertensive emergencies had a higher prevalence of abnormalities.

Like many well-designed, prospective blinded studies, this one raises as many questions as it answers. Of the 500 patients enrolled, 33 patients were removed. Two patients had inadequate studies, and 31 patients were determined to have a history of significant cardiovascular disease, or the current hospitalization represented an acute cardiovascular event. Fifty-two of 467 patients were unblinded for the incidental findings of a “critical” cardiovascular abnormality. Critical lesions were prospectively identified as severe valvular insufficiency or stenosis, right ventricular (RV) pressure ≥ 50 mm Hg, left ventricular (LV) ejection fraction ≤ 35%, pericardial effusion causing hemodynamic compromise, valvular vegetations, LV thrombus, or aortic dissection.

It is open to speculation if these critical abnormalities would have been discovered eventually or if preemptively finding them impacted patient outcome. It is also unknown whether the findings in the 130 patients with cardiac abnormalities that were not revealed to the treating physicians would have changed management or outcome. Interestingly, there are no comparable studies measuring the incidence of cardiac abnormalities in surgical ICU patients, those admitted to a non-ICU hospital ward, or the general population.

On a daily basis in a medical-surgical ICU, we must evaluate and manage a wide variety of hypertensive or hemodynamically labile patients. Our clinical acumen, based on history, physical examination, laboratory, and radiographic evaluation, is often limited, and further data are needed.1 Bossone et al reinforced the relative insensitivity of admission ECG combined with the portable chest radiograph in identifying TTE-determined cardiac findings. They also reported how infrequently TTE was ordered in patients who had cardiovascular abnormalities with findings that remained blinded to the investigators.

Unfortunately, Bossone and colleagues were not able to compare the utility of the pulmonary artery catheter (PAC) to the TTE in their diverse population with major medical illness. Routine use of the PAC has come into question because of the possible inaccuracy of pressure vs volume measurements, the lack of uniform and accurate interpretation of data acquired from the catheter, and concerns over excessive morbidity and mortality in patients who undergo catheterization.2 Therefore, there are many times when a “snapshot” of cardiac function, like that provided by a noninvasive test such as a transthoracic echocardiogram, might be helpful. Poelaert et al3 reported that 44% of patients with a PAC underwent a change in therapy after a transesophageal echocardiogram (TEE), showing that echocardiography can add to PAC measurements. There is ample evidence to suggest echocardiography can be helpful in dealing with the complex and dynamic patient in the ICU4,5; however there is inadequate information to guide intensivists on the utility, ease, and accuracy of TTE vs TEE. Bossone et al remind us that TEE may provide superior echocardiographic data.

Specially trained cardiologists independently interpreted all TTE studies in the study by Bossone.

References

and coauthors. The study did not compare the accuracy of noncardiologists in identifying incidental or critical pathology. Their study did not evaluate how the level of training affects who should perform or interpret echocardiography in the ICU, and what training is appropriate to allow a clinician to provide adequate interpretation for a general, definitive screen or a more focused study.

The use of echocardiography in the ICU is curtailed not only by the paucity of outcome data, but in many institutions by the unavailability of equipment, or 24 h/d access to echocardiography technicians or adequately trained physicians. These factors raise the following questions: (1) What information do intensivists need most often from bedside echocardiography? (2) What is the ideal technique to use, TTE or TEE? (3) Should intensivists be performing echocardiography more commonly and, if so, what training and experience do they need to obtain reliable information? (4) What is the liability of data that are missed on ICU echocardiographs?

As a minimum, we suggest that intensivists use TTE or TEE to assess a patient for RV and LV end-diastolic volume, dysfunction, or significant pericardial effusion. With increasing degrees of sophistication, identification of valvular pathology such as mitral regurgitation, aortic stenosis, or intracardiac clot from deep venous emboli may be anticipated.

Critically ill medical and surgical patients, by virtue of the fact that they are often receiving mechanical ventilation, are difficult to position, and may have bandages and monitoring devices covering their chest walls, may be difficult to examine with a transthoracic approach. These intubated and sedated patients are potentially ideal candidates for a TEE examination. Closer proximity of the transducer to the heart allows for the use of a higher-frequency transducer and hence improved resolution of most cardiac structures, compared with the TTE examination. In the sedated patient receiving mechanical ventilation, a TEE examination can be performed with minimal risk. Table 1 lists relative and absolute contraindications to TEE.

Appropriate training guidelines for the use of echocardiography in the ICU will undoubtedly need to be addressed. Focused examination probably requires a modest training program, but will result in a narrow expertise. Intensivists may need different levels of experience depending on patient population, access to equipment, and availability of appropriate support services and experts to review questionable findings.

Guidelines established in concert by the American College of Echocardiography and the Society of Cardiovascular Anesthesiologists generally recommend a minimum of 6 months of training to achieve a level 2 standard, which is the minimum level recommended for independent performance and interpretation of echocardiograms. Although no distinction is made between transesophageal and trans-thoracic qualifications, this level of training is the “gold standard” for comprehensive examination. The time commitment is, however, significant during an ICU fellowship, and is certainly extremely restrictive for the practicing intensivist seeking additional skills. Nonetheless, we would encourage current and future trainees to seriously consider obtaining these skills during their fellowship training electives, since echocardiography is likely to be increasingly useful in acute care settings such as the emergency department, ICU, and operating theater. Future use may include continuous real-time bedside echocardiographic monitoring.

Physicians who have trained extensively and fulfilled the full training requirements in echocardiography cite valid concerns regarding the potential errors that could result in decisions made after limited examination by less-thoroughly trained practitioners. This dilemma has been debated for emergency department physician training in limited emergency echocardiography.

Kimura et al showed that a “limited” echocardiographic study looking specifically for hemodynamically significant pericardial effusions and identification of an embolic source could identify significant incidental findings 85% of the time. This demonstrates that even a “limited” examination can reveal important pathology. Benjamin and colleagues found that training intensivists to perform a specific but limited TEE examination to evaluate LV function and volume status could be done rapidly, with excellent results. Cardiologists trained a group of intensivists utilizing didactic

| Table 1—Contraindications to TEE* |
|-----------------------------|-----------------------------|
| Absolute                  | Relative                    |
| History of dysphagia (needs further investigation) | Patient unable to cooperate |
| Esophageal stricture       | Oropharyngeal distortion    |
| Esophageal varices         | Cervical spondylisis        |
| Esophageal diverticuli     | Hiatal hernia               |
| Scleroderma                | Patients with head and neck trauma |
| Prior esophageal surgery   | Suspected cervical spine injury |
| Prior esophageal radiation | Gastric volvulus            |
| Gastric perforation        | Gastric volvulus            |
| Active upper GI bleeding   | Cervical spine instability  |
| Cervical spine instability | Cervical spine instability  |

*Modified from Fransis et al.*
sessions covering ultrasound principles, image acquisition and processing, and data interpretation. The intensivists attended regular weekly review sessions of echocardiograms, and were then taught the performance of TEE examination under the direct supervision of cardiologists. As their level of competence rose, the intensivists graduated to the unsupervised level. This occurred after completing the basic educational program and 8 to 10 procedures under direct supervision by the cardiologist. The study looked at the independent performance of limited goal-directed TEE examination by intensivists after this training program. The intensivists’ findings in this study were confirmed by the cardiologists’ findings in 93% of cases assessed for LV wall thickness, 87% of intracardiac volume status, 81% for focal LV wall motion, and 77% for global LV contractility. There was no data collected on the clinical significance of the differences in findings between the intensivists’ and the cardiologists. In fact, this same study found that the PAC data often disagreed with TEE data, potentially changing appropriate treatment strategies.11

TTE and TEE are powerful tools. Miniaturized, handheld devices are now available to clinicians, and wider application of echocardiography may be forthcoming. The choice of which modality to apply is based on clinical scenario, ease of access, potential contraindications to invasive echocardiography with current probes, and availability of equipment, technicians, and physicians skilled in the use of echocardiography. The future availability of more sophisticated interrogation devices, such as advanced handheld devices, miniaturized transesophageal, or contoured surface probes that can be left in place for a continuous monitor, may make echocardiography dramatically more available. The study by Bossone and colleagues opens our eyes to the surprising incidence of significant pathology that may or may not have remained undetected. Further studies are needed to show the benefit of echocardiography on outcome, the potential misapplication or misinterpretation of findings, and the use of additional unnecessary and potentially dangerous interventions for insignificant findings.

Jonathan T. Ketzler, MD
Mary E. McSweeney, MD
Douglas B. Coursin, MD, FCCP
Madison, WI

References

Therapeutic Whole Lung Lavage
A Stop-Gap Therapy for Alveolar Proteinosis

Pulmonary alveolar proteinosis (PAP) is characterized clinically by nonresolving pulmonary infiltrates and hypoxemia in patients in their third and fourth decades, and it occurs with a male predominance. This disease is quite remarkable for flooding of the alveoli with lipoproteinaceous material, yet with minimal local lung inflammation or distortion of architecture on biopsy, for reasons that are unknown. The last 8 years have seen some remarkable advances into the pathophysiology of this disease, through transgenic murine models that have clearly established that hematopoietic growth factor (granulocyte-macrophage colony stimulating factor [GM-CSF]) is critical for local regulation of surfactant

Jonathan T. Ketzler, MD
Mary E. McSweeney, MD
Douglas B. Coursin, MD, FCCP
Madison, WI

Correspondence to: Jonathan T. Ketzler, MD, Department of Anesthesiology, B6/319 UW CSC, Madison, WI 53792-3272; e-mail: Ketzler@facstaff.wisc.edu

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