



## Editorial

## Intraoperative Transesophageal Echocardiography During Coronary Artery Bypass Graft Surgery (CABG): A Major Step Toward Improving Outcomes in Cardiac Surgery



The use of transesophageal echocardiography (TEE) in the cardiac operating room represents one of the greatest advances in the field of cardiac anesthesia since its introduction in the 1980s.<sup>1</sup> In the rapidly changing environment of the operating room, the value of TEE becomes readily apparent as acquisition of real-time information on cardiac structure and function can facilitate the prompt management decisions that often are required in this setting.<sup>2</sup> Although the theoretical advantages of intraoperative TEE are evident, positive outcome data have been lacking thoroughly to support its use in coronary artery bypass graft (CABG) surgery. In the nationwide study published in the July issue of *Journal of the American College of Cardiology*, Metkus et al. have changed the landscape surrounding the use of intraoperative TEE and CABG surgery.<sup>3</sup> The authors presented a large retrospective cohort study on the use of intraoperative TEE in 1,255,860 patients undergoing isolated CABG across 1,218 centers from the Society of Thoracic Surgeons (STS) database. Using propensity matching and multivariate adjustment, the investigators found the use of intraoperative TEE during isolated CABG to be associated with a lower odds ratio (OR) of mortality in intermediate-risk (STS risk = 4–8%; OR = 0.93) and high-risk patients (STS risk >8%; OR = 0.89), as well as a greater probability (OR = 4.98) of modifying the surgical plan due to unexpected intraoperative echocardiographic findings. Regarding the low-risk group (STS risk <4%), the authors reported that the use of TEE during CABG did not show an outcome benefit (OR = 0.99). With respect to the secondary outcome measures, the investigators reported an association of TEE use and increased length of intensive care unit stay (OR = 1.14) and renal failure (OR = 1.09) in patients presenting for CABG.<sup>3</sup>

In an analogous study by MacKay and associates published in the June issue of *Journal of the American Society of Echocardiography*,<sup>4</sup> the investigators studied Medicare patients (age >65, n = 114,871) who underwent intraoperative TEE during CABG and compared them to a cohort that did not

receive TEE monitoring. MacKay et al. reported a lower mortality rate (3.7% v 4.9%) and composite outcome of stroke or mortality (4.5% v 5.6%) in patients who received intraoperative TEE during CABG compared to the non-TEE group.<sup>4</sup> In addition, patients who underwent intraoperative TEE did not exhibit any increased incidence of esophageal rupture compared to the non-TEE group. The findings of MacKay et al. complement that of the Metkus study in that intraoperative TEE may improve outcomes in cardiac surgical patients undergoing isolated CABG.<sup>3,4</sup> These landmark studies together represent a major contribution, as there has been a lack of outcome data regarding the use of intraoperative TEE in CABG thus far.

Although the results of the Metkus study provided essential outcome data, an equally important finding was the association of TEE monitoring and acute renal failure (OR = 1.09).<sup>3</sup> The mechanism responsible for increased rates of renal failure are unknown but potentially suggests a difference between TEE-guided hemodynamic management and patients who are not monitored by echocardiography. The answer to this complex question is critical, as perioperative renal injury has been associated with worse outcomes in cardiac surgery.<sup>5</sup> Perhaps there is a difference in vasopressor and/inotrope usage or fluid management strategies in patients guided by TEE monitoring. This important finding highlights a knowledge or treatment gap that may serve as a key area of investigation to reduce perioperative renal injury during cardiac surgery and potentially improve outcomes.

One of the most intriguing findings of the Metkus study was the strong trend toward an increase in TEE utilization during CABG surgery over time as the percentage of patients monitored by intraoperative echocardiography nationwide increased from 39.9% in 2011 to 62.1% in 2019.<sup>3</sup> However, there is a disparity in the use of TEE in the Midwestern and Southern regions of the United States where the likelihood to employ echocardiography as a monitor is among the lowest in

the nation.<sup>3,6</sup> It is unclear whether this discrepancy is a consequence of a lack of resources or trained personnel, regional practice patterns, patient socioeconomic status, or other factors. Nevertheless, this represents an area of potential improvement in the strategic use of TEE, especially in intermediate- and high-risk or older (>65 years) patients who likely benefit from intraoperative echocardiography.<sup>3,4</sup> An effort to make TEE available in these low-use regions may improve CABG outcomes, especially in sicker or older populations. The disparate use of TEE in the Midwestern and Southern regions also may highlight a need for increased training in perioperative TEE and improvement in resource allocation in these areas. Alternatively, patients who carry a higher STS risk score or are of advanced age may necessitate a referral to centers that offer TEE monitoring during CABG.

Consistent with observations from previous studies,<sup>7-10</sup> the Metkus study demonstrated that a significant number of patients presenting for isolated CABG required a change in the surgical procedure based on results obtained by intraoperative echocardiography.<sup>3</sup> The investigators reported a total of 2,691 (0.32%, n = 831,528) patients scheduled for isolated CABG required a modification to the planned procedure, corresponding to a five-fold difference compared to the non-TEE group.<sup>3</sup> The impact of TEE on surgical planning has been reported in several prior studies.<sup>7-10</sup> In a study by Eltzschig et al.,<sup>7</sup> surgical decisions were influenced in 5.4% of CABG procedures based on the prebypass TEE examination. In the same study, 1.5% of patients undergoing CABG required a return to cardiopulmonary bypass as a result of postbypass TEE findings.<sup>7</sup> The detection of undiagnosed valvular disease or structural abnormalities on intraoperative TEE, therefore, may represent an important means to improve outcomes during cardiac surgery. According to the STS database, approximately 40% of the patients nationwide undergoing CABG were not monitored by TEE in the Metkus study.<sup>3</sup> Similarly, in the MacKay study, the researchers reported that 43% of patients presenting for CABG did not undergo TEE monitoring during the procedure.<sup>4</sup> The failure to detect occult valvular disease at the time of CABG may be even more pronounced in the regions of the Midwest and South where use of TEE is lowest.<sup>3,6</sup>

One of the potential conclusions suggested by Metkus and colleagues was that the underuse of TEE monitoring in low-risk patients might be justified due to a lack of clinical benefit.<sup>3</sup> Although the data are equivocal regarding the mortality benefit of TEE in the low-risk group, absence of TEE in these patients would lead to a significant number of concomitant valvular or structural abnormalities that will go unaddressed at the time of CABG.<sup>3,7</sup> As opposed to the preoperative echocardiogram, the utility of intraoperative TEE during CABG extends much beyond its role for evaluating valvular or structural abnormalities.<sup>11,12</sup> In the dynamic setting of the operating room, the anesthesiologist may be faced with sudden and unexpected hemodynamic changes at any instant. The rescue value of TEE in the face of hemodynamic instability has been well established and is currently a Class I indication for its use.<sup>2,13-17</sup> In the Elszschig study,<sup>7</sup> 1.5% of patients undergoing

CABG required a return to cardiopulmonary bypass after initial separation, underscoring the utility of intraoperative TEE as a dynamic monitoring tool to evaluate for and prevent life-threatening hemodynamic instability in real time.<sup>2,11,14</sup> In addition to its vital role as a point-of-care monitor, TEE often is employed as a procedural adjunct to guide and facilitate the conduct of both anesthesia and surgery.<sup>11,12</sup> For example, TEE-guided cannulation of the coronary sinus is a common practice for cardiac surgeons to deliver retrograde cardioplegia.<sup>12</sup> Similarly, TEE can be used to confirm central line placement or guide the placement of a Swan-Ganz catheter as it travels through the right heart and into the pulmonary artery.<sup>12</sup> Moreover, live imaging commonly is used for a variety of medical procedures and device implantation without clearly defined outcome data.<sup>18-20</sup> In the operating room, TEE serves a much greater role than simply serving as a monitor. To this end, from monitor-to-procedure adjunct, the use of TEE during CABG in low-risk patients still may be useful despite a lack of outcome data.

The results of the Metkus<sup>3</sup> and MacKay<sup>4</sup> studies were groundbreaking and pointed toward a change in the guidelines to support the use of TEE during CABG. However, several important questions are raised surrounding the mechanisms driving the improvement in outcomes. It is tempting to speculate that the value of TEE may be greater in sicker or older patients, as the likelihood of encountering hemodynamic instability, concomitant valvular abnormalities, increased stroke risk, and need for mechanical support is much greater compared to low-risk groups. That is, in lower-risk groups, the benefit-to-risk ratio is much narrower, as the likelihood of encountering a complication or clinical challenge for which TEE may be useful is much lower. Nonetheless, one can argue that TEE still may be useful in the low-risk groups as detection of concurrent valvular lesions<sup>3,7-10</sup> and the rescue potential that TEE offers still may confer benefit.<sup>2,11,13,14</sup> The narrower benefit-to-risk ratio in low-risk patients also underscores the importance of refining the intraoperative examination to maximize clinical benefit while minimizing complications like esophageal injury. The question centering on maximizing the utility of TEE to improve outcomes in low-risk patients remains to be answered. Nevertheless, the authors of the Metkus and MacKay studies should be commended for their invaluable contribution.<sup>3,4</sup> These studies represent a major step toward improving outcomes in cardiac surgery.

### Conflict of interest

The authors have no conflicts of interest to declare.

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