Perioperative Transthoracic Echocardiography: “Universal Acid”?

IN HIS BOOK, *Darwin’s Dangerous Idea*, philosopher Daniel Dennett introduces an imaginary substance he calls “Universal Acid.”1 This liquid is so powerful it can eat through any substance—rock, steel, the Earth—ultimately invading everywhere and everything. Dennett draws an analogy between Evolutionary Theory and “Universal Acid,” making the argument that Evolutionary Theory is so powerful a concept that it withstands, even flourishes, as scrutiny increases. People can try to escape or avoid it, but the facts and evidence will persist, ultimately leading to a single conclusion.

Dennett may or may not be right about Evolutionary Theory’s status as “Universal Acid” (Intelligent Design/Creationists please hold your letters!), but perhaps the concept of “Universal Acid” applies to some of the good (incontrovertible?) ideas currently applied in this specialty. These ideas, although unproven in large, prospective, randomized, controlled trials, simply will not go away. Examples include arterial oxygen saturation, expiratory carbon dioxide, and “level-of-consciousness” monitoring during anesthesia (perhaps that last one is a little “iffy,” but do doubters really think the concept of monitoring the brain during anesthesia is going to go away?).

In this issue of the *Journal of Cardiothoracic and Vascular Anesthesia*, Dr Brian Cowie presents a feasibility study of the perioperative use of focused transthoracic echocardiography (TTE) by anesthesiologists.2 Reasons for performing the examination, as requested by the primary anesthesiologist, included hemodynamic instability, suspected valvular disease/murmur, ventricular function assessment, dyspnea/hypoxemia, and poor functional capacity. In the first author’s institution, as in many others, the cardiology service is busy and unable to respond immediately to requests for cardiac ultrasound. The focused TTE, which is not intended to replace a formal, extensive TTE, is performed by a cadre of 5 cardiothoracic anesthesiologists with skill and experience in both transesophageal echocardiography (TEE) and TTE.

The authors answer their “feasibility” question with a resounding YES! An anesthesiology-run TTE service is feasible, appropriate in their institution, medically valuable (resulting in a change in care in 84% of patients referred for the examination) and reliable (87% concordance with later formal TTE).

There are financial and social benefits as well. There were important changes in monitoring and anesthetic techniques that likely decreased morbidity and resource utilization, and there was occasional cancellation of surgery for further workup and preparation of patients with severe cardiac conditions. Clinicians can easily envision the potential benefits to the patients, their families, and the hospital in these situations.

So, it already should be clear that this concept, as applied by the authors, shares some properties with “Universal Acid.” Their application, however, represents only part of the potential utility of this technique. What about doing “spot checks” for goal-directed therapy (GDT) during major surgeries? The potential benefits of GDT during major surgery are firmly established,3–5 and intraoperative TTE may be a useful tool for periodically assessing cardiac filling and function.

Current routine hemodynamic monitoring is inadequate to meet the demands of the changing nature of cardiovascular disease in an aging population. Recent studies have shown that the leading admission diagnoses for medicine and cardiology services in the United States have shifted from coronary artery disease (CAD) to congestive heart failure (CHF) with normal ejection fraction (diastolic dysfunction).6–10 The clinical reality of long-standing hypertension and its associated CHF is especially apparent in the baby boomer population.8–12 The prevalence of diastolic dysfunction in the general population now exceeds 53% in individuals over 65 years, leading to an 8-10 times higher risk of mortality at 5 years compared to individuals with normal diastolic function.13 These patients are at particularly high risk when undergoing surgery. For instance, in a recent study, CHF patients who underwent noncardiac surgery were readmitted to the hospital...
at 30 days postoperatively 1.5 times more often than patients with CAD, and twice as often as the control group. Mortality was also 3 times greater in CHF patients compared to patients without CHF. In fact, following routine surgical procedures, nearly 1 out of 10 of the CHF patients died within 30 days postoperatively. Based on these results, the authors concluded that management of heart failure patients undergoing noncardiac surgery still needs improvement. More specifically, current methods of cardiovascular monitoring such as electrocardiography, systemic blood pressure (BP), and urine output (UO) may not meet the hemodynamic monitoring demands of these patients.

The financial burden associated with patients’ readmission to the hospital is significant. In April of 2009, Jencks and colleagues published a large retrospective study on Medicare patient readmissions and estimated their costs at more than $17 billion per year. Congestive heart failure was the primary reason for unplanned readmission for both surgical and medical patients.

One of the most important goals in providing anesthetic, perioperative, or critical care is ensuring the adequacy of the patient’s circulatory status by optimizing cardiac function. The electrocardiographic monitor, systemic BP, and UO are considered the basic standard of care for assessing circulatory function. However, these parameters fall short in their ability to provide information about cardiac output and filling pressure in patients with systolic and diastolic dysfunction (ie, CHF). In other words, using BP and electrocardiography as basic cardiovascular monitoring parameters may be clinically acceptable for patients with normal cardiovascular function, but often are inadequate for patients with cardiovascular risk factors and/or comorbidities.

The pulmonary artery catheter (PAC) has been used and studied as a possible technology to reduce perioperative cardiovascular complications in patients with heart failure and CAD. However, the PAC is invasive, with significant risks and complications associated with its use. In addition, the putative benefits of this technology have come under question and, as a result, its clinical use has declined.

Esophageal Doppler monitoring (EDM) is a technology that uses an internal probe inserted into the esophagus of an anesthetized patient to estimate the cardiac output. The information acquired by the device may help the healthcare provider administer enough intravenous fluids and/or blood products to maintain a normal-range cardiac output. In 2008, Abbas and colleagues published a meta-analysis of EDM on 420 patients undergoing major abdominal surgeries. The statistical analysis included 5 studies comparing fluid administration according to EDM versus conventional parameters. EDM-based fluid administration was associated with a shorter hospital length-of-stay, fewer intensive care unit admissions and, overall, fewer complications. Compared to conventional parameters, the EDM-derived data represented a step in the right direction, but remain clinically incomplete. EDM does not address left ventricle filling pressure, diastolic dysfunction, valvular structure and function, or contractile function and subsequent CHF. In other words, EDM helps the healthcare provider administer enough intravenous fluid or blood products, but does not prevent them from giving too much. Other technologies, involving bioimpedance and arterial pulse contour analysis, can be used effectively for hemodynamic management, but also lack specific information about cardiac structure and function.

When used appropriately, echocardiography is uniquely capable of noninvasively evaluating real-time cardiac output, filling pressures, diastolic function, valvular structure, and ventricular contractility of both the right and left heart. These benefits make echocardiography an ideal technology, particularly in concert with continuous minimally invasive monitoring such as EDM or pulse contour analysis, to accurately identify and assess frequently overlooked cardiovascular comorbidities that dictate individualized clinical perioperative management. At the very least, patients at risk for diastolic dysfunction could be evaluated preoperatively, so appropriate monitoring (including the possibility of TTE itself) could be implemented.

The potential benefits of applying this technology perioperatively are significant. It is a form of “Universal Acid”; an idea that will not go away. Furthermore, before long somebody is going to be doing it. Anesthesiologists, particularly those with previous TEE experience, are uniquely positioned to step up to the plate. It may be difficult for anesthesiologists to acquire the skill set, and the non-trivial questions of logistics and how clinicians will be reimbursed fairly for it, will arise. Of course, these issues should be studied, along with the medical cost/benefit factors. They should be studied, however, after clinicians have already implemented the programs. Clinicians correctly refer to “anesthesiology” as the practice of medicine. Well, here is some medicine for anesthesiologists to practice, unless of course they would rather sit back and let other physicians (or extenders!) do it for them.

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REFERENCES


