Utility of Perioperative Transesophageal Echocardiography in Non-Cardiac Surgery

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Dr. Alan Jay Schwartz: Hello. This is Alan Jay Schwartz, Editor-in-Chief of the American Society of Anesthesiologists' 2016 *Refresher Courses in Anesthesiology*, the latest research and education information. The focus of the new online format of the *Refresher Courses in Anesthesiology*'s CME program, and the modules featured, is to educate learners on current developments in the science and clinical practice of the specialty of anesthesiology, critical care medicine and pain management. For the first time ever, we will be speaking directly with individual authors to learn about their expertise, perspective and insight regarding their featured module.

Today, we are pleased to present the following one-on-one conversation with *Refresher Courses in Anesthesiology* Editor, Dr. Sam Wald, and author Dr. Stanton Shernan, and they will be highlighting the module titled, "Utility of Perioperative Transesophageal Echocardiography in Non-Cardiac Surgery."

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Dr. Samuel Wald: We're here with Dr. Stanton Shernan, Professor of Anesthesia at Brigham and Women's Hospital in Boston, Massachusetts, and he's going to speak to us today about the utility of perioperative transesophageal echocardiography in non-cardiac surgery.

Dr. Stanton Shernan: Thank you very much for that introduction. As I said, this is an evolving topic; I think, a topic that could be useful to a large population of anesthesiologists, and clearly it's tailored towards a non-cardiac surgical anesthesiologist—the one who doesn't practice or use echo for that particular indication. And I hope that becomes evident throughout this discussion here.

The primary objectives I wanted to cover first is, to review the indications of intraoperative TEE for non-cardiac surgery; to discuss a little bit about the utility of intraoperative TEE for monitoring during high-risk non-cardiac surgery; and then I want to cover another objective, which is to discuss the role of intraoperative rescue TEE for unanticipated hemodynamic collapse—very different from the anticipated use of it prospectively, if you will, as a monitoring tool.

Just a little bit of background here. The overall concept of using transesophageal cardiography in the operating room for both non-cardiac and cardiac anesthesia purposes or surgical procedures, is really not new. This goes back almost 20 years ago, when the initial training guidelines came out, sponsored by the American Society of Echocardiography and the Society of Cardiovascular Anesthesia, trying to delineate clinical indications and contraindications for perioperative echo, and examining issues of education, training and certification.

And it was during this time that the whole concept of using non-cardiac, or TEE for non-cardiac surgery, really was introduced. And within this area there were three categories, or three general indications, for the use of echo for non-cardiac surgery, where category one was supported by the strongest evidence; and within that category one, issues pertaining to the intraoperative evaluation of acute, persistent and life-threatening hemodynamic disturbances in which ventricular function and its determinants are uncertain and have not responded to treatment. So, those indications were heavily supported by the evidence.

Category two were those indications that were not as well-supported by the evidence, and these include the perioperative use of echo in patients with increased risk of myocardial ischemia or infarction, and the intraoperative detection of air emboli during upright neurosurgical procedures.

And then the final category outlined in these training guidelines was category three, where was limited evidence for, or expert support, and this was when TEE was anticipated for using as a means of monitoring for air emboli during orthopedic procedures. This document, which was produced in 1996, was followed up by a second document, also supported by the ASA and the SCA, that came out in 2010. And they kind of simplified the concept of using perioperative/intraoperative TEE for non-cardiac surgery in the following way.

What they stated was that recommendations for non-cardiac surgery were such that TEE may be used when the nature of the planned surgery or the patient's known or suspected cardiovascular pathology might result in severe hemodynamic, pulmonary or neurological compromise; and then, if equipment and expertise are available, TEE should be used when unexplained life-threatening circulatory instability persists, despite corrective therapy.

So, when you put these two training guidelines together, this is kind of the way I like to think about it, just to simplify it. I would suggest there are two general categories for using intraoperative echo for non-cardiac surgical. Let's call category one, rescue echo. And what I mean by that is, rescue echo is for the specific purposes of diagnosing the etiology of acute, persistent and life-threatening hemodynamic disturbance, and to guide appropriate triage and medical/surgical therapy.

Let's call the second category, monitoring in high-risk patients for changes. So, this is something that is planned for upfront, where there's an anticipation as a

result of the procedure or patient morbidity for potential changes in global cardiac performance, regional myocardial contractility, emboli, or in some cases surgical procedure-specific indications—and I'll get into that in a few minutes.

When we think of category two first – so, again, this is when TEE is used upfront as an anticipated monitor of cardiac performance in a relatively high-risk population. There's actually quite a bit of literature out there. I'll just give you a little bit of a sample here. For example, in a study authored by Dr. Cabrera Schulmeyer in 2006, they looked at 98 non-cardiac surgical patients, and these patients were considered high-risk for a couple of reasons. Some of them were high-risk for coronary artery disease. At least 43 of these patients had a previous MI. Some had unstable angina; they had a positive stress test; et cetera. And the other patients were considered at risk for unstable hemodynamics because they had left ventricular dysfunction or valvular heart disease.

When they looked at these patients and they found how often intraoperative TEE discovered new findings—namely, these were findings that were not necessarily anticipated, albeit with a high-risk population—they found new findings in about 25% of those patients, including new wall motion abnormalities in eight, or a low EF – one that was not known beforehand; a new, undiagnosed intraventricular thrombus; valvular heart disease, et cetera. So, these were new findings in 25% of the patients that were not known, or would not have been known, simply by the history and physical exam beforehand.

They then went and identified how TEE impacted interventions during these procedures. And in 2% they said that TEE did not affect management at all. But in 48%, TEE directed changes in intraoperative management, namely drug

therapy or fluid therapy, that was guided based off of TEE discovery, or discovery of diagnoses—so, new changes in cardiac performances.

And then they said that TEE directed postoperative management in 25%, and TEE successfully substituted for a PA catheter in 24%. So, you know, it looks like between 25 and 50% of these patients actually underwent medical management or changes in therapy based off of TEE-directed findings.

The other particular type of indication in this category two, as I alluded to before, was TEE diagnoses that were specific for certain surgical procedures. So, for example, patients undergoing thoracic aortic endovascular stenting. You might want to confirm the extent of the aortic pathology and where the stent is—looking for leaks, for example, after the stent was deployed.

For patients undergoing laparoscopic surgery, looking for venous air embolism detection; paradoxical embolus; monitoring for cardiac performance; or diagnosing iatrogenic vascular injury as associated with the surgical technique itself; for patients undergoing renal or hepatic tumor surgery, to determine the extent of IVC or RA involvement; hepatic transplantation, looking for right ventricular dysfunction; evidence of pulmonary hypertension or post-transplant IVC stenosis that could be easily diagnosed with TEE; orthopedic procedures involving tourniquets. You might want to use TEE to look for pulmonary artery embolic load or a paradoxical embolus.

Finally, there's thoracic surgery and lung transplantation. These patients are very prone to right ventricular dysfunction, pulmonary vein stenosis, left atrial thrombus, potentially from mediastinal tumors.

Again, these are all indications for TEE, thought of upfront before induction, when TEE is not necessarily used for monitoring myocardial performance per se, but specifically to guide surgical procedures or to determine iatrogenic

injury associated with those particular types of procedures. When you think about, therefore, category one indications, and you look overall in the literature, it looks like TEE is useful in about 20 to 80% of these patients. And you probably see that broader range because the population's kind of diverse.

So, some authors may feel, or may define, a high-risk population in one way, and other authors may determine a high-risk population, or define it, in another way. In addition, how TEE impacts management may also have a wide range of definitions between one group and another. And so, that probably explains why we see such a broad range of how TEE might be useful in this particular patient category.

The second category that I mentioned before, for the use of TEE in non-cardiac surgery, is once again what we called rescue echo. And just to remind people of what that is, I would suggest that rescue echo is the use of TEE in non-cardiac surgical indications for the evaluation of acute, persistent and life-threatening hemodynamic, or potentially hypoxemic, disturbances in which ventricular function and its determinants are uncertain and have not responded to treatment. And this is a situation, kind of, when, if you happen to be covering the echo service, there is a code that goes overhead in the operating room and down the hall. And you're expected to run to that room with an echo system and help with the diagnosis, and potentially with the triage, presumably in a patient who is extremely hemodynamically unstable. And because of this, and because time is so important in these patients, I think you really have to go in with a certain mindset of what these categories can be. And they generally fall in four categories.

The first is global and regional cardiac performance. So, this is a situation where, perhaps, a patient with unknown ventricular dysfunction has a relatively acute event in the operating room. A TEE probe is placed, and new diagnosis of a severely dysfunctional left ventricle or right ventricle is made.

Alternatively, it could be a regional area of dysfunction, usually associated with an acute coronary event—a thrombus or a ruptured plaque, resulting in an isolated area of myocardial dysfunction which may result in hypotension or may result in profound EKG changes; but you may be asked to make a diagnosis based on echo which may, for example, result in the patient being brought to the cath lab. We've seen that, actually, quite a few times.

The second category of this is abnormal or hemodynamically significant fluid collection. So, this might be a case, once again, where, for example, a patient might be undergoing a laparoscopic procedure; there is sudden hemodynamic compromise that's refractory to the usual management of fluid administration and pressors; and you're asked to come in quickly; place a TEE probe. And what you're looking for, perhaps, in this situation, is a large fluid collection—blood in the peritoneum that might be either accumulating quickly, and that's why the patient's unstable, or might be compressing against a major vessel.

The third category is a chamber-compressing mass. And this is not that common, because most large masses are known beforehand. But we've certainly seen some cases, especially in the thoracic rooms, where patients maybe undergoing a mediastinal exploration, not really knowing what is the problem. And the patient, once again, crashes, if you will, on induction, and we're asked to put in the TEE probe. And in this particular case we see, for example, the superior vena cava might be compressed by a large mediastinal mass which, again, may have been known beforehand, but the actual impact on hemodynamics wasn't anticipated, and this is something that's relatively easy to diagnose with TEE.

And then the fourth category is iatrogenic or external trauma. So, again, this might be a case, once again, where a laparoscopic procedure, where the trocar or some of the instruments disrupted a major vessel, and this patient becomes hemodynamically unstable, and a probe is placed; and, once again, you see a

large fluid collection, but there is other evidence to indicate this might be direct trauma.

Another patient type in this category is when they're doing lead extractions, and in the process of extracting a pacing wire, some tissue is extracted or a major vascular structure is interrupted, and the patient becomes unstable. And when I'm called to that room, my first impulse is to rule out pericardial tamponade, or certainly a large fluid collection that might be compressing a big structure.

So, these particular situations—again, these are kind of surprises. But you have to walk into this scenario with a very organized frame of mind, because you usually have about one to two minutes to make a diagnosis before the correct triage and management can be made. So, again, a very difficult situation from category two, where there's intention upfront to use the TEE probe only for monitoring purposes; not to make a life-threatening decision.

When we look, again, at the literature for category one, under rescue echo, the results seem to be a lot more consistent from manuscript to manuscript. For example, we did a study at our own institution—22 patients undergoing emergent rescue echo. The primary diagnosis in these perspective was achieved in 19 of them, so 86%. There were nine thromboembolic events; six acute myocardial ischemia; two patients – hypovolemia; and two patients with pericardial tamponade. Of 18 patients, 82% were aided by TEE. So, 12 patients underwent surgical intervention. Six patients underwent medical therapy. And 14 patients survived to leave the operating room, and seven patients were discharged from the hospital.

So, even in those kind of dramatic results, suggesting that TEE in many patients may have saved their lives, we have to remember that there'll never be a randomized trial for this type of patient population where, for example, a patient's having a cardiac arrest, and we flip a coin and randomize half follow

them to TEE and the other half not to TEE. So, we can't ever say for sure that TEE saved lives. But I think, given the circumstances and the role of TEE in these situations, where a rapid diagnosis was made, leading to a definitive intervention, we can make some generalized conclusions that the use of echo in these rescue situations is quite evident and can be anticipated to be quite useful.

So, therefore, in comparison to the utility of echo in rescue situations versus its utility as simply a monitor or cardiac performance, the literature's more consistent. So, for example, when used intraoperatively for patients undergoing CPR, the use of echo in defining the diagnosis and guiding decision is as much as 80 to 90% of the time, as you might expect. Even if TEE rules out one of these major categories, that may also be important too, because it still leads to a different type of management—perhaps not surgical intervention, but watch-and-wait or medical management. So, the incidence, again, in this case, of TEE's use, is much higher and much more consistent, as you might expect.

Taking this all into consideration, I think it's still important – I want to end up with kind of a last point here, which is, in recognition of the use of TEE, it's important to understand that this is still considered an intervention, and somewhat invasive in the sense that you're putting an instrument in a blind space. And despite its – the fact that its utility is very, very high, and people may want to use it in a number of situations, we have to understand that there is still a potential for complications associated with this device. So, for example, the incidence of swallowing dysfunction—dysphagia—after using TEE, is considerably high, in the sense that there's a direct association between its use and dysphagia, which, for example, presents with aspiration. So, it's not a benign phenomenon.

Furthermore, there is a small but important incidence of GI and esophageal injury associated with the use of TEE: anything from lacerations and bleeding, to esophageal perforation and mediastinitis, which has an incidence of mortality

close to 50%. The point being that the use of TEE, we believe, may at some point become a relative standard in monitoring high-risk patients. But it's important that appropriate training, education, credentialing, and even certification, be understood as important components of learning how to use TEE before it becomes dispersed throughout the operating room, and becomes a standard, recognized monitor for non-cardiac surgical patients.

Dr. Samuel Wald: Thank you, Dr. Shernan, for your wonderful insights and in-depth analysis on what is a rapidly-emerging and spreading tool in perioperative anesthesiology. And now, Dr. Schwartz, I'll turn it back over to you.

Dr. Alan Jay Schwartz: Thank you for joining us today, and participating in this insightful conversation with this month's featured author. Be sure to join us for next month's one-on-one author interview, presented in this new, exciting format.

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