Stroke Volume Optimization Versus Central Venous Pressure in Fluid Management

Q What is the current evidence for using stroke volume optimization rather than central venous pressure and urine output for fluid management?

A This question is easy to answer. Little evidence supports the use of central venous pressure (CVP) and urine output to guide fluid therapy, but a large body of evidence supports use of stroke volume optimization. A little background will illustrate why stroke volume optimization should be the predominant method used when giving fluids.

The assessment of volume status (eg, hypovolemia) is a major problem in the perioperative setting and in intensive care units. Because of caregivers’ inability to accurately assess the severity of hypovolemia and the patient’s response to treatment, patients are often misdiagnosed and do not receive the proper treatment. The results are delays in treatment, undertreatment, and overtreatment, all of which lead to outcomes that are less than desirable and increases complications and patients’ length of stay.

The problem in assessment of hypovolemia stems from the inability to measure blood flow, specifically stroke volume, directly. Stroke volume (how much blood the heart pumps with each beat) is the first parameter to change when a patient has volume loss. Every other compensatory sign occurs because of the reduction in stroke volume; such signs include increased heart rate, decreased cardiac output, decreased urine output, increased oxygen extraction, and reduced blood pressure. Even parameters such as CVP, which purportedly measures cardiac volume (a point that will be disputed in the following paragraph), are not helpful because it is not volume that is important, but blood flow. A patient whose heart is not even beating can have adequate volume (ie, normal CVP). It is the loss of blood flow that threatens patients’ outcomes.

Clinicians often like to think that they can determine volume status by using the compensatory methods listed in the preceding paragraph and other physical signs. However, multiple studies have shown that physicians and nurses cannot accurately assess volume status with the current techniques. Measuring stroke volume only recently became feasible. In the early 1970s, Drs Swan and Ganz introduced the flow-directed pulmonary artery catheter in an attempt to help position assessment of cardiac function and flow. Unfortunately, one of the main clinical tools used with the Swan-Ganz catheter was cardiac filling pressures, such as CVP and pulmonary artery occlusion pressure (PAOP) or “wedge” pressure. These pressures were designed to estimate volume status of the right and left ventricles. Unfortunately, no study of CVP and PAOP has shown that those pressures correlate well with volume or flow status. In addition, CVP and PAOP do not reveal any information about stroke volume. Marik et al recently recommended that CVP not even be used...
in intensive care units, emergency departments, and operating rooms because of its lack of accuracy.

With the development of technologies to measure stroke volume, fluid requirements have moved from guesswork to precise treatments. Many technologies exist to measure stroke volume, including Doppler monitoring, bioimpedance/reactance measurements, and arterial waveform analysis. All techniques to measure blood flow and stroke volume have strengths and limitations, and the best choice often depends on the particular patient. Clinicians should evaluate the technologies to determine which is best for their patient. However, when stroke volume is used as the end point, particularly with esophageal Doppler monitoring, improved outcomes for patients have been clearly demonstrated.

For example, treatment of low stroke volume is relatively easy. If a fluid bolus is administered (rapidly, not just by increasing the infusion rate on the intravenous pump) and the stroke volume increases by more than 10%, then more fluid is needed. The concept of Starling’s Law is being used at this point. Only when the stroke volume does not increase by more than 10% is the fluid stopped. This simple algorithm allows fluids to be administered precisely so that the patient is not given too much or too little fluid.

Optimizing stroke volume in surgical populations has resulted in a substantial decrease in hospital length of stay and the frequency of postoperative complications. The Centers for Medicare and Medicaid Services Web site has an annotated bibliography summary of the research and the reasons why they approved one form of Doppler monitoring for reimbursement (because of the economic benefit of stroke volume optimization). At this point in medical practice, no strong scientific reason supports use of CVP to guide fluid therapy. However, multiple studies have shown that stroke volume optimization is the best guide to fluid therapy. We can decrease our patients’ complications, length of stay, and costs by using stroke volume optimization, the more accurate technique for assessing fluid volume.

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References


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