Commentary

Pro/con clinical debate: Pulmonary artery catheters increase the morbidity and mortality of intensive care unit patients

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Abstract

One of the highlights of the intensive care unit when I was a resident was the opportunity to place a pulmonary artery catheter and then spend the rest of the day calculating parameters such as oxygen delivery, oxygen consumption, intrapulmonary shunt fraction, and so on. I have noticed in the past few years that the use of these devices in our unit is much less frequent. In our case I am not absolutely certain of the reason for this. Perhaps with time our clinical sense has improved to the point that we do not need the data available, perhaps other tests have replaced the pulmonary artery catheter’s role or perhaps we are worried about the possible morbidity/mortality associated with its use. In the present article, we revisit this important debate.

Keywords hemodynamics, pulmonary artery catheterization, pulmonary wedge pressure, Swan-Ganz catheterization

The scenario

A 35-year-old woman is in the intensive care unit (ICU) with abdominal sepsis secondary to a perforated bowel. Complications include acute respiratory distress syndrome and hypotension, requiring mechanical ventilation and inotropes, respectively. The only worrying laboratory values are a doubling of the patient’s serum creatinine level (despite good urine output) and a slightly elevated lactate level. You are comfortable that surgical interventions are adequate and that antibiotic selections are appropriate. However, despite your best supportive care, the patient is not improving. You think a pulmonary artery catheter (PAC) could assist you further but you are worried that it may be harmful to the patient.

Pro: Yes, PACs increase the morbidity and mortality of ICU patients

Stephen E Lapinsky

Although PACs are widely used in critical care, the precise role for this invasive monitoring intervention remains unclear. One approach to this discussion would be a review of clinical studies demonstrating a lack of efficacy of PACs in improving outcome [1,2] or of studies suggesting a potential harmful effect [3,4]. However, this argument does not seem to have been effective in changing practice. The present discussion will therefore take a logical approach to evaluating the benefits of invasive hemodynamic monitoring in this clinical scenario. Several pertinent questions should be considered.

What hemodynamic information do I need in this patient?

This patient has septic shock with acute renal failure. The clinical evaluation (jugular venous pressure, peripheral perfusion) can be very informative and there is usually little risk associated with careful additional volume administration. A trial of the hemodynamic effects of progressive fluid boluses [5] may be more useful than measurement of filling pressures. The evaluation and correction of volume status would be more important if the patients had imminently...
Can the PAC provide this information reliably?

Various factors influence the ability to derive accurate hemodynamic information, and these should always be considered. Intrinsically, the design of the PAC is unfortunately not ideal for the reliable measurement of pressures. An optimal system would use a short, large-bore catheter with stiff tubing [6]. A number of patient factors may make PAC measurements difficult or inaccurate [7]. A common problem is the spontaneously breathing, tachypneic patient. Pressure measurements and cardiac output estimations rely on timing with the respiratory cycle. The large intrathoracic pressure swings occurring in the patient with respiratory distress can make accurate pressure measurements impossible.

Con: No, PACs do not increase morbidity and mortality of ICU patients

Guy A Richards

It should be remembered that hemodynamic monitoring is not itself diagnostic of an underlying disease process unless the patient is merely hypovolemic. The following discussion does not therefore consider what further might be wrong with this patient, but this obviously warrants further attention. It is, however, necessary to support the patient until the primary disease responds and invasive monitoring would be useful to guide the use of vasoactive agents and fluid replacement. Clinical parameters alone are relatively inaccurate with regard to hemodynamic status in critically ill patients [11].

Parameters that are of particular value are cardiac output, pulmonary artery occlusion pressure, mixed venous oxygen saturation, right ventricular end diastolic volume, and systemic vascular resistance. Whereas some parameters may be obtainable with less invasive techniques, such as Doppler esophageal monitoring, only the PAC can easily and continuously or repetitively monitor them all. Despite these benefits, no agreement has been reached with regard to its potential to cause harm [12]. There have even been calls for a moratorium on its use until the issue is settled [13,14].

Most recent studies, although not showing benefit, have not shown an increase in mortality or morbidity [15,16]; although some have found an increase in length of stay and costs. Those studies that do suggest an increased mortality have serious methodologic flaws such as small numbers of heterogeneous patient populations, inappropriate use of the PAC, insufficient evaluation of intensivist expertise and nonprotocol-driven therapeutic strategies in response to PAC data [17,18].

The most important shortcoming of the PAC appears to be that the derived data is incorrectly measured, interpreted and utilized [19]. In a recent study by Squara and colleagues, at least 35% of doctors attending three critical care congresses suggested at least one potentially harmful intervention when assessing clinical data in a case study provided. Subsequent to insertion of a PAC, the range of treatments and the number of harmful interventions were reduced and there was improved agreement between participants and designated experts as to correct management [20]. Nevertheless, the harmful interventions remained greater than 15% even without the participants themselves having to measure and record the PAC data. Ten percent of physicians still suggested harmful therapeutic strategies even after three PAC recordings were given, effectively increasing PAC-associated mortality by 30%. This study concurs that the PAC is more accurate than clinical assessment of hemodynamic status and that, when correctly utilized, diagnosis and management is improved. However, the persistent misutilization of data by a relatively small percentage of participants, and by extension a small percentage of study populations, will result in the
The latter, the circumstances in which the PAC is unreliable do not support a beneficial effect of the PAC in patients with hemodynamic compromise, the default state should be to rely on the clinical assessment. The PAC should be reserved for the minority of cases where, despite attempts to optimize therapy, further hemodynamic information is required and where these data can be interpreted and utilized correctly.

**Pro’s response**
Stephen E Lapinsky

As Guy Richards points out, both clinical assessment and PAC measurement are associated with errors in evaluation and management. Clinical assessment is sometimes inaccurate in the evaluation of hemodynamic status but, similarly, PAC data is often incorrectly interpreted and utilized. The current standard of practice is to insert a PAC in cases of hemodynamic uncertainty. As there is no data supporting a beneficial effect of the PAC in patients with hemodynamic compromise, the default state should be to rely on the clinical assessment. The PAC should be reserved for the minority of cases where, despite attempts to optimize therapy, further hemodynamic information is required and where these data can be interpreted and utilized correctly.

**Con’s response**
Guy A Richards

Stephen Lapinsky has not provided any evidence that the PAC would increase mortality. He states only that hemodynamic data would be unnecessary and that measurements may be unreliable. In terms of the former, clinical data must have been insufficient as “despite best supportive care” the patient did not improve. In terms of the latter, the circumstances in which the PAC is unreliable do not apply to this patient; the fact that she was ventilated and was on inotropes without improvement mandates hemodynamic monitoring to exclude adverse effects of these interventions. It is true that the PAC is of value in certain selected patients. The present scenario describes just such a patient.

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