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PAC in FACTT: Time to PAC it in?

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Expanded Abstract

Citation

Wheeler AP, Bernard GR, Thompson BT, Schoenfeld D, Wiedemann HP, deBoisblanc B, Connors AF, Jr., Hite RD, Harabin AL. Pulmonary-artery versus central venous catheter to guide treatment of acute lung injury. N Engl J Med 2006;354:2213-2224 [1].

Background

The balance between the benefits and the risks of pulmonary artery catheters (PACs) has not been established.

Methods

Objective: To assess the safety and efficacy of PAC-guided vs. central venous catheter-guided management in reducing mortality and morbidity in patients with established acute lung injury (ALI).

Design: Randomized, controlled, non-blinded trial.

Setting: 36 centers in the United States and 2 in Canada.

Subjects: 1000 patients with established acute lung injury of less than 48 hours duration. Subjects were excluded if they already had a PAC in place or had chronic conditions that could independently influence survival, impair weaning, or compromise compliance with the protocol, such as dialysis dependence, severe lung or neuromuscular disease, or terminal illness.

Intervention: Subjects were randomized to hemodynamic management guided by a PAC or a CVC using an explicit management protocol.

Outcomes: Hospital mortality during the first 60 days before discharge home was the primary outcome. Secondary outcomes included ventilator-free days, intensive care unit-free days, organ failure-free days, and adverse events.

Results

The groups had similar baseline characteristics. The rates of death during the first 60 days before discharge home were similar in the PAC and CVC groups (27.4 percent and 26.3 percent, respectively; P=0.69; absolute difference, 1.1 percent; 95 percent confidence interval, -4.4 to 6.6 percent), as were the mean (+/-SE) numbers of both ventilator-free days (13.2+/-0.5 and 13.5+/-0.5; P=0.58) and days not spent in the intensive care unit (12.0+/-0.4 and 12.5+/-0.5; P=0.40) to day 28. PAC-guided therapy did not improve these measures for subgroup of patients in shock at the time of enrollment. There were no significant differences between groups in lung or kidney function, rates of hypotension, ventilator settings, or use of dialysis or vasopressors. Approximately 90 percent of protocol instructions were followed in both groups, with a 1 percent rate of crossover from CVC- to PAC-guided therapy. Fluid balance was similar in the two groups, as was the proportion of instructions given for fluid and diuretics. Dobutamine use was uncommon. The PAC group had approximately twice as many catheter-related complications (predominantly arrhythmias), though rates per catheter insertion were similar between groups.

Conclusions

PAC-guided therapy did not improve survival or organ function but was associated with more complications than CVC-guided therapy. These results, when considered with those of previous studies, suggest that the PAC should not be routinely used for the management of acute lung injury. (ClinicalTrials.gov number, NCT00281268.).

Commentary

The balloon-tipped, flow-directed, pulmonary artery catheter (PAC), introduced by Swan in 1970 [2], made bedside

assessment of hemodynamics available to the masses. Because of the obvious appeal of PAC-derived data, widespread adoption ensued. Concern emerged in the 1990s that PAC use might be associated with increased mortality. At least six randomized controlled trials of PAC use in general or specialist intensive care have been conducted, none of which found harm or benefit for PAC use [3-8]. These trials were criticized for a variety of reasons, including small size, selection bias, lack of a central venous catheter (CVC)-based comparison group, or the possibility that clinician participants may not have used PAC data "correctly", either due to incorrect interpretation or because treatment was not explicitly directed by a protocol.

The current study, the NIH-funded Fluid and Catheter Treatment Trial (FACTT), was designed to address the limitations of prior studies [1]. The goal of FACTT was to evaluate the safety and efficacy of PAC-guided versus CVC-guided management in reducing mortality and morbidity in patients with established ALI. Using a factorial design, this trial also compared liberal versus conservative fluid management [9]. FACTT was an efficacy trial where the interpretation and subsequent management decisions were entrained within tightly administered protocols. FACTT generated considerable controversy even before its completion, because of disagreement over what constitutes a safe approach to ventilator management in the critically ill [10]. The finding that PAC-guided therapy did not improve survival or organ function but was associated with more complications than CVC-guided therapy generated its share of controversy [11,12] as did the study's other main finding, which supported the use of a conservative fluid management strategy in patients with ALI [9,11,13-16].

FACTT was a well-conducted trial with a number of strengths. All study personnel underwent extensive training in measurement of intravascular pressure to avoid misinterpretation of PAC or CVC-derived data. Furthermore, pressure tracings underwent centralized review. Protocol compliance, which was monitored twice daily, was high (~90% of all instructions followed) and similar between groups. Follow-up was complete, with the exception of one subject that withdrew consent before study-related treatment was received. The analysis was conducted on an intent-to-treat basis and, importantly, looked for evidence of interaction between type of catheter used and fluid management strategy. No interaction was found, meaning that a PAC was not beneficial regardless of the fluid management strategy employed.

Limitations of the trial include that of 11,511 subjects screened, 10,511 (91%) were excluded. Significant reasons for exclusion were current PAC use (21%), chronic lung disease (14%), dialysis (9%), chronic liver disease (7%), and acute myocardial infarction (6%). The first of these raises the possibility that clinicians may have already inserted a PAC in patients that "needed" one, leaving only those patients less likely to benefit from PAC insertion to be enrolled in the clinical trial, a form of selection bias. However, it seems unlikely that clinicians were that proficient in determining who would or would not benefit from a PAC. The majority of subjects were enrolled in medical ICUs. This and the remaining exclusion criteria limit the generalizeability of study results, in that surgical patients or those with excluded medical conditions might still benefit from the titrated hemodynamic management a PAC offers. Though subjects were enrolled early (≤48 hours) in the course of ALI, first study-related interventions were not received until a mean of 25 hours after qualification for ALI and 44 hours after ICU admission. Therefore, these findings do not inform the debate regarding early goal-directed therapy, such as for resuscitation in the first 6 hours of septic shock [17].

These limitations not withstanding, will the results of this study lead to dramatic changes in clinical practice? The answer, strangely enough, may be no. Across a variety of disease states, PAC use is already undergoing precipitous decline, as recently reported [18] and as many clinicians have no doubt observed. With decreasing PACs use, maintaining competency will become increasingly difficult, with significant implications for physicians, nurses, and especially trainees. Decreasing PAC use may represent more judicious PAC use or, perhaps, substitution of less invasive monitoring technologies. As pointed out by Rubenfeld and colleagues [19], we must alert to this second possibility, in that titrating care based on data obtained from these new devices is itself of unproven benefit.

Recommendation

PACs should not be routinely used to guide hemodynamic management in the ICU. It remains possible that their use may benefit select patient groups. Clinicians must weigh carefully the perceived benefits, which may be largely intangible, against the small, but non-zero, risk of harm to the patient. The safety and efficacy of alternative hemodynamic monitors must be tested, if the mistakes associated with the widespread adoption of the PAC are to be avoided.

Competing interests

The authors declare no competing interests.

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