See Article page 1965.

Commentary: To Swan or not to Swan in cardiac surgery? Narrowing the window of benefit

Juan N. Pulido, MD

The development of the flow-directed pulmonary artery catheter (PAC) allowing for bedside placement, originally by Swan and colleagues in 1970,¹ revolutionized the care and study of hemodynamics in the intensive care unit (ICU) and operating room settings. The PAC or Swan-Ganz catheter was crucial to define and differentiate the different types of shock with objective and real-time hemodynamic data, serving as a diagnostic tool and monitor response to treatment at a time when echocardiography was in its infancy. These features helped propel the widespread use of the PAC in critical care and perioperative medicine during the 1980s and 1990s. Despite the logic of the benefit from real-time hemodynamic data, this reign was relatively short-lived after a large prospective observational study of critically ill adults demonstrated that patients managed with PAC not only had an increased 30-day mortality but also increased the cost of care.² The first large multicenter randomized controlled trial of high-risk surgical patients failed to demonstrate any benefit from using a PAC in the perioperative care setting.³ This study did not include cardiothoracic surgery patients. The largest meta-analysis on this subject evaluated 13 randomized controlled trials and more than 5600 patients, and demonstrated that PAC did not show difference in mortality or length of stay.⁴

Despite the evolution of intraoperative transesophageal echocardiography and the logical steady reduction of PAC use in cardiac surgery, the PAC continues to have certain immunity in this patient population. There have been

Juan N. Pulido, MD

CENTRAL MESSAGE

The routine use of the PAC in cardiac surgery does not improve mortality, may increase ICU length of stay, and should be more selective.

studies evaluating the PAC in this setting with mixed results. In 2011, Schwann and colleagues⁵ evaluated the use of the PAC in patients undergoing coronary artery bypass grafting in a large international, prospective observational study. The authors found that PAC use was associated with a higher risk of morbidity and mortality. More recently, however, Shaw and colleagues⁶ performed a large multicenter retrospective electronic health record database analysis to identify associations between PAC use in a variety of cardiac surgeries (including complex multivalvular procedures, cardiac transplant) and effects on clinical outcomes. They found no difference in mortality, but there was decreased cardiac morbidity and length of stay in the patients treated with the PAC.⁶

In this issue of the *Journal*, Brown and colleagues⁷ evaluate the impact of the use of PAC in cardiac surgery patients. This is a large observational study of prospectively maintained data of 11,820 patients at a single center over a span of 8 years. The authors excluded left ventricular assist device implantation, cardiac transplantation, aortic surgery, pulmonary endarterectomy, multivalvular operations, pericardiectomy, intracardiac tumor resections, and Cox Maze procedures. Patients who received a PAC were matched 1:1 with patients without a PAC. Propensity score matching yielded 3519 balanced pairs. This stratification was based on comorbidities, valvular involvement, surgical procedure, emergency nature of the operation, and year of index surgery. The authors found that on multivariate analysis of the entire matched cohort, the PAC was not independently associated with mortality (odds ratio, 0.94; 95%

From the Critical Care Medicine and Cardiovascular Anesthesiology, Cardiovascular Intensive Care Unit, Swedish Medical Center, US Anesthesia Partners, Seattle, Wash.

Disclosures: The author reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

Received for publication Feb 7, 2021; revisions received Feb 7, 2021; accepted for publication Feb 8, 2021; available ahead of print Feb 19, 2021.

Address for reprints: Juan N. Pulido, MD, Critical Care Medicine and Cardiovascular Anesthesiology, Cardiovascular Intensive Care Unit, Swedish Medical Center, US Anesthesia Partners, Cherry Hill Campus, Seattle, WA 98122 (E-mail: Juan.PulidoSierra@Swedish.org).

J Thorac Cardiovasc Surg 2022;164:1976-7
0022-5223/\$36.00

Copyright © 2021 Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2021.02.045>

confidence interval, 0.66-1.35, $P = .736$). Moreover, it was associated with longer ICU length of stay (48 [interquartile range, 27-75] hours vs 39 [interquartile range, 25-69] hours, $P < .001$) and with higher intraoperative red blood cell transfusion (26.3% vs 23.4%, $P = .004$). When looking specifically at mitral valve or tricuspid valve operations, the mortality was not different with or without a PAC.

This study sheds further light on other important aspects of care beyond mortality. Longer ICU length of stay and higher transfusion could be a reflection of “overtreatment,” which can translate into morbidity and higher cost of care. Of note, the incidence of infectious complications, reexploration rates, and acute kidney injury were no different between the groups, in particular, acute kidney injury, because it is one outcome variable susceptible to hemodynamic manipulation and optimization.

It is important to underline that the study excluded complex cardiac surgery, multivalvular operations, severe ventricular dysfunction, and left ventricular assist devices. The outcomes noted should not be generalized to all cardiac surgery and, given the exclusion of these, could explain some of the different results in other studies.

Studying the impact of the PAC is challenging. Many variables that can tilt the balance for or against its use are impossible to control. As for any diagnostic and monitoring

device, the data derived from the catheter could be inaccurate or the interpretation of the data is erroneous given a gap of knowledge, potentially triggering a harmful therapeutic approach.

The PAC is likely to stay; however, the scope of use continues to be narrowing, because its widespread nonselective use clearly has demonstrated detrimental effects.

References

1. Swan HJ, Ganz W, Forrester J, Marcus H, Diamond G, Chonette D. Catheterization of the heart in man with use of a flow-directed balloon-tipped catheter. *N Engl J Med*. 1970;283:447-51.
2. Connors AF Jr, Speroff T, Dawson NV, Thomas C, Harrell FE, Wagner D, et al. The effectiveness of right heart catheterization in the initial care of critically ill patients. SUPPORT Investigators. *JAMA*. 1996;276:889-97.
3. Sandham JD, Hull RD, Brant RF, Knox L, Pineo GF, Doig CJ, et al; Canadian Critical Care Clinical Trials Group. A randomized, controlled trial of the use of pulmonary-artery catheters in high-risk surgical patients. *N Engl J Med*. 2003;348:5-14.
4. Rajaram SS, Desai NK, Kalra A, Gajera M, Cavanaugh SK, Brampton W, et al. Pulmonary artery catheters for adult patients in intensive care. *Cochrane Database Syst Rev*. 2013;2013:CD003408.
5. Schwann NM, Hillel Z, Hoeft A, Barash P, Möhnle P, Miao Y, et al. Lack of effectiveness of the pulmonary artery catheter in cardiac surgery. *Anesth Analg*. 2011;113:994-1002.
6. Shaw AD, Mythen MG, Shook D, Hayashida DK, Zhang X, Skaar JR, et al. Pulmonary artery catheter use in adult patients undergoing cardiac surgery: a retrospective, cohort study. *Perioper Med*. 2018;7:24.
7. Brown JA, Aranda-Michel E, Kilic A, Serna-Gallegos D, Bianco V, Thoma FW, et al. The impact of pulmonary artery catheter use in cardiac surgery. *J Thorac Cardiovasc Surg*. 2022;164:1965-73.e6.