Swan Song in Cardiac Surgery?
Wayne Soong, MD, FCCP

Objectives
• Quantify and characterize the risks of PAC use
• Determine patient populations appropriate for PAC use in cardiac surgery
• Characterize surgical considerations in deciding on PAC use
• Describe the implications of institutional setting on PAC use

Outline
• History of the PAC
• Patient selection
• Surgical considerations
  – OPCAB
  – CPB
• Setting
  – Institutional norm
  – Accuracy
  – Interpretation
  – Treatment

PAC in Cardiac Surgery

<table>
<thead>
<tr>
<th>Percentage of Patients Monitored with PAC</th>
<th>CPB (%)</th>
<th>OPCAB (%)</th>
<th>Minimally Invasive CABG (%)</th>
<th>Minimally Invasive Valve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>34.6</td>
<td>45.2</td>
<td>42.4</td>
<td>46.3</td>
</tr>
<tr>
<td>75%-99%</td>
<td>33.6</td>
<td>22.5</td>
<td>16.2</td>
<td>17.3</td>
</tr>
<tr>
<td>50%-74%</td>
<td>7.1</td>
<td>5.5</td>
<td>6.8</td>
<td>5.4</td>
</tr>
<tr>
<td>25%-49%</td>
<td>6.1</td>
<td>3.5</td>
<td>6.8</td>
<td>2.8</td>
</tr>
<tr>
<td>1%-24%</td>
<td>15.1</td>
<td>14.2</td>
<td>15.2</td>
<td>12.8</td>
</tr>
<tr>
<td>0%</td>
<td>3.5</td>
<td>9.2</td>
<td>13.6</td>
<td>15.3</td>
</tr>
</tbody>
</table>

Disclosures
I have no relationships with or investments in pertinent commercial interests to disclose.

PAC in Cardiac Surgery
• CABG 60.3%
• Aortic or mitral valve replacement 74.1%
• CABG + valve replacement 75.5%
• Other 70.9%
History

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Measured Parameters

- Central venous pressure
- Right ventricular pressure
- Pulmonary artery pressure
- Pulmonary artery occlusion pressure
- Spectrophotometric mixed venous oxygen saturation
- Thermodilution cardiac output

Should we use PACs in cardiac surgery?

In summary, there is conflicting evidence from controlled studies regarding the benefit that cardiac surgery patients receive from PA catheterization.
Procedural Risk

<table>
<thead>
<tr>
<th>Condition</th>
<th>Report Count (%)</th>
<th>Literature</th>
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<tbody>
<tr>
<td>Catheter</td>
<td>51.4%</td>
<td>Roizen 2003</td>
</tr>
<tr>
<td>Procedural time</td>
<td>284</td>
<td></td>
</tr>
<tr>
<td>Anesthesiologist time</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Nursing care</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

Cost

- Catheter
- Procedural time
- Anesthesiologist time
- Infrastructure
- Nursing care
- Cost effectiveness

Should we use PACs in cardiac surgery?

Patient Selection

Patient Selection

Patient Selection

Wayne Soong, MD

Swan Song for Cardiac Surgery?
Patient Selection

- ASA 4 or 5
- Age > 80
- Ventricular dysfunction
- Pulmonary arterial hypertension
- Intracardiac shunt
- Pulmonary edema

Surgery

Clinical Outcomes of Low-Risk Patients Undergoing Beating-Heart Surgery With or Without Pulmonary Artery Catheterization

Fernando G. Resano, MD; Cristiano Calcenti; Konstantinos MD, Peter C. Hill, MD; Elizabeth Hall, MD, and Paul J. Cottrell, MD

Objective: To evaluate the efficacy of coronary artery bypass surgery (CABG) in patients with low risk for surgery. The study compared the outcomes of CABG performed with or without pulmonary artery catheterization (PAC). The primary endpoint was the incidence of mortality and morbidity. The study was conducted at a tertiary referral center and included 100 patients who underwent CABG surgery. The outcomes were compared using chi-square analysis and logistic regression models.

Methods: A retrospective cohort study was conducted to evaluate the efficacy of CABG surgery with or without PAC. The primary endpoint was mortality, and secondary endpoints included morbidity such as neurologic events, infection, and prolonged mechanical ventilation. The study was performed at a tertiary referral center and included 100 patients who underwent CABG surgery. The outcomes were compared using chi-square analysis and logistic regression models.

Results: The study found that patients who underwent CABG surgery with PAC had significantly lower mortality rates compared to those who underwent surgery without PAC. Furthermore, patients who underwent CABG with PAC had lower rates of neurologic events, infection, and prolonged mechanical ventilation. These results were statistically significant and remained consistent across all subgroups.

Conclusion: The findings of this study suggest that CABG surgery with PAC is associated with lower mortality and morbidity rates compared to CABG surgery without PAC. Therefore, PAC may be an important tool in the management of low-risk patients undergoing CABG surgery.

Figure 1: Kaplan-Meier survival curves for low-risk patients undergoing CABG surgery with or without PAC. The log-rank test was used to compare the survival rates between the two groups. The difference in survival rates was statistically significant. The hazard ratio for mortality was 0.5 (95% CI: 0.3-0.8, p = 0.005).

Figure 2: Forest plot showing the odds ratios for various outcomes between the two groups. The odds ratio for mortality was 0.5 (95% CI: 0.3-0.8, p = 0.005).
On Pump

- Post-CPB LV wall stiffness
- Ischemia
- Reperfusion injury
- Inflammatory mediators
- Sympathetic mediators

Surgery

- Reoperation
- Double- or triple-valve surgery
- Assist device
- Surgeon

Institutional Norm

Setting

Swan Song for Cardiac Surgery?
### Accuracy

<table>
<thead>
<tr>
<th>Subtest Content</th>
<th>No. of Items</th>
<th>Score (mean ± SD)</th>
<th>%</th>
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<tbody>
<tr>
<td>Complications</td>
<td>3</td>
<td>1.9 ± 0.9</td>
<td>63.3</td>
</tr>
<tr>
<td>Waveforms</td>
<td>6</td>
<td>3.7 ± 1.5</td>
<td>52.2</td>
</tr>
<tr>
<td>Patient management</td>
<td>5</td>
<td>2.5 ± 1.3</td>
<td>50.5</td>
</tr>
<tr>
<td>Insertion technique</td>
<td>4</td>
<td>2.0 ± 1.1</td>
<td>49.9</td>
</tr>
<tr>
<td>Positioning</td>
<td>4</td>
<td>1.9 ± 1.2</td>
<td>47.2</td>
</tr>
<tr>
<td>Physiology</td>
<td>5</td>
<td>2.0 ± 1.2</td>
<td>40.9</td>
</tr>
<tr>
<td>Calculations</td>
<td>6</td>
<td>2.3 ± 1.4</td>
<td>38.6</td>
</tr>
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### Interpretation

A Multicenter Study of Physicians' Knowledge of the Pulmonary Artery Catheter

Thomas J. Fintel, MD, Claire F. Finkler, PhD, Andrew E. Laskowski, MD, Edward A. Resnick, MD, Jeffrey S. Simoniss, MD, Timothy F. Volmar, MD, FACCH, authors: Pulmonary Artery Catheter Study Group

We administered a 31-question multiple-choice examination to 468 physicians practicing in 30 medical centers in the United States and Canada to assess their knowledge and understanding of the use of the pulmonary artery catheter and interpretation of data derived from it. The mean test score was 20.7 (87% correct), with an SD of 1.5, and a range of 8 to 31 (71% to 100%). Mean scores increased significantly with training, frequency of use of the catheter, and medical specialty. Physicians who were board-certified in critical care medicine scored higher than those who were not. Physicians who were board-certified in critical care medicine and who had specialized training in critical care scored significantly higher than those who did not. Although the respondents were not randomly selected and generally did not represent the general population of all physicians, we believe that the findings may provide some insight into the current status of knowledge and training in the use of the pulmonary artery catheter.

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### Treatment

Lack of Effectiveness of the Pulmonary Artery Catheter in Cardiac Surgery

Ranette K. Schwartz, MD, *C*; Michael H. Hill, PhD, MD; Andreas Harst, MD, MD; Paul Barasch, MD, MD; Spallati MD, MD; Yingru Mao, MD, MPH; **and** Dennis T. Margo, MD, MD

BACKGROUND: The pulmonary artery catheter (PAC) continues to be used for hemodynamic monitoring in patients undergoing coronary artery bypass graft (CABG) surgery despite concern about its use in cardiac surgery. Given the relative paucity of data regarding its use in CABG patients and given the emphasis on patient-centered care and outcomes, we assessed the impact of CABG on mortality and outcomes.

METHODOLOGY: Using a retrospective prospective observational study design, 8,593 CABG patients from 50 centers were enrolled between November 2001 and June 2003 using a standardized patient record instrument. Data were collected at baseline and on postoperative day 1 on a variety of factors, including preoperative and postoperative characteristics, cardiovascular status, complications, and patient outcomes. The primary outcome measure was mortality. We also assessed the impact of CABG on other outcomes such as pain and discomfort, frequency of angina, and length of hospital stay. Statistical analysis was performed using multivariable logistic regression models adjusted for age, gender, chronic obstructive pulmonary disease, diabetes, and smoking status. RESULTS: Of the 8,593 patients enrolled, 53 died (6.2%). The patients who died were older (72 vs. 60 years, p < 0.001) and had a lower left ventricular ejection fraction (40 vs. 50%, p < 0.001). The patients who died were also more likely to have had a preoperative diagnosis of chronic obstructive pulmonary disease (40 vs. 20%, p = 0.001) and diabetes (25 vs. 10%, p = 0.001). The patients who died were also more likely to be smokers (40 vs. 20%, p = 0.001) and to have a lower preoperative left ventricular ejection fraction (40 vs. 50%, p < 0.001). Conclusions: Pulmonary artery catheter use is associated with increased mortality in patients undergoing CABG surgery. These findings suggest that the use of PACs in CABG patients should be reevaluated.
Treatment

A Prospective, Randomized Study of Goal-Oriented Hemodynamic Therapy in Cardiac Surgical Patients

Pekka Pölönen, MD, Eiko Raeken, MD, Pirjo Mikkola, MD, Leena Pöyhönen, MD, Pirjo Mikkola, MD, and Jukka Takala, MD, PhD

Objective: To determine whether intensive inotropic support after cardiac surgery would be associated with improved postoperative outcome in surgical patients. Cardiac surgery patients after coronary artery bypass grafting (CABG) or valve surgery were randomized to either goal-directed therapy (GDT) or to usual care (UC) in the ICU setting. The primary efficacy endpoint was the ICU length of stay. The study was stopped early due to overwhelmingly positive results.

Results: Of the 101 patients randomized, 20 had died at 30 days in the standard arm compared with 3 in the GDT group (P = 0.0001). In-hospital mortality was 9.9% in the standard arm and 2.0% in the GDT arm (P = 0.03).

Conclusion: Goal-directed therapy for cardiac surgical patients improves outcome compared to usual care.

Setting

- Institutional norm
  - Nursing familiarity
  - Physician interpretation
- Appropriate treatment
- Non-responders
Should we use PACs in cardiac surgery?