Commentary: The perils of the pump

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The development of cardiopulmonary bypass (CPB) technique has been central to the evolution of contemporary cardiac surgery. In fact, the routine use of “safe” CPB allows cardiac surgeons to perform complex intracardiac and extracardiac repairs. CPB is associated with increased risk of morbidity and mortality, however, as reported by Axtell and colleagues¹ in this month’s edition of the *Journal*. Axtell and colleagues¹ correlate the duration of CPB with development of acute renal failure (ARF) after cardiac surgery. ARF after cardiac surgery remains a “highly morbid complication,” with a reported mortality greater than 50%.^{2,3} Furthermore, nationwide increases in the rate of ARF after cardiac surgery emphasize the findings reported.⁴

In this study, Axtell and colleagues¹ analyzed the potential dose-dependent effect of CPB time on postoperative renal function. The stated objective evaluated the relationship between CPB as a continuous variable and the risk of development of ARF (stratified by preoperative renal function) after cardiac surgery. This study reported a single-institution analysis of 3889 patients undergoing cardiac surgery in the contemporary era (2011-2017). ARF, as defined by current Society of Thoracic Surgeons criteria, occurred in only 2% of the patients (72 patients); however, patients with preoperative estimated glomerular filtration rate less than 30 had a significantly higher (20%) incidence of ARF. The majority of patients with ARF (70%) required continuous renal replacement therapy and in-hospital mortality was 42%. In addition, this ARF group had higher morbidity with increased rates of postoperative transfusion, re-exploration for bleeding, and stroke. Multivariable logistic regression modeling confirmed the “dose effect” of CPB time as an independent risk factor for the development of ARF. In patients with normal preoperative renal function (estimated glomerular filtration rate >60 mL/min/1.73 m²), the risk of ARF was low (0.2%), regardless of CPB time (0.2% per 1 hour of CPB; 3% for 5 hours of CPB). Patients

Samuel Jacob, MD (left), and Kevin P. Landolfo, MD, MSc (right).

Central Message

Acute renal failure is a highly morbid complication. Cardiopulmonary bypass duration is linked to development of acute renal failure in a dose-dependent manner.

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with impaired preoperative renal function (estimated glomerular filtration rate <30 mL/min/1.73 m²), however, demonstrated a significant increase in the probability of ARF with CPB time (6% per 1 hour of CPB; 25% for 5 hours of CPB).

This study confirms the negative effect of ARF on patient outcomes in the current era of cardiac surgery. The mortality and morbidity observed in patients with postoperative ARF were high, consistent with previous reports in the literature. Importantly, this study demonstrated a unique dose-dependent effect of CPB time (analyzed as a continuous variable) on ARF that was seen particularly in patients with impaired preoperative renal function. Axtell and colleagues¹ suggest that preoperative consideration should be given to the risk of CPB time when lengthy, complex procedures are planned, particularly in patients with impaired renal function. Techniques to limit CPB time now possible in the current era, including hybrid endovascular and transcatheter procedures, should be considered. Concomitant procedures and the necessity of complete surgical repair should be measured against an observed 50% mortality demonstrated in patients with ARF. Many surgeons consider the development of CPB to be a “great equalizer and the pump a friend to the cardiac surgeon.” Although this is true to a degree, this study of Axtell and colleagues¹ highlights the fact that limiting CPB times where possible and efficient CPB are important to limiting the “perils of the pump.”

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