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Commentary: Urine output— When less is still less

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Acute kidney injury (AKI) remains an important modifier of patient outcomes following cardiac surgery. A recent systematic review and meta-analysis based on pooled data from the studies using RIFLE (ie, Risk, Injury, Failure, Loss, and End-stage kidney disease), Acute Kidney Injury Network, and Kidney Disease Improving Global Outcomes (KDIGO) classifications report that the incidence of stage 1 or greater of cardiac surgery (CSA)-associated AKI remains at 22.3%.^{1,2} The classifications of renal injury are based on urine output (UO) and serum creatinine (SCr) level, but these criteria are not used equally. UO is highly dependent on volume status, cardiac output, and medications and, therefore, may be prone to inflated sensitivity. A retrospective study of 443 patients reported that the discrepancy between both criteria in the diagnosis of CSA-AKI can be more than 4-fold and did not demonstrate a relation between oliguria, hospital length of stay, and 1-year mortality.² Therefore, at present, UO is not included in publicly reported benchmarks such as the Society of Thoracic Surgeons Risk Model Outcomes. Conversely, other investigators have demonstrated that oliguria is associated with perioperative mortality,³ suggesting that UO is a potentially important clinical parameter that must not be overlooked or underreported.

In this issue of *Journal*, Priyanka and colleagues⁴ have sought to address this discrepancy through the study of a retrospective cohort of 6637 patients who underwent cardiac surgery in 5 hospitals within 1 regional health care system. The authors reviewed an incidence of CSA-AKI using UO and SCr criteria of the KDIGO classification, both in

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CENTRAL MESSAGE

Urinary output is an important diagnostic criterion for CSA-AKI. It is potentially linked to significant clinical outcomes such as persistent renal dysfunction and long-term survival.

combined and independently, as well as major adverse kidney events at 180 days after surgery (MAKE180). When both criteria were used, the overall incidence of CSA-AKI was 81.2, with 20.5% of patients having stage 1 injury, 48.7% having stage 2, and 12% having stage 3. Isolated oliguria was found in 43% of patients, with 28% having stage 2 injury. Interestingly, only 3.7% of patients met the Society of Thoracic Surgeons definition of renal injury, which includes the increase of SCr more than 4.0 mg/dL (or more than 3× preoperative value) or a new requirement for dialysis. The impact of isolated oliguria on MAKE180 was not anticipated, with even stage 1 leading to a 2-fold risk of persistent renal dysfunction (odds ratio, 2.01, $P = .003$). This relationship was not demonstrated in previous studies. Furthermore, a more advanced injury by UO criteria was associated with worse MAKE180 and 6-month survival in patients with SCr showing less severe stage.

As with any retrospective study, there are important limitations to consider. First, the confounders such as type of surgery and perioperative events were not adjusted in this analysis. Furthermore, while a 180-day outcome is of value, it may not have been long enough to gain insights into any association with isolated oliguria on other important outcomes such as new hemodialysis and longer-term mortality.

Despite these limitations, however, the study highlights that the perioperative team needs to consider that isolated oliguria following routine cardiac surgery is not a benign finding and sets the stage for future trials. It also highlights the need to consider the inclusion of all KDIGO stages within national benchmarks and long-term patient reported outcomes.

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Commentary: A little is way too much: What we have learned about perioperative acute kidney injury

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In this issue of the *Journal*, Priyanka and colleagues,¹ in an innovative analysis, raise awareness of the significant and hereto-underappreciated risk of acute kidney injury (AKI) following cardiac surgery. They analyzed the rates of AKI in a large multihospital cohort of 6637 patients undergoing cardiac surgery.¹ They examined the relationship between The Kidney Disease: Improving Global Outcomes (KDIGO) AKI stage, defined by either serum creatinine (SCr) elevation and/or urine output criteria and the rates of subsequent major adverse kidney events (MAKE) at 180 days. In this study, KDIGO AKI occurred in a staggering 81% of patients—stage 1: 21%, stage 2: 49%, and stage 3: 12%. In stark contrast, the Society of Thoracic Surgeons (STS) database reportable AKI rate occurred in only 4%, thus giving clinicians a false sense of security and accomplishment. Most impressively, patients with stage 3 AKI had a 61.3% incidence of MAKE and a 33.3% mortality by 180 days. Importantly, even patients

Cardiac surgery frequently causes kidney injury.

CENTRAL MESSAGE

Any stage of AKI causes permanent damage and reduces both short- and long-term survival.

with stage 1 AKI had a 14.9% MAKE and 6.6% mortality compared with patients with no AKI who had a 4.5% MAKE and 2.2% mortality by 180 days. Even in the absence of any elevation of creatinine, and thus not captured by the current STS database, stage 1 AKI, as determined solely by oliguria, was an independent predictor of MAKE (odds ratio, 1.76, $P = .004$). The authors further demonstrated that oliguria superimposed on stage 1 SCr-based AKI further increased the risk of adverse outcomes and intermediate-term harm.

Others have similarly demonstrated that any perioperative kidney injury, no matter how minor, and despite its apparent complete resolution during the index hospitalization as determined by a normalized SCr, significantly increases postoperative morbidity and mortality.² Stage 1 AKI has also been independently associated with infection following cardiac surgery.³ Given the appreciable renal functional reserve, even a small increase in SCr does not occur before 50% of the renal glomerular filtration capacity is impaired. In

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