Perioperative Acute Kidney Injury

Risk Factors and Predictive Strategies

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KEYWORDS

• Acute kidney injury • AKI • Prediction scores • CEUS • BOLD MRI • DWI MRI • Biomarkers

KEY POINTS

- Acute kidney injury is common and is associated with many adverse perioperative outcomes.
- Clinical risk factors for AKI vary in different surgical populations, and preventable risk factors are often underappreciated before surgery.
- Surgical patients should have a systematic preoperative assessment of kidney health, with an emphasis on the patient's renal reserve and susceptibility to new injury.
- The exposure to any intraoperative risk, and the extent of any renal damage, needs to be evaluated using a combination of clinical parameters, biomarkers and imaging techniques.

INTRODUCTION

Acute kidney injury (AKI) is a common and morbid complication in surgical patients and is associated with significant increases in mortality, an increased risk for chronic kidney disease (CKD) and hemodialysis after discharge, and increased cost and resource utilization.[1–11] It is characterized by inappropriate oliguria and/or an increase in serum creatinine levels beyond normal. Perioperative AKI complicates the hospital course for up to 50% of surgical patients.[1,2,12–16] Despite this impact

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AKI remains among the most underdiagnosed and undertreated postoperative complications. Better understanding of the risk factors that contribute to perioperative AKI has led to recent advances in AKI prediction and will eventually lead to improved prevention of AKI, mitigation of injury when AKI occurs, and enhanced recovery in patients who sustain AKI. The development of advanced clinical prediction scores for AKI, new imaging techniques that enable more accurate detection of renal injury, and urinary and serum biomarkers of injury for early detection of AKI provides new tools toward these ends. Surgery provides a unique environment for the study of AKI, as the physiologic stress on the kidney at the time of surgery provides a well-defined opportunity for both risk stratification and the initiation of protective and preventive strategies.

DEFINITIONS AND EPIDEMIOLOGY

Before the development of consensus definitions of AKI, the reported incidence of AKI in the surgical population varied from 1% to 31%. The tendency was to focus on severe, and relatively rare, AKI as defined by large increases in serum creatinine and/or the need for dialysis.[17,18] In 2004 the original Risk, Injury, Failure, Loss, and End-stage Kidney (RIFLE) consensus definition for AKI was released by the Acute Dialysis Quality Initiative. The RIFLE criteria graded less severe AKI stages and provided taxonomies for both severity and recovery.[19] The current guidelines from Kidney Disease: Improving Global Outcomes (KDIGO) modified the RIFLE criteria to include changes in creatinine as small as 0.3 mg/dL[20] (**Table 1**). The KDIGO guidelines also provide an updated staging system from CKD (**Table 2**). The epidemiology of perioperative kidney disease has been almost completely redefined since the publication of these consensus definitions.

The consensus definition of AKI has not been uniformly incorporated into the clinical registries and databases used in the surgical community. The American College of Surgeons' (ACS) Committee on Trauma defines AKI as a serum creatinine increase greater or equal to 3.5 mg/dL, and the Society of Thoracic Surgeons Quality Performance Measures defines postoperative renal failure as an increase of serum creatinine to 4.0 mg/dL or greater or 3 times the most recent preoperative creatinine level. The ACS National Surgical Quality Improvement Project (NSQIP) defines AKI as an increase in serum creatinine greater than 2 mg/dL from patients' baseline or as the acute need for renal replacement therapy (RRT).[21] Studies using the ACS NSQIP database typically have high mortality associated with a low incidence of reported AKI, giving the perception that AKI in surgical patients is rare and often fatal.[22] It has been shown that the ACS NSQIP definition for AKI severely underestimates the incidence of AKI, as defined by consensus criteria, in postoperative patients.[12] The incidence of AKI in recent studies using current consensus criteria ranges from 25% in trauma patients[2] to as high as 75% for patients undergoing ruptured abdominal aortic aneurysm repair.[23]

OUTCOMES

Postoperative AKI has been demonstrated to be common and associated with increased incidence of CKD, increased incidence of other postoperative complications, increased risk for short- and long-term mortality, and much higher cost and resource utilization compared with patients with no postoperative AKI.[2,3,5,12,24–32] Two recent studies have demonstrated a continuous risk-adjusted association between postoperative increase in serum creatinine and worse clinical outcomes, and this association persisted at lower cutoffs than in the original RIFLE definition.[12,24] The adverse effects of AKI persist for years even for those patients who demonstrate partial or even full recovery in renal function by the time of hospital discharge.[3,4]