Epidemiology, outcomes, and management of acute kidney injury in the vascular surgery patient

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ABSTRACT

Objective: Conventional clinical wisdom has often been nihilistic regarding the prevention and management of acute kidney injury (AKI), despite its being a frequent and morbid complication associated with both increased mortality and cost. Recent developments have shown that AKI is not inevitable and that changes in management of patients can reduce both the incidence and morbidity of perioperative AKI. The purpose of this narrative review was to review the epidemiology and outcomes of AKI in patients undergoing vascular surgery using current consensus definitions, to discuss some of the novel emerging risk stratification and prevention techniques relevant to the vascular surgery patient, and to describe a standardized perioperative pathway for the prevention of AKI after vascular surgery.

Methods: We performed a critical review of the literature on AKI in the vascular surgery patient using the PubMed and MEDLINE databases and Google Scholar through September 2017 using web-based search engines. We also searched the guidelines and publications available online from the organizations Kidney Disease: Improving Global Outcomes and the Acute Dialysis Quality Initiative. The search terms used included *acute kidney injury, AKI, epidemiology, outcomes, prevention, therapy,* and *treatment*.

Results: The reported epidemiology and outcomes associated with AKI have been evolving since the publication of consensus criteria that allow accurate identification of mild and moderate AKI. The incidence of AKI after major vascular surgery using current criteria is as high as 49%, although there are significant differences, depending on the type of procedure performed. Many tools have become available to assess and to stratify the risk for AKI and to use that information to prevent AKI in the surgical patient. We describe a standardized clinical assessment and management pathway for vascular surgery patients, incorporating current risk assessment and preventive strategies to prevent AKI and to decrease its complications. Patients without any risk factors can be managed in a perioperative fast-track pathway. Those patients with positive risk factors are tested for kidney stress using the urinary biomarker TIMP-2●IGFBP7, and care is then stratified according to the result. Management follows current Kidney Disease: Improving Global Outcomes guidelines.

Conclusions: AKI is a common postoperative complication among vascular surgery patients and has a significant impact on morbidity, mortality, and cost. Preoperative risk assessment and optimal perioperative management guided by that risk assessment can minimize the consequences associated with postoperative AKI. Adherence to a standardized perioperative pathway designed to reduce risk of AKI after major vascular surgery offers a promising clinical approach to mitigate the incidence and severity of this challenging clinical problem. (J Vasc Surg 2018;■:1-13.)

Keywords: Acute kidney injury; Preoperative risk; Postoperative complications; Vascular surgery

Until recently, conventional clinical wisdom has been largely nihilistic regarding the prevention and management of acute kidney injury (AKI).[1] In part, this perspective may have been influenced by the frequency with which this complication occurs in association with other postoperative morbidity events, leading some providers to question whether AKI is simply a bystander to the complex physiologic perturbations of the postoperative patient. However, recent developments have shown that AKI is not inevitable and that relatively small changes in management of patients can reduce both the incidence and morbidity of perioperative AKI.[2-4] Moreover, the emerging implications of cardiac-hepatic-renal organ crosstalk have increasingly placed the kidney into a more central role as a physiologic regulator of organ dysfunction.[5]

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Kidney disease and vascular disease are closely linked. Patients with chronic kidney disease (CKD) have been shown to have accelerated atherosclerosis and higher vascular calcification burdens[6,7] as well as an increased incidence of cardiovascular events and death.[8] The two conditions also share several common risk factors, such as hypertension, diabetes, and hyperlipidemia, that contribute to a high concurrent prevalence. Given this relationship, patients undergoing vascular surgical procedures are likely to have higher rates of preexisting kidney disease and to be at higher risk for development of postoperative complications such as AKI. The implications of this elevated kidney disease burden are highlighted by the dramatically increased risk in short- and long-term mortality for vascular surgery patients experiencing postoperative AKI (pAKI).

We review the epidemiology and outcomes of AKI in patients undergoing vascular surgery as well as some of the novel emerging risk stratification and prevention techniques relevant to the vascular surgery patient.

METHODS

We performed a critical review of the literature on AKI in the vascular surgery patient using the PubMed and MEDLINE databases and Google Scholar through September 2017 using web-based search engines. We used the search engine tools for relevant or related articles along with a search of the bibliographies of relevant articles and manuscripts citing these articles to find additional relevant publications. The search terms used included *acute kidney injury, AKI, surgery, vascular surgery, cardiovascular surgery, epidemiology, outcomes, prevention, therapy*, and *treatment*. We also searched the guidelines and publications available online from the organizations Kidney Disease: Improving Global Outcomes (KDIGO), Acute Kidney Injury Network, and Acute Dialysis Quality Initiative. We emphasized articles published within the past 5 years, but older manuscripts were included for historical context or if they were still clinically relevant. As our interest is in describing the current state of the art in a rapidly evolving field rather than in evaluating randomized trials of a specific intervention, we did not limit ourselves to the protocols of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Definitions and epidemiology. AKI is one of the most common yet underdiagnosed postoperative complications after any type of surgery. Historically, there was wide variability in the reported incidence of pAKI because of the widely variable definitions of AKI that were in use.[9,10] Previous definitions focused on large increases in serum creatinine concentration or the need for renal replacement therapy, which led to AKI being portrayed as a rare and fatal complication.[11] In 2004, the Acute Dialysis Quality Initiative group introduced the Risk, Injury, Failure, Loss, and End-stage (RIFLE) classification, a standardized definition for the diagnosis and staging of AKI using serum creatinine concentration and urine output measurements.[12] These consensus criteria were the first to recognize the less severe stages of AKI. The RIFLE criteria were further expanded in 2012 by the KDIGO clinical practice guidelines, which included even milder forms of AKI with serum creatinine concentration increases as small as 0.3 mg/dL.[13] Whereas the use of the consensus definition for AKI is now common in clinical studies, the definitions have not yet been incorporated into the common surgical registries. The American College of Surgeons National Surgical Quality Improvement Program, the Society of Thoracic Surgeons National Database, and the Society for Vascular Surgery Vascular Quality Initiative (VQI) use their own definitions for AKI, none of which corresponds to current consensus definitions (Table I).[11,15,16]

The VQI is a collaborative of regional quality groups collecting and analyzing perioperative and 1-year follow-up data in an effort to improve patient care.[14] The VQI is governed by the Society for Vascular Surgery Patient Safety Organization, which provides oversight of data sharing, outcome and quality measure analyses, and dissemination of information. Data collection for the VQI database is procedure dependent. Data collected to assess renal dysfunction vary from none (for amputations, cava filter placements, hemodialysis access procedures, and carotid procedures) to measurement of highest postoperative serum creatinine concentration and recording of any dialysis (endovascular aortic procedures) to a staged measurement of any change in renal function (for open aortic procedures and peripheral bypass procedures). Although it does not use the same staging as the consensus KDIGO guidelines, the VQI database does recognize the importance of even mild degrees of AKI, with any increase in serum creatinine concentration of >0.5 mg/dL recorded as a stage 1 change of renal function.

The reported epidemiology and outcomes associated with pAKI have been evolving since the publication of these new consensus definitions. The incidence of AKI after major vascular surgery using the current criteria has been reported as high as 49% across a cohort of all vascular surgery patients, although there are significant differences, depending on the type of procedure performed.[17] Peripheral vascular procedures have some of the lowest rates, from 4% for patients undergoing infrainguinal lower extremity bypass up to 19% for endovascular revascularization of critical limb ischemia[18-21] (Fig 1).

Thoracic and abdominal aortic procedures generally have higher rates of pAKI than peripheral vascular operations. Elective endovascular aneurysm repair of infrarenal abdominal aortic aneurysms (AAAs) has reported incidences of pAKI between 5.5% and 18%.[22,23] One recent study reported a rate as low as 2.9%; however,

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