

## Clinical Science

## Incidence, risk factors, and outcomes of perioperative acute kidney injury in noncardiac and nonvascular surgery

Murat Biteker, M.D.<sup>a,\*</sup>, Akın Dayan, M.D.<sup>b</sup>, Ahmet İlker Tekkeşin, M.D.<sup>c</sup>, Mehmet M. Can, M.D.<sup>d</sup>, İbrahim Taycı, M.D.<sup>e</sup>, Erkan İlhan, M.D.<sup>f</sup>, Gülizar Şahin, M.D.<sup>g</sup>

<sup>a</sup>Medipol University, Faculty of Medicine, Department of Cardiology, Istanbul, Turkey; <sup>b</sup>Department of Family Medicine, Haydarpaşa Numune Education and Research Hospital, Istanbul, Turkey; <sup>c</sup>Department of Cardiology, Dr. Siyami Ersek Cardiovascular and Thoracic Surgery Research and Training Hospital, Istanbul, Turkey; <sup>d</sup>Department of Cardiology, Bağcılar Education and Research Hospital, Istanbul, Turkey; <sup>e</sup>Department of Internal Medicine, Haydarpaşa Numune Education and Research Hospital, Istanbul, Turkey; <sup>f</sup>Department of Cardiology, Van Erciş State Hospital, Van, Turkey; <sup>g</sup>Department of Nephrology, Haydarpaşa Numune Education and Research Hospital, Istanbul, Turkey

**KEYWORDS:**

Perioperative acute kidney injury; Noncardiac surgery; Outcome

**Abstract**

**BACKGROUND:** The aim of this study was to determine the incidence rate, identify the risk factors, and describe the clinical outcome of perioperative acute kidney injury (AKI) in patients undergoing noncardiac, nonvascular surgery (NCS).

**METHODS:** A total of 1,200 adult consecutive patients undergoing NCS were prospectively evaluated. Patients with pre-existing renal dysfunction were excluded. The primary outcome of this study was perioperative AKI defined by the RIFLE (risk, injury, failure, loss of function, and end-stage kidney disease) criteria.

**RESULTS:** Eighty-one patients (6.7%) met the AKI criteria. Multivariate analysis identified age, diabetes, revised cardiac risk index, and American Society of Anesthesiologists physical status as independent predictors of AKI. Patients with AKI had more cardiovascular (33.3% vs 11.3%,  $P < .001$ ) complications and a higher in-hospital mortality rate (6.1% vs 0.9%,  $P = .003$ ) compared with patients without AKI.

**CONCLUSIONS:** Several preoperative predictors are found to be associated with AKI after NCS. Perioperative AKI is an independent risk factor for outcome after NCS.

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Perioperative acute renal failure remains a leading cause of morbidity and mortality in patients undergoing surgery.<sup>1-4</sup> The incidence varies between 1% and 36%

depending on the type of surgery and the definition of renal failure.<sup>5-9</sup> Most of the previous studies used the term acute renal failure, which is a nonspecific description of an acute decrease in renal function, and they considered patients to have acute kidney injury (AKI) only when a deterioration in renal function requiring postoperative dialysis was documented. However, AKI has now replaced the term acute renal failure. To address the lack of a universal definition for AKI, a collaborative network of international experts established the Acute Dialysis Quality Initiative and devised the

The authors declare no conflict of interest.

\* Corresponding author. Tel.: +90-216-414-4502; fax: +90-216-336-0565.

E-mail address: [murbit2@yahoo.com](mailto:murbit2@yahoo.com)

Manuscript received May 17, 2012; revised manuscript March 17, 2013

RIFLE (risk, injury, failure, loss of function, and end-stage kidney disease) definition and staging system for AKI.<sup>10</sup> Although it has been shown that there is an AKI risk associated with noncardiac and nonvascular surgeries, relatively few data are available regarding the incidence, risk factors, and effect on the outcome of perioperative AKI for these surgeries.<sup>11–13</sup> Therefore, we aimed to determine the incidence, risk factors, and outcome of perioperative AKI using the RIFLE criteria in patients with previously normal renal function undergoing noncardiac, nonvascular surgery.

## Methods

### Study population

The study population consisted of 1,200 consecutive patients older than 18 years who underwent noncardiothoracic, nonvascular surgery between January 2010 and February 2012 at Haydarpaşa Numune Education and Research Hospital, which is a tertiary medical center in Istanbul, Turkey. Written informed consent was obtained from each patient before entry into the study. We received study approval from our local institutional review board. The following variables were recorded on admission: age, sex, body mass index, preoperative medications, American Society of Anesthesiologists (ASA) physical status,<sup>14</sup> and comorbidities. The Revised Cardiac Risk Index (RCRI) was used for the prediction of cardiac risk based on 6 prognostic factors: high-risk type of surgery (defined as intraperitoneal, intrathoracic, or suprainguinal vascular procedures), ischemic heart disease, congestive heart failure, history of cerebrovascular disease, insulin therapy for diabetes, and preoperative serum creatinine  $>2.0$  mg/dL.<sup>15</sup> One point was assigned for each of the prognostic factors. Anesthetic management, monitoring, and other aspects of perioperative management were at the discretion of the attending physician. Electrocardiography (12-lead) and cardiac biomarkers (creatinine kinase-MB and troponin I) were evaluated 1 day before surgery; immediately after surgery; and on postoperative days 1, 3, and 7. All serum creatinine measurements were performed preoperatively, daily for 7 days after surgery, and on request thereafter. Standard transthoracic echocardiography was performed in all patients using the Vivid Three System (Vivid 3 pro; GE Vingmed, Milwaukee, WI) before surgery. Left ventricle ejection fraction was measured using the modified Simpson rule.

Standard, 2-dimensional M-mode and Doppler echocardiographic measurements were obtained in all patients. Patients presenting for surgery requiring only local anesthesia or monitored anesthesia care and day case surgical procedures were excluded. Emergent surgical cases, patients with an ASA classification of 5 (moribund, not expected to live 24 hours irrespective of operation), and patients with pre-existing renal dysfunction (serum creatinine level greater than 1.6 mg/dL for men and greater than

1.4 mg/dL for women or preoperative dialysis-dependent renal failure) were also excluded. Vascular and intrathoracic surgery is not performed in our institution. In our study patients, major gastrointestinal surgery (laparotomy, advanced bowel surgery, and gastric surgery), major gynecologic cancer surgery (abdominal hysterectomy and oophorectomy for cancer), major open or transurethral urologic surgery (cystectomy, radical nephrectomy, and total prostatectomy), head and neck surgery, and hip or knee arthroplasty were included. Cardiac risk assessment, preoperative preparation, drug therapy, and postoperative follow-up were completed according to current American College of Cardiology/American Heart Association guidelines.<sup>16</sup> Patients were followed up by the study team until discharge after surgery. Preoperative risk factors and laboratory test results were measured and evaluated for their association with the occurrence of in-hospital perioperative adverse events and AKI. All pre- and postoperative complications were systematically registered and classified during the study period.

### Definition of outcomes

The primary outcome of this study was perioperative AKI defined by the RIFLE criteria using the maximal change in serum creatinine and estimated glomerular filtration rate during the first 7 postoperative days compared with baseline values before surgery.<sup>10</sup> The glomerular filtration rate was estimated by using the Chronic Kidney Disease Epidemiology Collaboration formula.<sup>17</sup>

Secondary outcome measures included the postoperative length of stay in the hospital, perioperative cardiovascular and noncardiovascular events, acute ischemic stroke, and mortality. To assess the effect of perioperative AKI on the length of stay, the mean length of stay was calculated for patients without complications and for those experiencing AKI. The perioperative cardiovascular events were defined as the occurrence of severe arrhythmias requiring treatment, acute heart failure, acute coronary syndrome (nonfatal acute myocardial infarction or unstable angina), pulmonary thromboembolism, nonfatal cardiac arrest, and arterial thromboembolism. Perioperative myocardial infarction was defined according to the universal definition of myocardial infarction.<sup>18</sup> Arterial thromboembolic events were defined as any symptomatic systemic embolism except cardioembolic stroke confirmed by arteriography, magnetic resonance angiography, spiral computed tomography imaging, or Doppler studies.

Noncardiovascular complications were lobar pneumonia confirmed by a chest radiograph and requiring antibiotic therapy, respiratory failure requiring intubation for more than 2 days or reintubation, wound infection, bacteremia, and major and minor bleeding. Major bleeding was defined as fatal or life threatening, bleeding at a critical location (retroperitoneal, intracranial, intraocular, or intraspinal), the necessity of acute medical diagnostic procedures or

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