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Postoperative Acute Kidney Injury: Management Strategies and Prognosis

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Abstract | **Original Research Article**

Postoperative acute kidney injury (AKI) is a common and serious complication of major surgical procedures, associated with increased morbidity and mortality. This retrospective descriptive study, conducted over a nine-month period from January to September 2024 in the Surgical Emergency and Intensive Care Unit of Ibn Tofail Hospital, Mohammed VI University Hospital in Marrakech, aims to analyze the management strategies of postoperative AKI in order to optimize prevention, treatment, and improve patient outcomes. Twelve patients were included, with a mean age of 50.8 years and a male-to-female sex ratio of 0.71. Half (50%) of the postoperative AKI cases were classified as severe (KDIGO stage 3). All patients had at least one identifiable risk factor for AKI, particularly major abdominal surgery (75% of cases); 50% of the patients underwent emergency surgery. Intraoperative hemorrhagic shock was observed in 75% of cases, while septic shock was noted in 25%. Associated comorbidities mainly included hypertension (41.6%) and type 2 diabetes (25%). All patients received individualized perioperative hemodynamic optimization, with an average crystalloid infusion of 2266 ml. Vasopressor support with norepinephrine was initiated early in 91.6% of cases, and 66.6% of patients required blood transfusions. Personalized therapy led to favorable renal recovery in 83.3% of cases. However, 16.6% of patients (n=2) progressed to severe oligo-anuric renal failure requiring renal replacement therapy. The mean duration of surgical procedures was 3.7 hours, and the average hospital stay was 15.5 days. The observed in-hospital mortality rate was 16.6% (2 patients), exclusively among those who required dialysis. In our cohort, the predominant contributing factors were visceral surgery, acute hemorrhagic shock, emergency surgical context, and high-risk profiles (cardiovascular comorbidities). Despite the severity of patient conditions, personalized management combining volume optimization, early vasopressor support, and adequate transfusions facilitated renal recovery in the majority of cases.

Keywords: Acute Kidney Injury; Postoperative; Risk factors; Surgical Intensive Care; Prognosis.

INTRODUCTION

Postoperative acute kidney injury (AKI) is a serious complication of major surgeries, associated with high morbidity and mortality. Studies report an overall average incidence of approximately 13% of AKI among patients undergoing major abdominal surgery. In high-risk surgical settings (cardiac, vascular, or emergency abdominal surgeries), up to 30–40% of patients may develop postoperative AKI [1]. In France, the incidence of postoperative AKI across all types of surgery is lower (ranging from 0.1% to 2%) due to the relative rarity of severe cases among scheduled procedures. Nevertheless, when it occurs, postoperative AKI is associated with significant in-hospital mortality, reported to range from 15% to 30%, depending on the severity of renal impairment and the patient's underlying condition. Mortality may exceed 40% in the most severe forms requiring dialysis in the intensive care unit [2]. Patients who experience postoperative AKI are also at increased risk for long-term complications, including progression to chronic kidney disease and reduced overall survival.

Multiple perioperative risk factors for AKI have been identified in the literature. These may be patient-related (advanced age, hypertension, diabetes, pre-existing heart or kidney failure, shock), surgery-related (type of surgery, emergency context, massive blood loss, prolonged vascular clamping), or related to perioperative management (use of iodinated contrast agents, nephrotoxic drugs, or insufficient fluid optimization). For example, a study conducted at the University Hospital of Parakou in Benin identified hypertension, diabetes, heart failure, septic shock, hypovolemic shock,

and an ASA score ≥ 3 as factors significantly associated with postoperative AKI [3]. The accumulation of these risk factors in a single patient exponentially increases the risk of postoperative AKI.

The objective of our work is to study the management strategies of postoperative AKI within the context of surgical intensive care and to evaluate its prognosis. We present the findings of a single-center retrospective study involving 12 cases of postoperative AKI, discussing the observed epidemiological, clinical, therapeutic, and outcome characteristics in light of current literature.

MATERIALS AND METHODS

1. Study Design:

This was a retrospective, cross-sectional, and descriptive study conducted in the Surgical Emergency and Intensive Care Unit of Ibn Tofail Hospital, Mohammed VI University Hospital in Marrakech. The inclusion period spanned nine months, from January to September 2024.

2. Study Population:

Included were all postoperative patients admitted to the surgical ICU who developed acute kidney injury (AKI) during the postoperative period. This included both emergency surgical patients (non-scheduled surgeries admitted directly to the ICU postoperatively) and patients undergoing scheduled surgery who developed intraoperative or postoperative complications requiring transfer to the ICU and in whom AKI was subsequently diagnosed. Patients with a known history of chronic kidney disease were excluded. 12 patients met these inclusion criteria during the study period.

3. Definition and Classification of AKI:

The diagnosis of postoperative acute kidney injury was established according to the 2012 KDIGO (Kidney Disease: Improving Global Outcomes) criteria, namely: an increase in serum creatinine by ≥26.5 µmol/L within 48 hours, or an increase in serum creatinine to ≥1.5 times the baseline value within 7 days, and/or urine output <0.5 mL/kg/h for more than 6 hours. The severity of AKI was also determined using the KDIGO classification into three stages (1, 2, or 3), based on the magnitude of creatinine elevation and the reduction in urine output. (Table 1)

Table 1: Classification of AKI According to KDIGO Criteria [4]

Stage	Serum Creatinine	Urine Output
1	Increase ≥ 26.5 µmol/L within 48 h or ≥ 1.5 to 1.9 times baseline within 7 days	< 0.5 mL/kg/h for 6 to 12 h
2	Increase to 2.0–2.9 times baseline	< 0,5 mL/kg/h for ≥ 12 h
3	Increase to ≥ 3.0 times baseline or ≥ 353.6 µmol/L (≥ 4.0 mg/dL) or initiation of renal replacement therapy	< 0,3 mL/kg/h for ≥ 24 h or anuria ≥ 12 h

4. Data Collection:

Data were collected retrospectively from medical records. The variables gathered included: demographic information (age, sex, medical history), type of surgery performed (surgical specialty, emergency or elective), intraoperative conditions (hemodynamic status, blood loss, procedures performed, operative time), biological parameters (serum creatinine peaks), treatments administered in the ICU (fluid resuscitation, vasopressor use, transfusion, dialysis, etc.), and clinical outcomes (renal function recovery, length of hospital stay). The vital prognosis at short-term follow-up (in-hospital survival or death) was also recorded.

5. Statistical Analysis:

Data analysis was performed using IBM SPSS Statistics version 23.0. Given the small sample size, the analysis was primarily descriptive. Quantitative results are presented as mean ± standard deviation or median, depending on the data distribution. Qualitative results are reported as counts (n) and percentages (%). No inferential statistical comparisons were made due to the limited number of subjects; the study was not designed to test a hypothesis but rather to describe a clinical case series.

6. Ethical Considerations:

This study was conducted as part of a retrospective evaluation approved by the steering committee of the Intensive Care Unit. All patients or their families had provided consent for intensive care management.

RESULTS

1. General Characteristics of Patients:

During the study period, 12 patients meeting the inclusion criteria were enrolled. The cohort included 5 men and 7 women, with a mean age of 50.8 ± 11.2 years (range: 27 to 63 years), indicating a relatively young population. Notable medical histories included hypertension in 5 patients (41.6%), type 2 diabetes mellitus in 3 patients (25%), and a history of smoking in 2 patients (16.6%). No patient had a known history of chronic kidney disease (which was an exclusion criterion). The preoperative ASA score was ≥ 3 in 5 patients (41.6%). ASA "U" classification was reported in 50% of patients (equally distributed between ASA 1U and ASA 2U), and one patient (8.3%) had an ASA score of 2.

2. Surgical Context and Risk Factors:

Preoperative use of iodinated contrast agents was reported in 11 patients (91.6%). A total of 9 patients (75%) underwent Abdominal surgery. The remaining three patients underwent orthopedic trauma surgery (n=2) and neurosurgery (n=1). Half of the surgeries (6 patients) were emergency procedures. Intraoperative hemorrhagic shock was noted in 9 patients (75%), requiring substantial blood transfusions. Additionally, septic shock due to peritonitis was identified in 3 patients (25%). The main risk factors predisposing to postoperative AKI observed in our series and their frequency are summarized in. (Table 2)

Table 2: Main Risk Factors Identified in Patients with Postoperative Acute Kidney Injury (n = 12)

Clinical or Surgical Risk Factor	Count (n)	Frequency (%)
Use of iodinated contrast agents	11	91.6
Major abdominal (visceral) surgery	9	75
Intraoperative hemorrhagic shock	9	75
Emergency surgery (ASA xU)	6	50
ASA class 3	5	41.6
Arterial hypertension (medical history)	5	41.6
Septic shock	3	25
Type 2 diabetes mellitus (medical history)	3	25

3. Biological Data and AKI Classification:

At the time of diagnosis, the mean serum creatinine level was 231 ± 75 µmol/L (26 ± 8.5 mg/L). According to the KDIGO criteria, 3 patients (25%) had stage 1, 3 patients (25%) had stage 2, and 6 patients (50%) had stage 3. Among the latter, 2 patients were in a state of persistent anuria despite a fluid challenge. In all cases, the renal injury was non-obstructive (renal ultrasound showed no dilatation of the urinary tract).

4. Therapeutic Management in the ICU:

All patients received personalized hemodynamic optimization based on hemodynamic monitoring, including MAP (Mean Arterial Pressure), hourly urine output, delta pulse pressure (DPP) in mechanically ventilated patients, passive leg raise tests, and inferior vena cava assessment. Fluid resuscitation with crystalloids (0.9% NaCl) was administered to all patients, with a mean volume of 2266 ± 478 mL delivered within the first 24 hours (minimum: 1500 mL, maximum: 3000 mL). In parallel, vasopressor support with norepinephrine was initiated early in 11 patients (91.6%) to maintain a mean arterial pressure ≥ 65 mmHg, due to their initial shock status (either hemorrhagic or septic). The mean dose of norepinephrine required during the first 24 hours in patients with hemorrhagic shock was 0.35 ± 0.15 µg/kg/min. In patients with septic shock, the mean dose was 0.85 ± 0.21 µg/kg/min. Additionally, 8 patients (66.6%) required blood transfusions. Among them, 5 received fresh frozen plasma and 1 patient received platelet concentrate in the context of massive transfusion. Regarding potentially nephrotoxic therapies, no iodinated contrast agents were used postoperatively. Non-steroidal anti-inflammatory drugs (NSAIDs) were avoided in all patients. Loop diuretics (furosemide) were administered in 4 patients with oliguria as a fluid challenge test, with a transient functional response observed in 2 of them.

5. Evolution and Prognosis:

Renal function improved in ten patients (83.3%), of whom seven regained normal serum creatinine (≤ 120 µmol/L) before ICU discharge, and three had persistent moderate renal insufficiency (creatinine 150–200 µmol/L) at discharge. In contrast, two patients (16.6%) progressed to severe acute kidney injury with persistent anuria despite optimal therapeutic measures. These two patients required dialysis (intermittent hemodialysis). Despite dialysis, both patients had poor outcomes and died in the ICU (on postoperative days 25 and 32, respectively) due to refractory septic shock complicated by multiorgan failure. Thus, in-hospital mortality in our cohort was 16.6%. Notably, these two patients had the most severe AKI (KDIGO stage 3 with dialysis).

6. Surgery and Hospital Stay Durations:

The average duration of the surgeries preceding AKI was 3,7 ± 1,2 hours. The median ICU stay was 7.5 days (range: 3 to 32 days). The mean total hospitalization duration (including ICU) was 15.5 days. The two deceased patients remained in ICU for 25 and 32 days, respectively.

DISCUSSION

Although limited by the small sample size, our study sheds light on the management of postoperative AKI in surgical intensive care. The main findings indicate that in the context of high-risk surgeries, AKI was frequently severe (50% KDIGO stage 3), requiring individualized therapy. Nevertheless, renal recovery occurred in over 80% of cases without requiring dialysis. The observed mortality (16.6%) exclusively concerned the most severe cases requiring renal replacement therapy. These findings are consistent with the literature, which shows that postoperative AKI mortality increases with KDIGO stage severity and is highest in dialysis patients [5]. For instance, Hobson and al. reported that

even moderate AKI significantly increases both in-hospital and one-year mortality after surgery, and that each increase in AKI stage worsens prognosis [6].

Epidemiologically, the mean age was (50 years) relatively younger than in many studies of postoperative AKI, where average ages are often above 60 [7]. This is likely due to the nature of the pathologies managed at our center (trauma, Urgent abdominal surgeries involving younger patients), and our exclusion of patients with advanced CKD (typically older).

Regarding risk factors and contributing contexts, our data confirm the significant role of hemorrhagic and septic shock in the onset of postoperative AKI. Most of our patients developed AKI in the context of acute circulatory failure during or shortly after surgery. In the study by Seraphin and al. in Benin, hypovolemic and septic shock were among the key risk factors for postoperative AKI, along with hypertension, diabetes, and ASA ≥ 3. Our findings align with this, as 75% of patients had hemorrhagic shock, 25% septic shock, and many were ASA 3 with comorbidities (41.6% with hypertension, 25% with diabetes).

Our personalized therapeutic management likely contributed to limiting the extent of AKI and promoting renal recovery in most patients. Key measures like volume optimization, maintaining adequate renal perfusion with vasopressors when needed, and prompt correction of acute anemia are in line with current AKI management guidelines in critical care. Several studies suggest that early, appropriate hemodynamic resuscitation reduces the incidence and severity of postoperative AKI. Conversely, insufficient fluid resuscitation or delayed use of vasopressors may worsen renal ischemia [8]. In our series, norepinephrine was used in 91.6% of patients, reflecting the frequency of vasoplegic or hypovolemic shock and our vigilance in avoiding prolonged hypotension. Likewise, transfusions in 66.6% of patients were justified by significant hemorrhage.

Renal and overall prognosis naturally depends on the cause of AKI and associated organ failures. In our series, both deaths occurred in multimorbid patients with refractory septic shock, suggesting that AKI was more a marker of overall severity than a direct cause of death. Nonetheless, numerous studies have shown that AKI itself, even in moderate forms, is an independent predictor of mortality and morbidity, even after adjusting for other factors [9]. Our mortality rate of 16.6% (2 out of 12 patients) is slightly lower than that reported in larger postoperative ICU AKI cohorts (usually 20-30%), potentially due to effective management or small sample size. The above-mentioned Benin study reported a similar lethality rate of 18.75% (3 deaths out of 16 AKI cases).

Our study has inherent limitations due to its retrospective nature and small sample size. It does not aim to offer generalizable conclusions but provides a descriptive analysis of actual cases in our local context. The absence of a control group without AKI prevents calculation of postoperative AKI incidence among all operated patients, and formal identification of risk factors through multivariate analysis. Furthermore, we lack long-term follow-up after hospital discharge to evaluate residual renal function, which would be valuable since AKI can have long-term consequences. Despite these limitations, the consistency of our results with the literature supports their validity.

CONCLUSION

Postoperative acute kidney injury remains a serious complication in surgical settings, associated with considerable morbidity and mortality. Our retrospective study, conducted in a surgical ICU on 12 operated patients, highlighted that postoperative AKI predominantly occurs in patients with identifiable risk factors such as major emergency surgery, hemorrhagic or septic shock, and pre-existing medical vulnerabilities. Half of the cases were already severe (KDIGO stage 3), reflecting the intensity of renal insult in such contexts. However, optimal management focusing on rapid restoration of volume and renal perfusion, avoidance of nephrotoxins, and organ support (vasopressors, transfusions) allowed renal recovery in the majority. Only the most severe forms, with prolonged shock and dialysis needs, resulted in death.

Preventing postoperative AKI remains the cornerstone of improving prognosis. This includes early identification of high-risk patients, correction of modifiable preoperative factors (hydration, suspension of unnecessary nephrotoxic drugs, hematologic preparation), and meticulous perioperative management: close urine output monitoring, maintaining adequate arterial pressure, and treating complications (bleeding, infection).

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