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Prevalence, Characteristics and Outcome of Post-Operative Acute Kidney Injury in Cameroon: A Prospective Study in Three Hospitals in Douala

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ABSTRACT

Objective: Post-operative acute kidney injury (AKI) is a frequent surgical complication. Data on this disorder are scare in our setting. We aimed to study the prevalence, characteristics and outcome of postoperative AKI in Cameroon.

Methods: A prospective and analytical study from December 2020 to Mai 2021 including all consenting adults' patients admitted in the departments of surgery, obstetrics/gynecology and intensive care unit (ICU) of 3 referral hospitals in Douala. For each patient, 3 serum creatinine assays were done on admission before the surgery, on days 2 and 7 after surgery. Postoperative AKI was defined and classified according to the modified KDIGO 2012 criteria. Outcome measure were kidney recovery at day 7 and mortality. Kidney recovery was total if serum creatinine on day 7 was less or equal to the preoperative value, partial if less than diagnostic value of day 2 but not the preoperative value and absent if creatinine on day 7 did not decrease or if the patient required dialysis. $p < 0.05$ was considered significant.

Result: Out of 203 patients included, 52 developed postoperative AKI, giving a prevalence of 26.6%. Mean age of AKI patients was 35.34 (13.74) years with 61.6% being (32/52) male; AKI stage 1 accounts for 55.7% (29/52), 19.3% (10/52) stage 2 and 25% (13/52) stage 3. AKI was functional in 61.5% (32/52) of cases mainly due to hypovolemia 42.5% (22/52) and sepsis 34.6% (18/52). For the 40 patients diagnosed on D2, kidney recovery was known in 75% (30/40); with 66.6% (20/30) total recovery, 23.4% (7/30) partial recovery and 10 % (3/30) without recovery. Mortality rate was 19% (10/52) mainly due to hemorrhagic shock. Intra operative hypotension (aOR: 6.09; CI: 1.4 - 26.33; $p = 0.016$) and dirty surgery (aOR: 6.22; CI: 1.35 - 28.75; $p = 0.019$) were factors associated with AKI.

Conclusion: Postoperative AKI occurred in 1/4 of patients in our setting. It is mainly due to hypovolemia and sepsis, renal recovery and mortality were high.

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Abbreviations

AKI: Acute Kidney Injury, **CI**: Confidence Interval, **HIV**: Human Immunodeficiency Virus, **IQ**: Inter Quartile, **NSAID**: Non-Steroidal Anti-Inflammatory Drugs **OR**: OD Ratio.

Background

Acute kidney injury (AKI) is a growing worldwide public health problem, it refers to any sudden deterioration or acute loss of kidney function which can be reversible if detected early enough [1-3]. The global prevalence in adults is estimated at 21.6%, with a mortality rate of 23.9% [4]. Reported risk factors are either patient's related (male sex, obesity, arterial hypertension, diabetes,

cancer, chronic kidney disease) and/or due to the clinical context such as the presence of sepsis, hypovolemia, nephrotoxic agents, severe trauma and surgery [1,5,6].

Postoperative AKI is a frequent complication of surgery; the prognosis is poor with a mortality rate estimated between 25 and 90% worldwide [7,8]. Its occurrence is multifactorial, the surgical patient being exposed to many potentially risk factors of AKI such as: the urgent context, the bleeding which can induce hypo perfusion, an underlying diseases (sepsis), anesthetic procedure/ products and more [9,10]. In the worldwide multicenter AKI-EPI study, the incidence of post-operative AKI varies from 52% to 56% [11]. In the USA, approximately 30% to 40%= of cases of AKI occur after surgery[12,13]. In England, amongst patients with AKI, surgery was implicated in about 30% of cases [14]. In Asia, the incidence ranges from 7.1% to 39% [6,15]. Sub-Saharan Africa alone is home to over 85% of global AKI cases with post-operative AKI accounting for 13 to 28% of cases; It is associated with a high mortality rate estimated at 32% well above the worldwide mortality of 23.9% [16,17], a longer hospital stays, high risk of nosocomial infections, high cost of care, a and 10-fold increase risk of progression to CKD [18-20].

In Cameroon the incidence of AKI was estimated at 22.3%, and the causes are mostly preventable [3,21]. Surgery is a common practice in that setting, with many emergencies cases or severe diseases partly due to late presentation of patients in hospital [3]. However, the burden of postoperative AKI remains unknown. Early identification and adequate management of risk patients undergoing surgery could help to reduce the morbi mortality of patients and the cost of care which is mostly out of pocket payment. Therefore, the aim of this study was to study the prevalence, characteristics and outcome of postoperative AKI in 3 hospitals in Cameroon.

Methods

Study Setting

This study was conducted in the departments of surgery, gynecology/obstetrics and intensive care unit (ICU) of the Douala General Hospital (DGH), Douala Laquintinie Hospital (DLH) and Douala Military hospital (DMH). The DGH is a tertiary referral hospital with the unique public hemodialysis center of the region and has a central laboratory where and average of 800 serum creatinine tests are carried out per month using a BT 1500 automatic analyzer. DLH and DMH are 2nd category health structures in the city. In these 3 hospitals approximately 500-600 surgeries are done monthly. This study obtained an ethical clearance (n◦2459 CEI-Udo/ 04/2021/T) from the Institutional Research Ethics Committee for Human Health of the University of Douala and we also obtained administrative authorization from the directors of the 3 hospitals.

Study Design and Participants

This was a prospective and analytical study including all consenting patients aged 18 years and above admitted in the departments of surgery, obstetric gynecology and ICU of the 3 studies sites from December 2020 to May 2021 (6 months). For each patient, 3 blood sample was collected for serum creatinine dosage before the surgery, on day 2 and 7 after the surgery. Creatinine was measured in the laboratory unit of the DGH using the Jaffe kinetic method with the BT 1500 automat analyzer. Other's variables collected were: socio demographic information's such as age and gender; clinical data including comorbidities such as obesity, arterial hypertension, diabetes, cancer, chronic kidney disease; peri operatives' information's such as blood pressure; diuresis; type of anesthesia; type and length of surgery; bleeding and outcomes. Outcomes measures were kidney recovery; death and causes of death.

Definition of Operational Terms

Postoperative AKI was defined and classified in 3 stages according to the modified KDIGO 2012 criteria as an increase or decrease in serum creatinine of 0.3mg/dl or greater in 48h between the preoperative sample and that taken on D2 postoperative or an increase of 50% or more within 7 days from the reference value obtained at admission [22].

Sepsis was defined as the presence a systemic inflammatory response and/or increased C-reactive protein level due to suspected or proven infection caused by any pathogen or a clinical syndrome associated with a high probability of infection [23]

Kidney recovery was complete if serum creatinine on day 7 was equal to or lower than baseline or preoperative reference value; partial it was lower than diagnosis value of day 2 but not to preoperative reference value, and no-recovery if serum creatinine did not decrease on day 7 and was greater than or equal to the diagnostic value of day 2.

The diagnosis of functional AKI was done based on medical history, presence of risk factors such as presence of hypovolemia, sepsis, non-steroidal anti-inflammatory drugs use (NSAID) and urine indices when available. Obstructive AKI was diagnosed based on history of acute olig0 anuria associated with dilatation of urinary tract on ultrasound. Nephrotoxic AKI was diagnosed based on a history of ingestion of known nephrotoxic drug, (Aminoside, Iodine contrast, NSAID…) or an herbal concoction in the absence of others etiological factors. Hypertension was considered in any patients on blood pressure lowering medication or with blood pressure greater than 140/90mmHg, while hypotension was considered when blood pressure was less than 90/60mmHg.

The ALTEMEIER classification was used to show the distribution of surgical procedures according to the risk of contamination and postoperative infection [24].

Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) 26.0 software. The variables were expressed either by graphical representations, or represented in a table. Quantitative variables were expressed as mean (standard deviation). Chi-square and Fischer's exact tests allowed us to assess the association between two variables. Logistic regression test was used to determine factors associated with post-operative AKI. The significance level was set at a p-value less than 0.05 with a 95% confidence interval.

Results

Prevalence and Characteristics of Post-Operative AKI among the Study Population

A total of 203 patients were included in our study of whom 52 developed AKI, giving a prevalence of 26.6% (Figure 1). Among these patients 40/52 were diagnosed on day 2 and 12/52 on day 7 post surgery. The mean age of AKI patients was 35.34 (13.74) years; 61.6% (32/52) were male. Hypertension account for 35.3% (12/52) of patients, diabetes 11.8% (4/52) and use of nephrotoxic drugs 38.2% (13/52), (Table 1). Emergency surgery was frequent 76.9% (40/52), with abdominal surgery been the most common

36.6% (19/52) and peritonitis the main indication 25% (13/52). Loco regional anesthesia was the most practiced modality in 44.3% (23/52) and the mean length of hospitalization (SD) was 8.54 (2.84) days (Table 2). The median (IQ) creatinine value was different according to the period and was respectively at 10.27mg/l (8.03-14.46) preoperatively; 13.82 mg/l (10. 69- 20.11) on day 2 and 12.30 mg/l (9.25-16.50) on day 7 (Table 3).

Table 1: Baseline characteristics of the study population

Variables	Frequency n=52	Percentages %
Mean age (SD)	35.34(13.74) years	-
Gender		
Male	32	61.5
Past medical history		
Use of nephrotoxic drugs	13	38.2
Hypertension	12	35.3
Diabetes mellitus	4	11.8
Heart failure	2	5.9
HIV	7	4.1
Hepatitis B	1	0.6

HIV: human immunodeficiency virus.

Table 2: Clinical and perioperative characteristics of participants

Variables	Frequency n = 52	Percentages %
Intraoperative blood pressure		
Hypotension	17	32.6
Hypertension	11	21.3
Temperature at admission		
Hyperthermia	11	21.2
Urine output on admission		
Normal	31	59.7
Oligo anuria	21	40.3
Type of surgery		
Emergency	40	76.9
Programmed	12	23.1
Indication of surgery		
Peritonitis	13	25
Fractures	12	23
Extra uterine pregnancy	3	5.7
Splenic rupture	5	9.6
Eclampsia/preeclampsia	6	11.5
Others	13	25
ALTEMEIER classification		
Clean and middle clean surgery	14	26.9
Contaminated surgery	11	21.2
Dirty surgery	27	51.9
Type of anesthesia		
Locoregional	23	44.2
General	29	58.8
Mean length of hospitalization (SD)	8.54 (2.84) days	

Table 3: Evolution of median creatinine value among the study population

Variable	Preoperative serum creatinine (n = 52)	Serum creatinine on Day 2 (n = 52)	Serum Creatinine on Day 7 (n = 40)
Med (IQ)	10.27mg/l (8.03-14.46)	13.82 mg/l (10. 69-20.11)	12.30 mg/l (9.25-16.50)

Med: median, IQ: interquartile, mg/l; milligram per letter

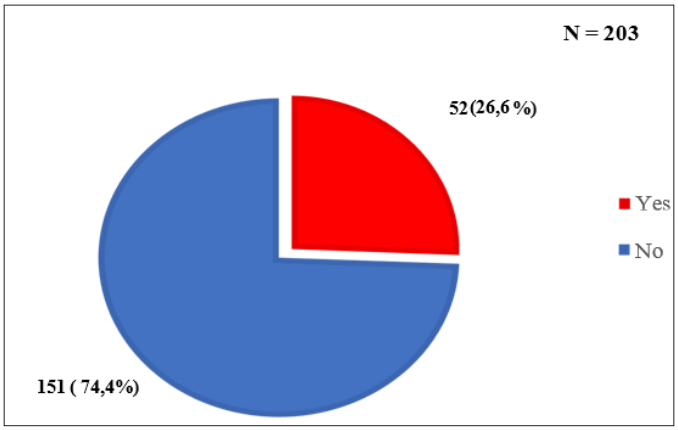

Figure 1: Prevalence of Post-Operative Acute Kidney Injury

A total of 55.7% (29/52) were at AKI stage 1; 19.3% (10/52) at stage 2 and 25% (13/52) at stage 3. Functional AKI was the most common mechanism 61.5% (32/52) and main etiologies were hypovolemia 69% (22/32) and sepsis 31% (10/32). Acute tubular necrosis accounted for 30.7¨% (16/52) due to sepsis (8/16), eclampsia/preeclampsia (6/16) and toxins such as herbal decoctions and NSAID (2 /16). Obstruction accounted for 7.8% (4/52) due to renal stone (3/4) and benign prostatic hypertrophy (1/4) (Table 4). Hemorrhagic fractures 42.8% (9/21) and splenic rupture 23.8% (5/21) were the main causes of hypovolemia. The origin of sepsis was digestive in 72.2% (13/18), urinary in 11.1% (2/18) and bone infection in 16.7% (3/18) (Table 4).

Table 4: Mechanism; severity, etiology, causes of sepsis, volume depletion and obstruction of AKI among participants

Variables	Frequency n	Percentages %
Mecanism of AKI (n=52)		
Pre renal	32	61.5
Renal	16	30.7
Obstruction	4	7.8
Severity of AKI (n= 52)		
Stage 1	29	57.7
Stage 2	10	19.3
Stage 3	13	25
Etiology of AKI (n = 52)		
Hypovolemia	22	42.5
Sepsis	18	34.6
Eclampsia/Preeclampsia	6	11.5
Nephrotoxics drugs	2	3.8
Obstruction	4	7.6
Causes of sepsis (n=18)		
Peritonitis	13	72.2
Urinary tract infection	2	11.1
Bone infection	3	16.7
Causes of volume depletion (n= 22)		
Hemorragics fractures	9	42.8
Splenic rupture	5	23.8
Extra uterine pregnancy	3	14.5
Uterine rupture	2	9.5

Hemorragic polymyoma	1	4.7
Polytrauma/ EDH	1	4.7
Causes of obstruction (n = 4)		
Kidney stones	3	75
Benign prostatic hyperplasia	1	25
Nephrotoxics drugs (n= 2)		
Herbal decoctions	1	50
NSAID	1	50

AKI: Acute Kidney Injury, EDH: extradural hematoma; NSAID: non-steroidal anti-inflammatory drugs

Outcomes of Post-Operative AKI among the Study Population

The overall mortality was 19% (10/52) mainly due to hemorrhagic shock (Table 5). Among the 40 patients diagnosed with AKI on day 2, kidney recovery could not be determined in 25% (10/40) due to early death. Of the 30 patients with known kidney outcome on day 7, 66.6% (20/30) recovered totally, 23.4% (7/30) partially and 10 % (3/30) did not recovered (Table 5). On multivariate logistic regression analysis intraoperative hypotension (aOR: 6.09; CI:1.4 - 26.33; p = 0.016) and dirty surgery (aOR: 6.22; CI: 1.35 - 28.75; p = 0.019) were factors associated to post-operative AKI (Table 6).

Table 5: Kidney outcomes, mortality and presumed causes of death in the study population

Variables	Frequency n	Percentages %
Kidney recovery on day 7 (n = 30)		
Total recovery	20	66.6
Partial recovery	7	23.3
No recovery	3	10.1
Unknown (early death)	10	33.3
Patient outcome (n= 52)		
Alive	42	81
Dead	10	19
Presumed causes of death (n = 10)		
Hemorrhagic shock	6	60
Sepsis	3	30
Eclampsia	1	1

Table 6: Independent factors associated to the occurrence of AKI in the study population

Variables	AKI			aOR (CI =95%)	p-value
	Yes n = 52	No n = 151	Overall n = 203		
High blood pressure	12(35.3)	18(10.7)	30(14.7)	1.33 (0.20-8.75)	0.765
Use of nephrotoxics drugs	13(38.2)	30(17.8)	43(21.2)	0.5 (0.15-1.80)	0.320
Intra operative hypotension	17(32.6)	11 (7.2)	28(13.7)	6.09 (1.4-26.33)	0.016
Dirty surgery	27(51.9)	44 (29.1)	71(34.9)	6.22 (1.35-28.75)	0.019

AKI: acute kidney injury; OR: odd ratio; CI: confidence interval

Discussion

To the best of our knowledge, studies on post-operative AKI are scanty in Cameroon. We aimed to evaluate the prevalence, characteristics and outcome of post-operative AKI in three hospitals in Douala. We found a prevalence of 26.6%. Emergency surgery was frequent 76.9%, abdominal surgery been most common (36.6%) and peritonitis the main indication (25%). AKI stage 1 accounts for 55,7% of case, 19.3% at stage 2 and 25% at stage 3. Functional AKI was the most frequent (61,5%) mainly due to hypovolemia and sepsis. kidney recovery was known in 30 patients and 66.6% recovered totally. About 1 out of 5 patients died mainly due to hemorrhagic shock and sepsis. Intra operative hypotension and dirty surgery were factors independently associated with occurrence of postoperative AKI.

Prevalence and Characteristics of Postoperative AKI

Worldwide prevalence varies widely across studies depending on populations investigated and setting[25]. In the present study, the overall prevalence of post-operative AKI was 26.7%. Papa Dieng et al. in Senegal found and approximatively prevalence of (33,3%)[26]. However, our result was higher compared to that reported in developed countries: In France Kellerman et al. found a

prevalence of 0.1% - 2% and Deman et al. in Belgium 1.2% [5,27]. The differences could be explained either by the heterogeneity of diagnostic criteria used in each series or the late presentation of patients in our hospitals with more severe diseases[27]. More, the difference in the technical platform could be taken in consideration: developed countries have a more appropriate technical platform, carried out earlier detection of AKI and more preventive care [1,28]. In this study, emergency surgery was frequently performed (76.9%) and the most common indication was peritonitis (25%). Similar data were reported in SSA countries where infectious disease are more prevalent [29,30] . Emergency surgery is considered as risk factor for AKI [17,31,32].. However, most western studies incriminate cardiovascular surgery as the first cause of postoperative AKI [5,33,34].

Mechanism, Severity and Etiology of Postoperative AKI

We found that functional AKI was the most frequent form (61.5%) mainly due to hypovolemia (42.5 %) and sepsis (34.6%). Our result is consistent with reported studies [1,31]. AKI stage 1 was also the most frequent (55.7%). Several studies reported similar results in developed and developing countries[17,33,35]. However, L Sadaoui et al. in Morocco found AKI stage 3 most frequently (33.3%) and acute tubular necrosis as the main type [36]. The difference could be explained, by the difference in diagnostic criteria: in the present study, the diagnosis of AKI was made within 48 hours, while in the study of L Sadaoui it was made until day 7.

Kidney Outcome, Mortality and Causes of Death among AKI Patients

Kidney outcome was known on day 7 in 30 patients and we noted 66.6% of total recovery, 23.3% partial recovery and 10% no recovery. This result was close to that of Ahoui et al in Benin who found that kidney recovery was total in 56.25% of patients, partial in 37.5% and absent in 6.25%[17]. That result was in agreement with the literature which mainly reports a total recovery of kidney function when the causes of AKI are rapidly identified and corrected [10,21,37]. The mortality of post-operative AKI varies depending of populations age and type of surgery, it is estimated between 25 and 90% worldwide [8]. The overall mortality in this study was 19% mainly due to hemorrhagic shock (60%) followed by sepsis (30%). Low technical platform, high frequency of emergently pathology in our study like bone fracture and peritonitis that occur hemodynamic instability can explain these results. Ahoui et al in Benin found similar results with a mortality rate of 18.75% [17]. However, higher mortality rate were reported by Gordon et al in England (40 -60%) and Tien-Jyun Chang in China (45.1%) mainly due to cardiogenic shock or multiple organ failure[33,38]. This difference is due to the profile of patients who were older and with more comorbidities and the predominance of cardiovascular surgery are known to be associated with a higher morbi-mortality[39].

Factors Associated with the Occurrence of Post-Operative AKI

The surgical patient is exposed to many potentially risk factors of AKI such as the bleeding, an underlying diseases, anesthetic procedure/products which can induce kidney hypo perfusion and generate AKI Intraoperative hypotension and dirty surgery were independent factors associated of postoperative AKI in this study [9,10]. Ahoui et al. in Benin found similar results but Kheterpal et al. in USA reported more factors such as male sex, emergency surgery, liver disease, chronic obstructive respiratory disease[17,40]. These differences can be explained by the difference in study participants: In the study of Kheterpal et al. patients were older with a mean age of 59 years compared to our participants (35.34 years) and therefore had more severe comorbidities that increased the risk of AKI [17,40,41].

Limitations and Strength of our Study

We acknowledge some limitations to this study. The follow up of patients was short and we could not reevaluate outcome after day 7, especially kidney outcome in patients with partial or without recovery on day 7. However, giving the prospective nature of data collection and the population studied in 3 different sites, we assume that these results could be representative. It is one of the first study that gives an overview of post-operative AKI in our setting and will provide to caregivers more knowledge to identify and adequately manage risk patients. It will also serve as basis for further studies in our context.

Conclusion

Postoperative AKI occurred in ¼ of patients in Douala and was mostly due to hypovolemia and sepsis. Renal recovery was high but 1 out of 5 patients died. Intraoperative hypotension and dirty surgery were factors associated with postoperative AKI. So, we recommend a systematic screening and early management of AKI in patients undergoing surgery especially in those with risk factors.

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Disclosure Statement

The author declares no conflict of interest

Author's Contribution

HMP, AEG, NNM; Study conception and design,
TLD: data collection and analysis,
HMP, MM; NMJP; supervision of data collection and analysis;
HMP; TLD: drafting of the manuscript;
FHD; NMJP; DV: interpretation of data
MM, FHD, NMJP, DV, AEG, NNM; critical revision of the manuscript.
All authors read and approved the final manuscript

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval was obtained from University of Douala, ethical clearance number 2459, and consent for participated was obtained from each patient.

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