

Factors associated with Acute Kidney Injury at the University Clinic of Nephrology and Hemodialysis of CNHU-HKM in Cotonou from 2020 to 2021

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Abstract

Introduction: Acute Kidney Injury (AKI) is associated with high morbidity and mortality due to the severity of the underlying diseases and related complications. The aim of this study was to investigate acute kidney injury at CNHU-HKM in Cotonou.

Methods: This was a cross-sectional study with retrospective data collection, descriptive and analytical in aim, including patients followed for acute kidney injury at the University Clinic of Nephrology and Hemodialysis (CUNH) of CNHU-HKM from January 1, 2020 to December 31, 2021. AKI was defined according to the KDIGO criteria: an absolute increase in serum creatinine ≥ 3 mg/L within ≤ 48 hours, or an increase in serum creatinine $\geq 50\%$ over 1 to 7 days. Factors associated with AKI were investigated by logistic regression. The significance threshold p was set at 5%.

Results: A total of 111 patients were included. The frequency of acute kidney injury was 18.32%. Infections ($p < 0.001$), toxic causes ($p < 0.001$), hemorrhages ($p < 0.001$), severe pre-eclampsia ($p < 0.001$), intravascular hemolysis ($p < 0.001$), extracellular dehydration ($p = 0.001$), tumors ($p = 0.2$), prostatic hypertrophy ($p < 0.001$), disseminated intravascular coagulation ($p = 0.035$), heart failure ($p = 0.003$), and shock states ($p = 0.003$) were the main etiologies of AKI. A history of hypertension ($p < 0.001$), diabetes ($p = 0.001$), and sickle cell disease ($p = 0.004$) was associated with AKI. In multivariate analysis, the presence of an obstruction (adjusted OR = 29.35; $p = 0.033$) and hypovolemia (adjusted OR = 13.80; $p < 0.0001$) were the factors associated with the occurrence of AKI. Altered level of consciousness (adjusted OR = 219.37; $p = 0.001$) and diabetes (adjusted OR = 72; $p = 0.001$) were the independent predictors of AKI-related mortality.

Conclusion: The frequency of AKI was 18.32% at the CUNH of CNHU-HKM. In multivariate analysis, urinary tract obstruction and hypovolemia were the factors independently associated with AKI occurrence. Altered level of consciousness and diabetes were the independent predictors of AKI-related mortality. Early referral of patients, prevention of hypovolemia in at-risk subjects, and appropriate hydration strategies are essential to reduce the burden of AKI.

Keywords: Acute kidney injury; Hypovolemia; Obstruction; Diabetes; Benin

Introduction

Acute Kidney Injury (AKI) is defined as a rapidly progressive and reversible failure of the renal excretory function, with an increase in uremia and serum creatinine that prevents the maintenance of body homeostasis [1]. It is associated with high morbidity and mortality due to the severity of the underlying diseases and related complications [2]. The incidence of acute kidney injuries has increased over the past decades, and given the deleterious consequences, particularly in the long term, AKI now constitutes a major public health problem and was the main theme of World Kidney Day in 2013 [3]. The global incidence of AKI is 1811 cases per million inhabitants per year. AKI is responsible for approximately two million deaths per year worldwide [4]. In Europe, the incidence of AKI in hospital settings

ranges between 1.9 and 7.2% [5]. In Africa, several studies have been conducted to establish an epidemiological and clinical profile of AKI in hospital settings. Lengani et al. found an incidence of 18.4% in Burkina Faso [6]. In Benin, Ahoui et al. found a prevalence of 12.31% for postoperative AKI [7]. In Benin, few studies have been devoted to the factors associated with AKI.

The objective of our study is to investigate acute kidney injury at the University Clinic of Nephrology and Hemodialysis of CNHU-HKM.

Patients and Methods

This was a cross-sectional study with retrospective data collection, descriptive and analytical in aim, conducted over a period of 2 years

from January 1, 2020 to December 31, 2021. The study population consisted of patients admitted to the University Clinic of Nephrology and Hemodialysis (CUNH) of CNHU-HKM in Cotonou during the study period. Patients aged less than 16 years and those whose medical records were incomplete or unusable

were excluded from the study. AKI is defined by the KDIGO criteria: an absolute increase in serum creatinine ≥ 3 mg/L within ≤ 48 hours, or an increase in serum creatinine $\geq 50\%$ over 1 to 7 days. The dependent variable was Acute Kidney Injury, and the secondary variables were of sociodemographic, clinical, paraclinical, therapeutic, and prognostic nature. The collected data were entered using CS Pro version 7.2 software. Data were analyzed with SAS Studio statistical software.

Study setting

This study was conducted at the University Clinic of Nephrology and Hemodialysis (CUNH) of the National Hospital and University Center – Hubert Koutoukou Maga (CNHU-HKM), located in Cotonou, the economic capital of the Republic of Benin, in the Littoral department. The CNHU-HKM is the top-level referral hospital in the Beninese health pyramid, with a current capacity of approximately 1000 beds. The CUNH comprises 21 inpatient beds and a hemodialysis unit equipped with 22 dialysis generators, and is staffed by 5 nephrologists, 34 nurses, and 14 nursing assistants.

To determine the associated factors, we successively performed a univariate analysis and a multivariate analysis. For the univariate analysis, the existence of an association between the dependent variable and the independent variables was investigated using the Wald chi-square test. The strength of this association was assessed through odds ratios (OR) and their 95% confidence intervals. The chosen significance threshold was 5%. For the multivariate analysis: in the logistic regression, all variables with a p-value $\leq 20\%$ during the univariate analysis were introduced into the initial model. Then, based on a stepwise modeling strategy, all variables with a p-value greater than 5% (significance threshold) were eliminated. The variables retained in the final model were those with a p-value less than or equal to 0.05.

Results

Of the 606 patients included during the study period, 111 (18.32%) were admitted for AKI. Among the 111 AKI patients, the age groups most represented were 20-40 years (52.25%) and 40-60 years (20.72%). There were 65 men (58.56%) and 46 women (41.44%), with a sex-ratio of 1.41. The majority of AKI patients were in a common-law union (44.14%) or married (38.74%). Students/pupils/schoolchildren were the occupational category with the highest proportion of AKI (54.05% of students developed AKI) (Table 1).

Artisans/workers and traders were the most represented occupations, accounting for 29.04% and 25.41% of cases, respectively. The majority of patients were married (63.70%) and came from urban areas (52.25%). Most patients (81.25%) had no healthcare coverage.

Clinical Characteristics

Altered renal function (54.13%) was the most frequently found reason for admission, with a delay before admission of between 3 and 15 days in 42.24% of patients. One or more medical histories were found in 82.18% of patients, including arterial hypertension (71.62%) and diabetes (22.44%). A gynecological history was found in 21.95% of female patients, and a surgical history in 15.18% of patients.

Table 1: Sociodemographic characteristics of the 111 AKI patients.

	AKI patients (n=111)	%
Age group (years)		
[16-20]	8	7.21
[20-40]	58	52.25
[40-60]	23	20.72
[60-80]	20	18.02
[80-92]	2	1.8
Sex		
Female	46	41.44
Male	65	58.56
Sex-ratio (M/F)	1.41	—
Marital status		
Single	17	15.32
Married	43	38.74
Common-law union	49	44.14
Widowed	2	1.8

Out of the 606 patients included, 580 patients (95.71%) reported renal functional signs. Only 26 patients (4.29%) reported no renal functional signs. Oliguria (51.98%), nocturia (17.16%), and anuria (12.21%) were the most frequently found renal functional signs. Several renal functional signs were present simultaneously in some patients. Asthenia (39.44%), anorexia (20.63%), and vomiting (16.50%) were the most frequent extra-renal signs. Several extra-renal signs were present simultaneously in some patients.

In our study, more than half (50.66%) of the patients used herbal medicine; 28.71% consumed alcohol, and 5.12% were smokers. Out of 606 patients, 48 (7.92%) had a drug allergy.

Patients classified at stage 0 of the World Health Organization (WHO) performance status accounted for 32.51% of the study population. The most frequently found general signs were: conjunctival mucosal pallor (77.39%), hypertension (52.15%), lower limb edema (47.19%), tachypnea (33.66%), tachycardia (27.56%), hyperthermia (24.42%), and bulbar jaundice (2.97%). Diuresis was preserved in 56.60% of patients, and 7.59% had dehydration. Urine dipstick was performed in 310 out of the 606 patients. The presence of proteinuria (50.65%) was the most frequently found abnormality.

Physical signs were found in 266 patients, i.e., in 43.89% of cases. The presence of crackles was noted in 20.46% of cases, and signs of heart failure in 64 patients (10.56%).

Paraclinical Characteristics

Interpretation of the ionogram and phospho-calcium assessment results allowed us to note hyponatremia (51.65%), hyperkalemia (20.30%), hypocalcemia (53.80%), and hyperphosphatemia (44.88%). The most frequently found hematological abnormality was normocytic

normochromic aregenerative anemia. Anemia was objectified in 87.60% of patients, and hyperleukocytosis in 35.70% of patients. The platelet count was normal in 73.14% of patients.

Frequency of AKI

During the period of our study, 626 patients were admitted to the CUNH. Among these patients, 606 met our inclusion criteria. Of these 606, 111 patients were followed for acute kidney injury. Thus, the frequency of acute kidney injury was 18.32%.

Factors associated with acute kidney injury

Association between sociodemographic data and AKI: Age ($p < 0.001$), occupation ($p < 0.001$), ethnicity ($p = 0.001$), and marital status ($p < 0.001$) were associated with AKI. Students/pupils/schoolchildren had nearly six times the risk of presenting with AKI.

Association between delay before admission and AKI: The delay before admission was associated with AKI ($p < 0.001$). No patient admitted beyond 3 months had presented with AKI.

Association between renal functional signs and AKI: The presence of renal functional signs ($p < 0.001$) was associated with AKI. Patients presenting with renal functional signs were 47.63 times more at risk of developing AKI. The emission of cola-colored urine ($p < 0.001$) and lumbar fossa pain ($p = 0.004$) were associated with the occurrence of AKI. Patients whose urine was cola-colored had more than sixteen times the risk of developing AKI, and those complaining of lumbar fossa pain had nearly six times the risk of presenting with AKI.

Association between extra-renal signs and AKI: Fever ($p = 0.001$) and nausea ($p = 0.018$) were associated with AKI. Patients complaining of fever had nearly three times the risk of presenting with AKI.

Association between medical history and AKI: A history of arterial hypertension ($p < 0.001$) and diabetes ($p = 0.001$) were associated with AKI. Sickle cell disease was also associated ($p = 0.004$). Sickle cell patients had 5.79 times the risk of presenting with AKI. A history of renal failure was not associated with AKI.

Association between lifestyle and AKI: The presence of drug allergy ($p = 0.005$) was associated with AKI. Patients with a drug allergy had more than two times the risk of developing acute kidney injury.

Association between general signs and AKI: Mucosal pallor ($p = 0.001$), the presence of jaundice ($p < 0.001$), and lower limb edema ($p = 0.002$) were associated with AKI. Patients with bulbar jaundice had nearly ten times the risk of presenting with AKI. Variations in heart rate ($p = 0.002$) and respiratory rate ($p = 0.002$) were also associated with AKI.

Association between physical signs and AKI: The presence of a urinary bladder globus ($p < 0.001$), signs of heart failure ($p = 0.003$), and crackles ($p = 0.005$) were associated with AKI. Patients who had a urinary bladder globus were 18.47 times more at risk of presenting with AKI.

Association between paraclinical signs and AKI: Variations in calcemia ($p < 0.001$) and phosphatemia ($p < 0.001$) were associated with AKI. Variations in hemoglobin level ($p < 0.001$), leukocytes ($p < 0.001$), platelet count ($p = 0.001$), and reticulocyte count ($p = 0.013$) were associated with AKI. Patients with hyperleukocytosis had nearly three times the risk of presenting with acute kidney injury.

The results of 24-hour proteinuria ($p = 0.004$) and hematuria ($p = 0.019$) were associated with AKI. Patients with positive 24-hour

proteinuria and positive hematuria had, respectively, more than one time and 2.26 times the risk of developing AKI.

Normal kidney size ($p < 0.001$), dilation of the pyelocaliceal cavities ($p < 0.001$), and good cortico-medullary differentiation ($p < 0.001$) were associated with AKI. Echo-structure and renal atrophy were not associated with AKI.

Association between etiological mechanism and AKI: The functional, obstructive, and organic mechanisms were all associated with the occurrence of AKI, with a p -value < 0.001 . Patients who had an obstruction of the excretory pathways were more than 43 times at risk of presenting with AKI. Patients with acute tubular necrosis were nearly 17 times more at risk of developing AKI. Those with acute glomerulopathy were more than 13 times at risk of developing AKI.

Association between etiologies and AKI: Infections were found in 42 of the 111 AKI patients (37.84%) and were significantly associated with AKI (OR = 10.15; 95% CI: 5.91–17.44; $p < 0.001$). Toxic causes were present in 17 AKI patients (15.32%; OR = 14.74; 95% CI: 5.66–38.36; $p < 0.001$). Hemorrhages were identified in 14 AKI patients (12.61%; OR = 71.30; 95% CI: 9.27–548.55; $p < 0.001$). Severe pre-eclampsia was observed in 10 AKI patients (9.01%; $p < 0.001$). Extracellular dehydration was found in 6 AKI patients (5.41%; OR = 7.01; 95% CI: 1.94–25.29; $p = 0.001$). Prostatic hypertrophy was present in 6 AKI patients (5.41%; $p < 0.001$). Tumors were found in 4 AKI patients (3.60%; OR = 4.59; 95% CI: 1.13–18.64; $p = 0.020$). Disseminated intravascular coagulation (DIC) was present in 1 AKI patient (0.90%; $p = 0.035$). Heart failure was identified in 2 AKI patients (1.80%; $p = 0.003$). Shock states were present in 3 AKI patients (2.70%; OR = 13.72; 95% CI: 1.41–133.19; $p = 0.003$) (Table 2).

Infections ($p < 0.001$), toxic causes ($p < 0.001$), hemorrhages ($p < 0.001$), severe pre-eclampsia ($p < 0.001$), intravascular hemolysis ($p < 0.001$), extracellular dehydration ($p = 0.001$), tumors ($p = 0.2$), prostatic hypertrophy ($p < 0.001$), disseminated intravascular coagulation ($p = 0.035$), heart failure ($p = 0.003$), and shock states ($p = 0.003$) were the main etiologies associated with AKI.

Patients presenting with hemorrhage were seventy-one times more at risk of developing AKI. Those presenting with infectious and tumoral diseases had, respectively, more than ten times and nearly five times the risk of developing AKI.

Patients in a state of dehydration and those in a state of shock were, respectively, more than seven times and nearly fourteen times at risk of presenting with AKI. Those with intravascular hemolysis had nearly six times the risk of developing AKI.

Association between complications and AKI: Hyponatremia ($p < 0.001$) was associated with AKI. Patients who had presented with severe hyponatremia were nearly five times more at risk of developing AKI.

Factors associated with AKI in multivariate analysis: After multivariate analysis by logistic regression, the factors independently associated with the occurrence of acute kidney injury were: the presence of a urinary tract obstruction (adjusted OR = 29.35; 95% CI: 1.31–658.02; $p = 0.033$) and hypovolemia (adjusted OR = 13.80; 95% CI: 5.59–34.08; $p < 0.0001$). The presence of a urinary tract obstruction and hypovolemia multiplied the risk of occurrence of AKI by 29.35 and 13.80 times, respectively (Table 3).

After multivariate analysis by logistic regression, the factors associated with the occurrence of acute kidney injury were: the presence of an obstruction of the urinary tract ($p = 0.033$) and

Table 2: Etiologies associated with AKI - univariate analysis.

Etiology	AKI n (%)	OR [95% CI]	p-value
Infections	42 (37.84)	10.15 [5.91-17.44]	<0.001
Toxic causes	17 (15.32)	14.74 [5.66-38.36]	<0.001
Hemorrhages	14 (12.61)	71.30 [9.27-548.55]	<0.001
Severe pre-eclampsia	10 (9.01)	0,17 [0,14-0,20]	<0.001
Prostatic hypertrophy	6 (5.41)	0,18 [0,15-0,21]	<0.001
Extracellular dehydration	6 (5.41)	7.01 [1.94-25.29]	0.001
Shock states	3 (2.70)	13.72 [1.41-133.19]	0.003
Heart failure	2 (1.80)	0,18 [0,15-0,21]	0.003
Tumors	4 (3.60)	4.59 [1.13-18.64]	0.02
DIC	1 (0.90)	0,18 [0,15-0,22]	0.035

Table 3: Factors independently associated with AKI - multivariate analysis.

Factor	Crude OR [95% CI]	Adjusted OR [95% CI]	p-value
Urinary tract obstruction	43.58 [5.46-347.84]	29.35 [1.31-658.02]	0.033
Hypovolemia	19.35 [10.03-37.36]	13.80 [5.59-34.08]	<0.0001

hypovolemia ($p < 0.0001$). The presence of an obstruction of the urinary tract and hypovolemia multiplied the risk of occurrence of AKI by 29.35 and 13.80 times, respectively.

Factors associated with AKI-Related Death

Univariate analysis: Age was associated with death ($p = 0.01$). The risk of death increased with age. Altered level of consciousness was associated with death ($p = 0.001$). Patients with an altered level of consciousness had nearly seventeen times the risk of dying.

Vomiting was weakly associated with death ($p = 0.043$). Patients complaining of vomiting were four times more at risk of dying. A history of diabetes ($p < 0.001$) was associated with death. Diabetic subjects had nearly twelve times the risk of dying.

The stage of acute kidney injury was associated with death ($p = 0.006$). The risk of death increased with the severity of AKI. Acute pulmonary edema ($p < 0.001$) and pneumonia ($p < 0.001$) were associated with death. Patients presenting with acute pulmonary edema were twenty times more at risk of dying. Patients with pneumonia had fourteen times the risk of dying.

Multivariate analysis: After multivariate analysis by logistic regression, the independent risk factors for AKI-related death were: altered level of consciousness (adjusted OR = 219.37; 95% CI: 8.58–560.73; $p = 0.001$) and diabetes (adjusted OR = 72; 95% CI: 5,34–960,77 $p = 0.001$) (Table 4).

After multivariate analysis by logistic regression, the risk factors for death were: altered level of consciousness ($p = 0.001$) and diabetes ($p = 0.001$).

Altered level of consciousness and diabetes multiplied the risk of AKI-related death by 219 and 72 times, respectively.

Discussion

In our study, the frequency of AKI was 18.32%. This result concurs with those of Lengani and al. [6] in Burkina Faso in 2009, and Uchino and al. [8] in Australia in 2006, who reported frequencies of 18.4% and 18%, respectively. Yaqini and al. [9] in 2004 in Tunisia had also reported a hospital frequency of 18% for AKI. Vigan and al. [10] in Benin in 2020, Fujii and al. [11] in Japan in 2014, and Abderraman and al. [12] in Chad in 2017 reported frequencies of 11.77%, 11%, and 11.57%, respectively. Malhotra and al. [13] in 2019, in a multinational survey, found a frequency also close to ours, with 20% of AKI cases.

In contrast, Vaara and al. [14] in 2012, Kellum and al. [15] in 2016, and Benouaz and al. [16] in 2017 reported slightly higher frequencies of 29.01%, 28%, and 32.50%, respectively. This could be explained by the longer duration of their study compared to ours.

Our results were largely lower than those of Aylward and al. [17] in South Africa in 2019, Hoste and al. [18] in 2015 in a multinational survey, and Gonçalves and al. [19] in Portugal in 2017, who reported frequencies of 58.5%, 57.3%, and 87.5%, respectively. They were also lower than those of Nisula and al. [20] in 2013, Srisawat and al. [21] in 2011, and Chen and al. [22] in 2020 in China, who reported frequencies of 40%, 50%, and 54.75%, respectively. This difference could be explained by the fact that these studies were conducted exclusively in intensive care units and that the definition of AKI was not the same as in our study.

Our results were significantly higher than those reported by Shusterman and al. [23] and Hou and al. [24], who found frequencies of 2% and 7%, respectively, in the 1980s. This would be explained by the absence of a universal definition of AKI at that time. They were also higher than those reported by Gurrieri, et al. [25] and Akolly, et al. [26] in 2019 in Togo, which were 0.40% and 2.40%, respectively. This difference could be explained by the choice of the study population: the first in gynecology-obstetrics and the second in pediatrics.

Our results concur with those of other authors [7,27–30]. Advanced age constitutes, for many authors, a predisposing factor for acute kidney injury [31,32]. El-Reshaïd and al. [33], in a retrospective study conducted over a period of 18 months (February 1989 to July 1990) in the State of Kuwait, and Lameire and al. [34] in 2006, found the patient's age as an associated factor in the occurrence of AKI in univariate analysis. This was also the case in our study after univariate analysis, where age was associated with AKI with a p -value < 0.001 . The presence of a history of arterial hypertension ($p < 0.001$), diabetes ($p = 0.001$), and sickle cell disease ($p = 0.004$) was also associated with AKI. The occurrence of AKI was statistically associated with morbid histories after univariate analysis. Lameire, et al. [34] found that the existence of concomitant diseases was linked to AKI.

Ahoui and al. [7] in 2015 in Benin had also reported that the occurrence of AKI was statistically associated with a history of arterial hypertension and diabetes, with $p = 0.0018$ and $p = 0.002$, respectively. Groeneveld and al. [35] reported that, independently of each other,

Table 4: Independent predictors of AKI-related mortality - multivariate analysis.

Factor	Crude OR [95% CI]	Adjusted OR [95% CI]	p-value
Altered level of consciousness	16.83 [2.01-141.08]	219.37 [8.58-560.73]	0.001
Diabetes	11.89 [2.49-56.65]	71,657 [5,34-960,77]	0.001

advanced age and prior chronic diseases are directly linked to the development of AKI.

During univariate analysis, ElHafeez and al. [36] in 2017 in Egypt reported that age ($p < 0.001$), marital status ($p = 0.03$), history of cardiovascular disease ($p < 0.001$), and diuretic use were all associated with AKI. This was also found in our study in univariate analysis.

Bullock and al. [37] found that age, pulmonary and cardiovascular complications, and jaundice were important associated factors in the development of AKI. This was also the case in our univariate analysis.

The presence of proteinuria and hematuria was also associated with AKI in our univariate analysis. Ahoui and al. [7] in 2015 in Benin had also found that postoperative AKI was significantly more frequent in patients with positive albuminuria ($p = 0.006$), positive hematuria ($p = 0.001$), and positive nitrituria ($p = 0.007$). Nitrituria is positive in cases of urinary tract infection.

Jonard and al. [38] in 2014 in France found, after univariate analysis, that hemolysis was associated with secondary AKI, with a p-value of 0.047. Ahoui and al. [7] in 2015 in Benin reported that heart failure ($p < 0.0104$), severe infections ($p = 0.006$), and hypovolemic shock state ($p = 0.002$) were linked to AKI. These factors were also associated with the occurrence of AKI in our univariate analysis. Heart failure is of hypovolemic cause. Its persistence leads to renal hypoperfusion, resulting in functional hemodynamic AKI. As for severe infections, two pathophysiological mechanisms could explain the genesis of AKI. Indeed, certain germs responsible for infectious states have renal tropism, causing direct alteration of the nephrons, responsible for organic AKI.

After multivariate analysis by logistic regression, the factors associated with acute kidney injury were: the presence of an obstruction of the urinary tract ($p = 0.033$) and hypovolemia ($p < 0.0001$).

These results concur with the literature data [39-41]. Yang and al. [39] in China in 2014 reported data similar to ours. In their study, functional or hypovolemic causes and obstructive causes were strongly associated with the development of AKI, all with a p-value of 0.0001. Shusterman and al. [23] found that hypovolemia (OR = 9.4, 95% CI [2.1-42.8]; $p < 0.0001$) constitutes a potential risk factor for the development of acute kidney injury. Ali and al. [4] in 2007, in a retrospective cohort study in the United Kingdom, and Leblanc and al. [41] in 2005 also found hypovolemia as a risk factor for the occurrence of AKI. Fouda and al. [42] in Cameroon in 2021 found that functional causes, dominated by gastrointestinal losses and malaria, were the most common risk factors for AKI. These data are comparable to those found in our study.

Wang and al. [43] in 2012 reported that obstructions such as ureteral stones in patients with a single functional kidney or bilateral ureteral stones constituted risk factors for the occurrence of AKI. Tang and al. [44] in the United States in 2014 also found that obstruction by lithiasis ($p < 0.05$) would be an important risk factor for acute kidney injury. The presence of an obstruction of the excretory urinary pathways was therefore correlated with the occurrence of acute kidney injury; this association could be explained by the frequent prostatic hypertrophy and the cases of urinary lithiasis observed in our study.

Nisula and al. [20] in 2013 in Finland reported that hypovolemia was a risk factor associated with AKI.

In multivariate analysis, Wijewickrama and al. [45] reported in 2014, after a prospective monocentric study at the National Hospital of Colombo, Sri Lanka, Asia, that neither age, nor sex, nor the presence

of comorbidities was associated with an increased risk of AKI. Rasmussen, et al. [46] also reported that age, diabetes, and long-term diuretic administration were not found to be risk factors associated with AKI in multivariate analysis and logistic regression; this was also the case in our study.

On the other hand, other authors found results contrary to ours. De Mendonça and al. [29] reported that the most important risk factors for the development of AKI were acute circulatory or respiratory failure, age over 65 years, the presence of infection, a history of chronic heart failure (CHF), lymphoma or leukemia, or cirrhosis. Yaqini and al. [9] in 2004 in Tunisia reported that shock state, septicemia, and advanced age were the main risk factors for AKI.

Bagshaw and al. [30] in 2005 in Canada found that the risk factors for the development of AKI included prior heart disease, stroke, pulmonary disease, diabetes mellitus, cancer, connective tissue disease, chronic renal dysfunction, and alcoholism. This was not observed in our study. These differences could be explained by the fact that their studies were multicentric, with a patient population exclusively in intensive care.

Data on factors associated with death in patients suffering from AKI in the literature are not all concordant.

It is first necessary to distinguish the populations of these studies, which are sometimes very different: hospital-based [47], polyvalent intensive care [48-51], in the postoperative period of cardiac surgery [52,53].

Certain authors such as Chen and al. [22] in China in 2020 and Kudose and al. [54] in 2018 in the United States reported the stage of AKI as a factor associated with death in univariate analysis, with p-values of 0.002 and 0.001, respectively. Mehta and al. [55] and Pereira and al. [56] also reported that the stage of AKI was associated with death in univariate analysis, with p-values of 0.0001 and 0.001, respectively. The risk of death increased with the severity of AKI. This finding was also made in our study.

During univariate analysis, Kohli and al. [57], Sural and al. [58], and Kleinknecht and al. [31] reported that age and pre-existing chronic diseases were associated with patient death; this was also the case in our study, where age and a history of diabetes were associated, with p-values of 0.01 and less than 0.001, respectively.

Studies conducted in Western countries had found age, respiratory failure, the use of an invasive ventilation technique, Black race, and oliguria as risk factors for death, with a p-value < 0.001 [47,22,59,60]. This finding was not made in our study. This could be explained by the fact that all our subjects were Black that our study was not conducted in an intensive care unit, and that diuresis could not be obtained in all records.

The use of a renal replacement therapy method was also associated with the risk of death, with a p-value < 0.001 [61,49,62]. El Khayat and al. [63] and Waikar and al. [64] had also found this result. This finding was not made in our study and could be explained by the low rate of dialysis performed. The performance of dialysis was limited by the lack of financial means.

In contrast, our results concurred with those of certain authors [27,52,65,56,66]. Chertow and al. [67], Bagshaw and al. [68], and Benouaz and al. [69] found altered level of consciousness as a risk factor for death in cases of acute kidney injury, with a p-value < 0.0001 . Liaño and al. [70] in Spain and Abosaif and al. [71] in the United Kingdom in 2006 also reported that mortality was higher in patients with coma,

with a p-value < 0.001. Pascual and al. [32] also reported that altered level of consciousness was associated with a poor prognosis. Bello and al. [72] in Nigeria in 2017 found that altered level of consciousness was correlated with death, with a p-value of 0.01.

A history of diabetes ($p = 0.001$) was a predictive factor for death in our study. Brivet and al. [27], el-Reshaïd and al. [33], and Bullock and al. [37] reported that altered prior health status or the presence of a pre-existing medical disease was a predictive variable for death. A history of diabetes ($OR = 1.9$; $p < 0.05$) was found as a risk factor for death by Shusterman and al. [23]. Herrera-Gutiérrez and al. [73] in Spain in 2006 also reported that a history of diabetes ($OR = 2.06$; $p < 0.05$) was a poor prognostic factor in patients with acute kidney injury.

Conclusion

Acute kidney injury remains a frequent and severe condition, associated with high morbidity and mortality, particularly in hospital settings. This work made it possible to highlight several factors significantly associated with the occurrence of acute kidney injury. Early identification of these risk factors constitutes a key element in the prevention and effective management of acute kidney injury. It allows not only reducing the incidence of this pathology, but also improving the prognosis of patients by limiting complications.

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