SRYAHWA PUBLICATIONS

Archives of Nephrology
ISSN: 2639-3573 | Volume 7, Issue 2, 2025
https://doi.org/10.22259/2639-3573.0702001

RESEARCH ARTICLE

Factors Associated with Post-Stroke Acute Renal Injury at the Regional Teaching Hospital of Borgou Alibori (Benin)

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Received: 05 November 2024 Accepted: 10 January 2025 Published: 28 February 2025

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Abstract

Background: Stroke is serious and often complicated. The aim of this study was to identify the various factors associated with acute kidney injury (AKI) in stroke patients treated atRegional Teaching Hospital of Borgou Alibori (Benin)the in 2024.

Methods: This was a cross-sectional study with prospective data collection from July 1, 2024 to September 30, 2024, carried out in the neurology department of the said hospital and concerned patients admitted for a stroke. Patients at least 18 years of age, hospitalized for a recent stroke (less than one month), with impaired renal function and having given free and informed consent (themselves or the patient's caretaker) were included. AKI was selected according to KDIGO 2012 criteria. Associated factors were identified and the significance threshold was $p<0.05$.

Results: Of the 70 patients hospitalized for stroke, 33 had had acute kidney injury and 22 (66.7%) were in stage 1. The mean age of the patients was 60.09 ± 3.97 years and the sex- ratio was 1.34. Factors identified were speech disorders (p=0.028), hypochloremia (p=0.004) and bladder catheterization (p=0.018).

Conclusion: The frequency of renal impairment in patients hospitalized for stroke is high. Many factors are associated with it, and corrective measures are urgently needed to prevent its occurrence.

Keywords: Acute Kidney Injury, Stroke, Benin.

1. Introduction

Stroke is the sudden onset of a neurological sign of presumed vascular origin [1,2]. It represents a major public health challenge worldwide [3,4] affecting all ages, but is more frequent in the elderly [3]. It is one of the leading causes of mortality and morbidity worldwide [5]. In Sub-Saharan Africa, for every 100,000 inhabitants, 15 to 1,300 suffer a stroke [6]. In Benin, in the general population, a prevalence of 460 and 1156 per 100,000 inhabitants was found respectively in Cotonou and Parakou in 2017; it constitutes 46.9% and 53.4% of neurology admissions with a high mortality of 16.7% during hospitalization[4]. Acute kidney injury is also a frequent pathology in hospitalization, especially in elderly subjects as well as patients hospitalized in intensive care [7]. In Burkina Faso, Lengani A et al.[8] reported a prevalence of 18.4% of acute kidney injury among patients hospitalized in the nephrology department. Similarly, pre-existing chronic renal failure is associated with a major risk of stroke [9].

Citation: AHOUI Séraphin, AGBETOU Mendinatou, VINASSE Aimé, *et al*. Factors Associated with Post-Stroke Acute Renal Injury at the Regional Teaching Hospital of Borgou Alibori (Benin). Archives of Nephrology. 2025; 7(2):1-8.

The present study was initiated to identify factors associated with the occurrence of acute kidney injury in patients hospitalized for stroke at the Regional Teaching Hospital of Borgou and Alibori(Benin) in 2024.

2. Methods

2.1 Design and Study Period

This was a descriptive cross-sectional study with analytical aims, conducted over a3-month period from July 1, 2024 to September 30, 2024, with prospective data collection from patients admitted in neurology department of theRegional Teaching Hospital of Borgou and Alibori for stroke.

2.2 Study Population, Sampling and Selection Criteria

The study covered all patients with recent stroke admitted to the CHUDB/A neurology department from July 1 to September 30, 2024, with exhaustive recruitment. All patients wereincluded in the study:

- At least 18 years old
- Hospitalized for a recent stroke (less than one month)
- Withimpairedrenalfunction
- Having given their free and informed consent (themselves or the patient's caretaker)

This study did not include patients:

- With stroke of more than 1 month duration
- Unable to carry out the necessary explorations

2.3 Variables of Interest (and Judgment Criteria)

The presence of acute kidney injury in a patient hospitalized for stroke was the variable of choice. This was defined, according to the *KDIGO*2012 criteria [10], as a rise in creatinine levels of over 3mg/l in two days, or a rise of at least 1.5 times the baseline value in seven days; or oliguria of less than 0.5ml/kg/h for 6 hours. Acute kidney injury was classified into three stages according to the 2012 *KDIGO*criteria, namely:

- Stage I: an increase in creatinine of more than 3mg/L or between 1.5 and 1.9 times the value on admission, or diuresis <0.5 ml/kg/h for 6 to 12 hours
- Stage II: an increase in creatinine between 2 and 2.9 times the admission value or diuresis <0.5 ml/kg/h for at least 12 hours.
- Stage III: an increase in serum creatinine of at least three times the value on admission, or diuresis <0.3 ml/kg/h for at least 24 hours, or anuria lasting more than 12 hours.

The parameters of interest included the sociodemographic, socioeconomic, clinical, paraclinical and therapeutic variables studied.

2.4 Collection Method and Technique

All included patients were examined and diuresis monitored. Blood urea and creatinine levels were determined on admission (D0) and on D2. Creatinine levels were measured on admission (D0) and on D2. Urine was collected using urinocol® or sterile jars, depending on the age and functional capacity of the patients. Creatinine levels were determined using the Jaffé method[11].

For patients with impaired renal function or abnormal diuresis, urine sediment was requested.

Data were collected using a survey questionnaire which was completed on patient admission to the neurology department.

2.5 Data Processing and Analysis

The collected data were recorded with Epi-info 7.2.6 and then exported toMicrosoft Excel 2019 for analysis. Analysis was performed using Stata 15 software. Data were organized in tabular and graphical form using Excel 2019. Qualitative variables were expressed as percentages, while quantitative variables were expressed as means with their standard deviation when normally distributed. Otherwise, they were expressed as the median and its interquartile range. Associated factors were tested using Pearson's Chi-square test or FISHER's test, as appropriate. The explanatory variables selected after a search for collinearity were included in a multivariate model. Explanatory variables were prioritized according to their Odds Ratio (OR) values and their 95% Confidence Interval (CI95%). The difference was statistically significant for a p-value of less than 0.05.

2.6 Ethical Considerations

This study was carried out within the framework of research initiated at the Faculty of Medicine, University of Parakou. Written or oral informed consent was obtained from the participants, or from the beneficiaries in the case of patients. Anonymity and confidentiality of data were respected.

3. Results

During the study period, 108 patients were hospitalized in the neurology department of CHUD-B/A, including 70 stroke patients (64.8%); 33 patients met our inclusion criteria (47.1%).

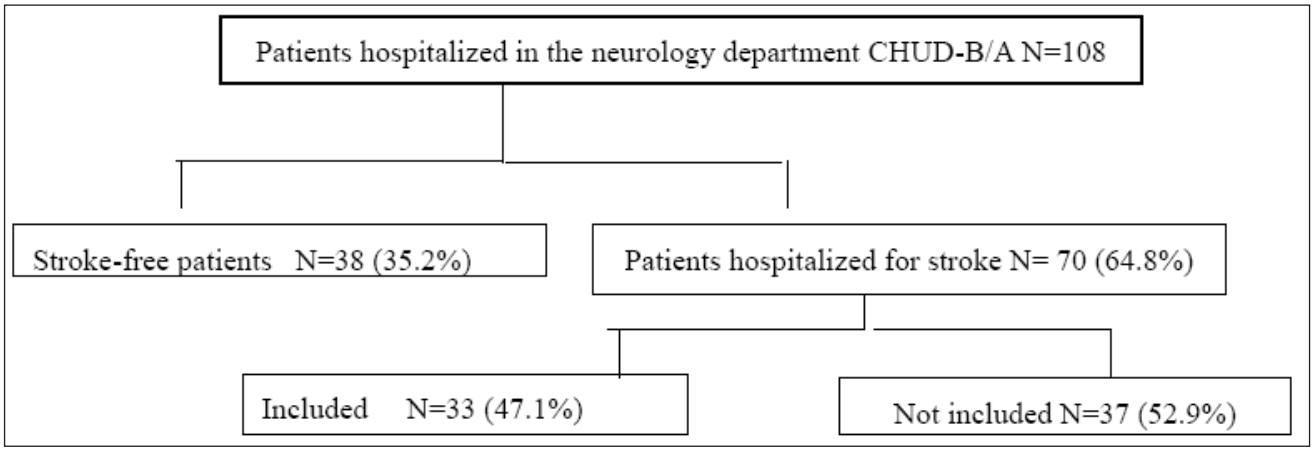

Figure1. *flow chart of stroke patients included(CHUD-B/A, July-September 2024)*

3.1 General Characteristics of Population

3.1.1 Overall Frequency of Acute Kidney Injury

Among the 70 stroke patients, 33 had developed acute kidney injury (AKI) as measured by creatinine increase within 48 hours (KDIGO 2012), representing a 47.1% frequency of AKI during the study period.

3.1.2 Frequency by Severity

Of the 33 patients with acute kidney injury, 22 patients (66.7%) were stage 1, 7 patients (21.2%) stage 2 and 4 patients (12.1%) stage 3 according to *KDIKO 2012.*

3.2 Sociodemographic and Socioeconomic Characteristics of Patients with Acute Renal Injury after Stroke

The mean age of patients who developed post-stroke acute kidney injury was 60.09 ± 3.97 years, with extremes of 36 and 82 years; the 60 to 69 age group was the most represented. Of the 33 patients, 19 (57.6%) were male, giving a sex ratio of 1.34. In terms of socio-economic category, 28 (84.8%) patients were self-employed and two (6.1%) were civil servants. In terms of distance travelled, 24 patients (72.7%) had travelled more than 50 km and eight patients (24.2%) less than 5 km to reach the hospital.

3.3 Clinical Characteristics of Patients with Immediate Post-Stroke Acute Kidney Injury

The risk factors for stroke in the 33 patients with acute kidney injury were: arterial hypertension in 29 patients (87.9%), diabetes mellitus in 6 (18.2%) and advanced age over 50 in 23 patients (69.7%). Two patients (6.1%) had a history of chronic renal failure. With regard to lifestyle, 20 patients used excessive phytotherapy. Mean systolic and diastolic blood pressure were 165.06 ± 10.48 mm Hg and 96.36 ± 4.48 mm Hg respectively, with a mean pulse rate of 94.42 ± 5.43 beats per minute**.** According to their hydration status, two patients (6.1%) had lower limb edema (LLE), and extracellular dehydration was present in three patients (9.1%). Also, in terms of their body mass index (BMI), nine patients (27.3%) were overweight, and five patients (15.1%) were obese.

On urine dipstick, leukocyturia and nitrituria were present in seven patients (21.2%) and six patients (18.2%) respectively. Albuminuria was massive (≥ 3 crosses) in two patients (6.1%) and severe hemoglobinuria (3 crosses) in seven patients (21.2%). The mean NIHSS score of these patients was 13.2, with extremes of 5 and 22

3.4 Stroke Severity and Complications

Of the 33 patients, 20 (60.6%) had a moderate stroke, 11 (33.3%) a severe stroke and 2 (6.1%) a severe stroke.

The post-stroke complications associated with prolonged decubitus in this study were infectious complications, notably pneumopathy, urinary tract infection, bedsores and digestive tract infection in eight patients (24.2%), six patients (18.2%), two patients (18.2%) and one patient (3%) respectively.

3.5 Paraclinical Characteristics of Patients With Post-Stroke Acute Kidney Injury

Hemoglobin levels in the 33 patients with post-stroke acute kidney injury averaged 12.31±1.00 g/dL with extremes of 7.1 and 14.3 g/dL; they were below 11.5 g/dL in six patients (18.2%) and below 12g/dL in seven patients (21.2%). The mean white blood cell count was 10.68 ± 1.75 G/L; 16 patients (48.5%) had a white blood cell count ≥ 10 G/L. Platelets averaged 285.03 ± 49.40 G/L; two patients (6%) and five patients (15.1%) had platelet counts below 150 G/L and above 400 G/L respectively. The blood ionograms of the 33 patients with acute renal failure revealed that the mean sodium level was 135.33±2.73mmol/L, with extremes of 115.1 and 147.7mmol/L; potassium and chloride levels averaged 3.58±0.40mmol/L and

101.04±3.24mmol/L respectively. Urine pellets from patients revealed isomorphic red blood cells in 28 (84.8%), white blood cells in 9 (27.3%) and granular cylinders in 8 (24.2%).

3.6 Therapeutic Aspect

Therapeutically, hyperhydration was used in 30 patients (90.9%) and 3 patients were on fluid restriction. Antibiotics were used in 16 patients (48.5%). Management of POA was based on halfsitting, oxygen therapy and loop diuretics; calcium gluconate and Kayexalate were used to manage hyperkalemia.

3.7 Factors Associated with Acute Post-Stroke Renal Injury

Factors associated with post-stroke acute kidney injury were hemicompartmental weakness (p=0.042), language disorders (p=0.016), fever (p=0.019), facial paralysis (p=0.002), hyperleukocytosis (p=0.018), hyperuricemia (p=0.016), bladder catheterization (p=0.001), antibiotic use (p=0.018), pneumopathies (p=0.001), urinary tract infections (p=0.008) and chloride (p=0.007). (Table 1)

Table 1. *Summary of factors associated with post-stroke acute kidney injury in bivariate analysis*

	acute kidney injury		OR	[95% CI]	P-value
	No (%)	Yes(%)			
Hemic body weakness					0.042
No	4(28.6)	10(71.4)	1		
Yes	33(59)	23(41)	0.27	0.64 ; 0.99	
Language disorders					0.016
No	23(67.6)	11(32.4)	1		
Yes	14(38.9)	22(61.1)	3.28	1.13 ; 8.77	
Fever					0.019
No	35(59.3)	24(40.7)	1		
Yes	2(18.2)	9(81.8)	6.56	1.30 ; 33.08	
Facial paralysis					0.002
Yes	30(66.7)	15(33.3)	1		
No	7(28)	18(72)	5.14	1.76 ; 15.0	
Hyperleukocytosis					0.018
No	29(63)	17(37)	1		
Yes	8(33.3)	16(66.7)	3.41	1.20 ; 9.63	
Hyperuricemia					0.016
No	23(67.6)	11(32.4)	1		
Yes	14(38.9)	22(61.1)	3.28	1.23 ; 8.77	
Chloremia					0.007
Normal	28(66.7)	14(33.3)	1		
Lowered	2(16.7)	10(83.3)	10	1.92 ; 51.97	
High	7(43.8)	9(56.2)	2.57	0.79 ; 8.34	
Wearing a urinary catheter					0.001
No	19(82.6)	4(17.4)	1		
Yes	18(38.3)	29(61.7)	7.65	2.24 ; 26.13	
Pneumopathy					0.001
No	37(59.7)	25(40.3)	1		
Yes	0(00.0)	8(100.0)	-	-	
Urinary tract infection					0.008
No	37(57.8)	27(42.2)	1		
Yes	0(00.0)	6(100.0)	-	-	
Antibiotic use					0.018
No	29(63.0)	17(37.0)	1		
Yes	8(33.3)	16(66.7)	3.41	1.20 ; 9.63	

After inclusion of the associated factors (and factors close to significance) found in bivariate analysis in a logistic regression model, the main factors associated with post-stroke acute kidney injury were : speech impairment (ORa=7.65; $CI_{95\%}$ = [1.24; 47.25], p= 0.028), hypochloremia (ORa=53.75; $CI_{95\%}$ = [3.28; 785.39], p= 0.004) and bladder catheterization (ORa=23.98; $CI_{95\%}$ = [1.74; 329.92], p= 0.018). (Table 2)

Table 2. *Summary of factors associated with post-stroke acute kidney injury in multivariate analysis*

Reference variables/modality	ORa	[95% CI]	p-value
Presence of language disorders	7.65	1.24 ; 47.25	0.028
Hypochloremia	53.75	3.68 ; 785.39	0.004
Bladder catheterization	23.98	1.74 ; 329.92	0.018

4. Discussion

4.1 Limits

The present work has some limitations, namely:

- Short studyperiod;
- Lack of availability of certain investigations in all patients, notably trans-thoracic echography (TTE) to detect cardiac pathologies, and completeness of investigations of mineral-bone disorders.

On the basis of these considerations, and despite these limitations, we consider the results obtained to be reliable. Nevertheless, this is a preliminary study that should be followed up by a large-scale study with a larger sample size, in a multi-center setting, and with substantial financial resources.

4.2 Commentary and Comparison of Results with those of other Authors

We identified 33 patients with acute kidney injury out of a total of 70 hospitalized for stroke. This corresponds to a frequency of 47.1%. The frequency varies in the literature, ranging from 5.1% to 30.18%.

Table 3. *Frequency of acute kidney injury in different*

Variousstudies	Country	Year	Number of study participants	Frequency (%)
Shimoyama et al [12]	Japan	2020	21	5.1
Saeed et al [13]	California	2015	372223	5.3
Huang [14]	China	2020	Not specified	12
Lima et al [15]	Brazil	2018	214	9.3
Walid et al [16]	Iraq	2019	58	13.5
Grosjean et al[17]	Italy	2019	79	18
Wang et al [18]	China	2017	135	20.9
Bassiouny et al[19]	Egypt	2012	122	24.4
Jiang et al [20]	China	2018	381	30.2
This study	Benin	2024	33	47.1

There are several possible explanations for the high frequency of post-stroke acute kidney injury in our study. Firstly, differences in sample size and study period may explain this frequency. Indeed, most of these studies were carried out over a long period of time and with a much larger sample size than ours. On the other hand, subtle variations in the definitions and diagnostic criteria of acute kidney injury may justify our results. Indeed, the diagnosis of some authors was based on the RIFLE classification[19]. We used the *KDIGO 2012* classification, which is highly sensitive for detecting acute kidney injury. Few studies have addressed this aspect of post-stroke acute kidney injury in Africa. In our study, 22 patients (66.7%), 7 (21.2%) and 4 patients (12.1%) were at *KDIGO* stage 1, stage 2 and stage 3 respectively. This result has been found in several studies including that of Jiang et al who found proportions of 66.9%, 20.9% and 12.2% in KDIKO stage 1, 2, and stage 3 respectively[20]. In 2017, Wang et al also had similar results, with proportions of 62.2%, 19.3% and 18.5% of patients at *KDIGO 2012* stage 1, 2 and 3[18] .Ansaritoroghi and Grosjean found the same results in India[21] and Italy[20] respectively. The high proportion of stage 1 acute kidney injury in this study may be due to the fact that acute kidney injury is detected earlier in hospitalized patients. The mean age of the 33 patients who developed post-stroke acute kidney injury in our study was 60.09 ±3.97 years, with extremes of 36 and 82 years, and the most represented age group

was between 60 and 69 years. Our results concur with those of Jiang et al in 2018 in China, where the median age of patients was 60[20] . In Brazil, on the other hand, the median age of patients with acute kidney injury was 66.46+/-13.73[15] . Similarly, in California, Saeed et al found a mean age of 74 ± 28 years[22] and in Japan, Kamouchi et al found a mean age of 73.7 years for patients with post-stroke acute kidney injury[23] . This average age in our study may be due to the fact that life expectancy is lower in less developed countries like ours. Hypertension was the most common risk factor in 29 patients (87.9%) with post-stroke acute kidney injury. Similar results have been found in other studies, including Saeed et al in 2014[13] , Wang et al[18] and Shimoyama et al in 2020[12] . Indeed, hypertension is the most important risk factor for stroke in the elderly due to its high frequency, which may explain our result[3] . Diabetes was also a risk factor found in 6 patients (18.2%), predominantly in the group suffering from acute post-stroke renal impairment. This finding was close to that of Saeed et al in 2014 California[13] as well as that found by Lima et al in Brazil[15] . Diabetes is a pathology associated with the occurrence of acute kidney injury[24] . Five patients (15.1%) in this study had a history of stroke. This result would be in line with that of Bassiouny et al, who found that 14.7% of patients with post-stroke acute kidney injury had had a previous stroke.[19] .

In our study, albuminuria at 3 crosses (+++) was found in two patients (6.1%). In Egypt, albuminuria was found in traces in 5.7% of patients with acute post-stroke renal injury[19] . The albuminuria at 3 crosses (+++) found in our study may be explained by the glomerular damage found in two patients in this study. Hemiplegia (left or right) was present in 30 patients, i.e. 90.9% of patients with post-stroke acute kidney injury. In Egypt, right and left hemiplegia were found in 59% and 32.7% of patients with post-stroke acute kidney injury respectively.[19] . The high frequency of hemiplegia among patients in this study may be explained by our small sample size. Stroke-related decubitus complications in this study were pressure sores in two patients (6.1%), pneumonitis and urinary tract infections in eight (24.2%) and six (18.2%) patients respectively. In California, hospital complications included pneumopathies and urinary tract infections in 4.7% and 17.5% of post-stroke acute kidney injury cases respectively[22]. Saeed et al in 2014 also reported pneumopathy and urinary tract infection in 11.4% and 10.2% of cases respectively. This discrepancy in frequencies may be due to the size of our sample[25] . Pneumopathies may be linked to the swallowing disorders often observed in these patients, and urinary tract infections to ascending contamination from a urinary catheter. Our study reported hyperleukocytosis in 48.5% of cases of acute post-stroke renal injury, with a mean of 10.68± 1.75 G/L. Hyperleukocytosis was also found by Bassiouny et al in 2020, and the mean white blood cell count was 13.4±6.4 G/L[19] . This result explains the high prevalence of bacterial infections in these patients, which would be the probable cause of their acute renal impairment (acute renal impairment in infectious states). Uric acid was elevated in 22 patients, representing 66.7% of patients with post-stroke acute kidney injury. This proportion is higher than that found in the group of patients who did not develop poststroke acute kidney injury. Two studies have confirmed this, notably the study by Zou et al in 2020[26] and that by Bassiouny et al in 2012[19] . In this study, antibiotics were used in 16 patients (48.5%) for the management of stroke-related infectious decubitus complications. Antibiotics were used more frequently in patients with acute kidney injury. Indeed, according to Grosjean et al, antibiotics were administered more during hospitalization in patients with post-stroke acute kidney injury than in those without[17] . We can explain our result by the fact that stroke-related infectious complications were more common in the group of patients who developed acute kidney injury. In this bivariate study, the factors associated with post-stroke acute kidney injury were hemicompartmental weakness (p=0.042), language disorders (p=0.016), fever (p=0.019), facial paralysis (p=0,002), hyperleukocytosis (p=0.018), hyperuricemia (p=0.016), bladder catheterization (p=0.001), antibiotic use (p=0.018), pneumopathies (p=0.001), urinary tract infections (p=0.008) and chloride (p=0.007). In multivariate analysis, language disorders (p=0.028), hypochloremia (p=0.004) and bladder catheterization (p=0.018) were associated with the occurrence of acute kidney injury. These results have been confirmed by several authors.

Indeed, Zou et al. found a significant link between hyperuricemia and the occurrence of post-stroke acute kidney injury in China[26] . In addition to hyperuricemia, Bassiouny et al. in Egypt found a significant association between acute kidney injury and hyperleukocytosis[19] . Several authors have found a significant association between acute kidney injury and infectious complications, including Ansaritoroghi, Saeed, and Kamouchi .[22,23,27]

5. Conclusion

In the present study, there was a high prevalence of post-stroke acute kidney injury in the CHUDB/A neurology department in 2024. Many factors have a link or relationship with the occurrence of acute kidney injury during stroke.

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