

(RESEARCH ARTICLE)



Frequency and pattern of acute kidney injury in patients with acute stroke

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Abstract

Background and objective: Stroke is a severe disease of the nervous system resulting in disability and death of the affected individual. Acute kidney injury (AKI) which is a clinical syndrome due to sudden renal function decline is considered as an important factor that increases fatality following a stroke. Thus, this study was conducted to determine the frequency and pattern of AKI in stroke patients and the outcome of patients with stroke and AKI.

Methods: This study was a descriptive cross-sectional study, carried out at the Delta State University Teaching Hospital (DELSUTH), Oghara, Delta state, which is a public tertiary health institution in Delta state in a semi-urban area in southern Nigeria.

Results: The mean age of patients was 58.9 ± 14.2 years. Slightly above half (53.7%) of the patients were males. Haemorrhagic stroke was the most common type of stroke. Hypertension was the most frequent co-morbid condition (59.0%). Twenty (14.9%) had acute kidney injury, of which stage one AKI was the most dominant (75.0%). Majority of the patients (79.9%) survived. Having sepsis was a significant factor associated with the presence of AKI. None of the clinical characteristics was associated with outcome of patients.

Conclusion: The frequency of AKI in stroke patients was 14.9%, with majority of the patients presenting with stage 1 AKI. Presence of sepsis was a significant risk factor for development of AKI in patients with acute stroke, while hypertension was the most prevalent comorbid condition in patients with acute stroke, thus the need for continuous screening of stroke patients for hypertension.

Keywords: Acute Kidney Injury; Frequency; Acute Stroke; Hypertension; Sepsis

1. Introduction

Stroke is a severe disease of the nervous system resulting in disability and death of the affected individual [1]. Globally, stroke is recognized as the second leading cause of death and the 3rd leading cause of Disability-adjusted life years (DALYs) across all ages [2]. Based on regional distribution, the highest burden of stroke has been reported from Sub-Saharan Africa which includes Nigeria [3-6]. In Nigeria, between 1990 and 2019, the incidence of stroke varied from 114.0 to 158.0 per 100,000 [7,8].

Though stroke is primarily considered as a neurological disorder affecting the elderly (60 years and above), there is increasing frequency of recent studies reporting the occurrence of stroke in younger people and children [9]. Stroke is

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defined based on the presence of objective evidence of infarction or haemorrhage via neuroimaging or neuropathology in the brain, spinal cord or retina [10,11]. It results from inadequate supply of blood to the brain [1]. Stroke is broadly classified into ischaemic stroke (accounting for 80% of all stroke) and haemorrhagic stroke (which accounts for 20% of all strokes) [12,13]. Amidst the various likely factors that increases fatality following a stroke, the occurrence of acute kidney injury has been increasingly considered as an important risk factor [14-16].

Acute kidney injury (AKI) is a clinical syndrome that degrades the outcome of a significant number of hospitalised patients [17]. AKI is a condition with mixed aetiology, and is regarded as a sudden (usually within hours) decline in renal function, which could include both impairment (loss of function) and or injury (structural mutilation) [17].

AKI frequently complicates an acute cerebrovascular event with a prevalence in stroke patients ranging from 8% to 21% [14,16]. The occurrence of AKI in stroke patients is affected by changes in physiological conditions of the patients such as; blood pressure, hormone levels, physical disability, advanced age, presence of co-morbid conditions such as heart failure, diabetes and ischemic heart disease, and the treatments of stroke [15,18,19]. Furthermore, the co-morbidity of AKI in stroke is known to result in increased short- and long-term mortality [14,15,20,21]. Therefore, this study was conducted to determine the frequency and pattern of AKI in stroke patients and the outcome of patients with stroke and AKI.

2. Material and method

2.1. Study Design/setting

This study was a descriptive cross-sectional study, carried out at Delta State University Teaching Hospital (DELSUTH), Oghara, Delta state, which is a public tertiary health institution in Delta state in a semi-urban area in southern Nigeria.

2.2. Study population

The study population consisted of patients with acute stroke who were admitted into the Internal Medicine department of DELSUTH.

2.3. Selection criteria

The inclusion criteria included: age being 18 years and above, and patients with acute stroke confirmed by neuroimaging. On the other hand, the exclusion criteria include: patients with acute stroke and history of chronic kidney disease.

2.4. Sample size

The minimum sample size calculated using Fisher's formula was 124. This calculation was based on an estimated stroke prevalence of 11.4%, a power of 80%, a 5% error margin and 95% confidence level. A 10% non-response rate was added to achieve a final sample size of 136.

2.5. Research instrument and Data collection

A proforma was designed to obtain information such as socio-demographics such as age, sex, education, and clinical characteristics of patients such as number of days before presentation, type of stroke, side affected by stroke, co-morbid condition, blood pressure, blood sugar level, use of mannitol, sepsis, and outcome of patients which was broadly classified into: survived or died.

2.6. Data analysis

Data obtained was entered and analysed using statistical package for social sciences (SPSS version 23). All variables obtained was summarized using descriptive statistics (frequency and percentage). Chi-square test was used for test of association between the dependent variables such as (presence of AKI, outcome of patients) and the independent variables (age, sex, side of stroke, type of stroke, presence of hypertension, presence of diabetes). Statistical significance was set at $p < 0.05$.

2.7. Ethical approval

Ethical approval for this study was obtained from the Health Research Ethics Committee of the Delta State University Teaching Hospital, Oghara. Written informed consent was also obtained from the participants prior to data collection.

3. Results

Table 1 shows the socio-demographic characteristics of patients. The mean age of patients was 58.93 ± 14.2 years. Thirty-five (26.1%) were between the age of 18 – 44 years, 50 (37.3%) 45 – 64 years and 49 (36.6%) ≥ 65 years. Seventy-two (53.7%) of the patients were males, 62 (46.3%) were females. Five (3.7%) had no formal education, 9 (6.7%) had attained primary education, 65 (48.5%) had attained secondary level of education and 55 (41.1%) had attained tertiary level of education.

Table 1 Socio-demographic characteristics of participants (n = 134)

Variable	Frequency	Percentage
Age (in years)		
18 – 44	35	26.1
45 – 64	50	37.3
≥ 65	49	36.6
Mean age	58.93 ± 14.2	
Gender		
Male	72	53.7
Female	62	46.3
Education		
None	5	3.7
Primary	9	6.7
Secondary	65	48.5
Tertiary	55	41.1

Table 2 shows the clinical characteristics of participants. One hundred and eighteen (88.0%) of the participants were admitted within 7 days of incidence of stroke, while 16 (12.0%) were admitted after more than 7 days post stroke. Fifty-seven (42.5%) of the study participants were affected in the right hemisphere, and 77 (57.5%) were affected in the left hemisphere. Forty-six (34.3%) had ischaemic stroke, while 88 (65.7%) had haemorrhagic stroke. Ninety-five (70.9%) had a comorbid condition. None of the participants had HIV, HBV and HCV as a comorbid condition, however, 28 (20.9%) had diabetes, 79 (59.0%) had hypertension, while 20 (14.9%) had acute kidney injury. Of those with AKI, 15 (75.0%) had stage 1 AKI, 3 (15.0%) had stage 2 AKI, and 2 (10.0%) had stage 3 AKI. A total of 107 (79.9%) of the patients survived, while 27 (20.1%) died.

Table 2 Clinical characteristics of participants (n = 134)

Variable	Frequency	Percentage
Number of days before admission		
≤ 7 days	118	88.0
> 7 days	16	12.0
Side of stroke		
Right hemisphere	57	42.5
Left hemisphere	77	57.5
Type of stroke		
Ischaemic	46	34.3

Haemorrhagic	88	65.7
Presence of comorbidity		
Yes	95	70.9
No	39	29.1
°Co-morbid conditions		
Diabetes	28	20.9
Hypertension	79	59.0
Acute Kidney Injury	20	14.9
Systolic Blood pressure		
>160	53	39.6
120 – 160	77	57.5
<120	4	3.0
Diastolic blood pressure		
>110	26	19.4
90 – 110	30	22.4
<90	78	58.2
Sepsis		
Yes	91	67.9
No	43	32.1
Use of mannitol (n = 116)		
Yes	39	33.6
No	77	66.4
Stage of AKI (n = 20)		
1	15	75.0
2	3	15.0
3	2	10.0
Outcome of patients		
Survived	107	79.9
Died	27	20.1

°Multiple response

Table 3 shows factors that are associated with the incidence of AKI in stroke patients. A higher proportion of those with AKI were above 60 years males, however, there was no statistically significant association between age, gender and presence of AKI.

A higher proportion of those with AKI were those who were affected in the right hemisphere, and had Ischaemic stroke, however, there was no statistically significant association between side of the brain affected, type of stroke and presence of AKI. A higher proportion of those who were hypertensive and diabetic had AKI, however, there was no statistically significant association between hypertension and diabetic status and presence of AKI. Systolic blood pressure, diastolic blood pressure and use of mannitol was not significantly associated with presence of AKI, however, having sepsis was a significant factor associated with the presence of AKI.

Table 4 shows the factors associated with mortality of patients. Age, gender, side affected, type of stroke, diabetes status, hypertension, the presence of AKI, systolic blood pressure, diastolic blood pressure, sepsis and use of mannitol were not significantly associated with mortality.

Table 3 Factors associated with the presence of AKI in stroke patients

Variable	Presence of AKI		X ²	p-value
	Absent	Present		
Age				
≤ 60 years	63 (86.3)	10 (13.7)	0.190	0.663
≥ 61 years	51 (83.6)	10 (16.4)		
Gender				
Male	61 (84.7)	11 (15.3)	0.015	0.902
Female	53 (85.5)	9 (14.5)		
Side of stroke				
Left hemisphere	66 (85.7)	11 (14.3)	0.058	0.809
Right hemisphere	48 (84.2)	9 (15.8)		
Type of stroke				
Haemorrhagic	78 (88.6)	10 (11.4)	2.561	0.110
Ischaemic	36 (78.3)	10 (21.7)		
Hypertension				
Hypertensive	64 (81.0)	15 (19.0)	2.501	0.114
Non-hypertensive	50 (90.9)	5 (9.1)		
Diabetes				
Diabetic	22 (78.6)	6 (21.4)	1.179	0.278
Non-diabetic	92 (86.8)	14 (13.2)		
Systolic Blood Pressure				
>160	47 (88.7)	6 (11.3)	Fisher's exact	0.448
120 – 160	63 (81.8)	14 (18.2)	test	
<120	4 (100.0)	0 (0.0)		
Diastolic blood pressure				
>110	23 (88.5)	3 (11.5)	Fisher's exact	0.709
90 – 110	24 (80.0)	6 (20.0)	test	
<90	67 (85.9)	11 (14.1)		
Sepsis				
Yes	72 (79.1)	19 (20.9)	7.917	0.005
No	42 (97.7)	1 (2.3)		
Use of mannitol (n = 116)				
Yes	33 (84.6)	6 (15.4)	0.042	0.837
No	64 (83.1)	13 (16.9)		

Table 4 Factors associated with outcome of patients

Variable	Outcome		X ²	p-value
	Died	Survived		
Age				
≤ 60 years	11 (15.1)	62 (84.9)	2.573	0.109
≥ 60 years	16 (26.2)	45 (73.8)		
Gender				
Male	10 (13.9)	62 (86.1)	3.791	0.052
Female	17 (27.4)	45 (72.6)		
Side affected				
Left hemisphere	18 (23.4)	59 (76.6)	1.172	0.279
Right hemisphere	9 (15.8)	48 (84.2)		
Type of stroke				
Haemorrhagic	20 (22.7)	68 (77.3)	1.059	0.303
Ischaemic	7 (15.2)	39 (84.8)		
Diabetes status				
Diabetic	4 (14.3)	24 (85.7)	0.756	0.384
Non-diabetic	23 (21.7)	83 (78.3)		
Hypertension				
Hypertensive	15 (19.0)	64 (81.0)	0.162	0.688
Non-hypertensive	12 (21.8)	43 (78.2)		
AKI				
Present	4 (20.0)	16 (80.0)	0.001	0.986
Absent	23 (20.2)	91 (79.8)		
Systolic Blood Pressure				
>160	14 (26.4)	39 (73.6)	Fisher's exact	0.065
120 – 160	11 (14.3)	66 (85.7)	test	
<120	2 (50.0)	2 (50.0)		
Diastolic blood pressure				
>110	5 (19.2)	21 (80.8)	0.244	0.885
90 – 110	7 (23.3)	23 (76.7)		
<90	15 (19.2)	63 (80.8)		
Sepsis				
Yes	19 (20.9)	72 (79.1)	0.094	0.759
No	8 (18.6)	35 (81.4)		
Use of mannitol (n = 116)				
Yes	8 (20.5)	31 (79.5)	0.251	0.616
No	19 (24.7)	58 (75.3)		

4. Discussion

This study was conducted to determine the frequency and pattern of AKI in stroke patients and the outcome of patients with stroke and AKI. The mean age of participants in this study was 58.93 ± 14.2 years. This is similar to that reported from Lagos, Abuja and Sokoto in Nigeria, and Ethiopia [22-25], but lower than the mean age of 64.7 ± 15.5 years and 66.46 ± 13.73 years, of stroke patients in Oyo state, Nigeria, and Brazil, respectively [8,15]. A higher proportion of the participants in this study were males. This is similar to a study conducted in Lagos, Sokoto, Abuja, Abakaliki and Oyo state in Nigeria [8,22-24,26,27], but contrary to a report obtained from Nigeria, Ethiopia and Brazil where females were more than males [15,25,28]. This variation could be attributed to regional differences, as a systematic review conducted in Nigeria has previously reported stroke to be more common among males, than females [29]. Only two-fifth had attained tertiary level of education.

About three-fifth of the study participants were affected in the left hemisphere, while Jaiyeola et al., reported the right hemisphere to be the most affected side among stroke patients in Sokoto, Nigeria [30]. In this present study, the most predominant type of stroke seen in about two-third of the participants was haemorrhagic stroke. A similar report has also been given from Sokoto, Nigeria and China [26,31]. Contrarily, various studies have reported Ischaemic stroke as the most common type of stroke [22,27,30,32]. Though haemorrhagic stroke was the most common type of stroke in this study, it is well known historically that ischemic stroke accounts for all four-fifth of all stroke cases globally [12,13,23]. The discrepancies in this study and that of previous authors could be attributed to the nature of facility. This study was carried out in a tertiary facility; thus, it is most likely that more severe cases of stroke might have been referred to the facility, of which haemorrhagic stroke is a more severe form of stroke.

Seven-tenth of the study participants had a comorbid condition, which includes: diabetes, hypertension and acute kidney injury, with hypertension being the most prevalent comorbid condition. This is similar to the report of other studies, where hypertension has been reported as the most prevalent comorbid condition among stroke patients [23-25,30,32]. The high proportion of hypertension could be attributed to the fact that hypertension is a potent risk factor for the development of stroke [24,28].

In this current study the prevalence of AKI among stroke patients was 14.9%. In line with the findings of this study, a meta-analysis reported a 12% prevalence of AKI in stroke patients [1]. Among a Brazilian population the prevalence of AKI in stroke was reported as 9.3% [15], while 20.9% prevalence of AKI in stroke patients was reported among Chinese population [31]. The lower prevalence of AKI reported by Lima et al. could be attributed to the inclusion of only patients with Ischaemic stroke in their study.¹⁵ Factors such as physiological changes, age, treatment therapy have been attributed to be responsible for the development of AKI in stroke patients [19]. In this present study, majority of those with AKI were in stage 1 of the disease. Similar findings have also been reported [31].

In this present study, sex, age, presence of hypertension, diabetes and type of stroke was not significantly associated with the development of AKI. Similar to the findings of this study, Wang et al. reported that age, sex, stroke subtypes, diabetes mellitus are not independently associated with the development of AKI [31]. However, contrary to the findings of this present study, history of hypertension and type of stroke has been associated with higher risk of AKI after stroke [1,31]. The discrepancy in the findings of this study compared with those of previous authors, could be attributed to the study method allowing for a larger sample size.

Finally, age, gender, side affected, type of stroke, diabetes status, hypertension, blood pressure, presence of AKI, sepsis, and use of mannitol were not statistically significantly associated with mortality although some of the potential risk factors were more prevalent among those that died.

5. Conclusion

This study has assessed the frequency and risk factors for the development of AKI in stroke patients. The frequency of AKI in stroke patients is 14.9%, with majority of the patients presenting with stage 1 acute kidney injury, while majority of the patients survived. Age, sex, type of stroke, and comorbid condition were not significant risk factors for AKI in patients with acute stroke, however, presence of sepsis was a significant risk factor for development of AKI in stroke patients, and none of the clinical characteristics evaluated were significantly associated with patient outcome. Furthermore, hypertension was the most prevalent comorbid condition in stroke patients, thus there is need for continuous screening of stroke patients for hypertension. Prompt management of infections in stroke patients may prevent AKI.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Ethical approval was obtained from the institution. Approval Number HREC/PAN/2022/056/0502.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Author's contribution

OEM conceptualization of the study, literature review, design of the methodology, design of study instrument, data collection; OOC – conceptualization of the study, design of the methodology; ANS – literature review, design of study instrument, data analysis, UEC – literature review, design of study instrument, data analysis. All authors developed, read, and approved the manuscript.

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