Udeze *et al. BMC Nephrology* (2025) 26:135
https://doi.org/10.1186/s12882-025-04062-x

BMC Nephrology

RESEARCH

Open Access

Incidence, risk factors and outcomes of AKI among trauma patients in a tertiary hospital in south-east, Nigeria

Chinedu O. Udeze[1*], Monday U. Nwobodo[1], Olaronke F. Afolabi[1], Chinaka Ifeanyi[1], Onyinye J. Nwikwu[1], Anthony C. Agbo[1], Christiana Ologwu[1], Ngozi A. Ifebunandu[1] and Ifeoma I. Ulasi[1,2]

Abstract

Background Acute kidney injury is a preventable and treatable complication of trauma-related injuries associated with increased mortality. Data on the burden and predisposing factors to the development of AKI following trauma are lacking in our environment. This study aims to evaluate the incidence, predisposing risk factors, and short-term outcomes of AKI in trauma patients seen at the Accident and Emergency Unit of Alex Ekwueme Federal University Teaching Hospital Abakaliki, Nigeria.

Methods The study was a hospital-based cohort study of trauma patients. Consenting patients presenting after a trauma-related event were enrolled. Socio-demographic data, the time of the incident, the time of presentation to the hospital, the nature and extent of injuries, and the treatment received were recorded. Blood was taken at specified intervals for haemoglobin, white blood cell count, serum urea, and creatinine estimation. AKI was defined based on the Kidney Disease: Improving Global Outcomes guidelines. Multivariate logistic regression analysis was applied to determine independent risk factors for AKI in trauma patients.

Results 186 trauma patients participated; 83.3% were males. The patients' mean age was 35.3 (± 11.1) years, and most were traders (31.7%). The commonest mechanism of trauma was road traffic accidents (62.9%). The incidence of AKI in this study was 27 (14.5%). Multivariate logistic regression analysis showed that the development of AKI was independently associated with injuries complicated by fractures and longer hospital stay. The 30-day outcome was: 26 (96.3%) recovered fully, and 1 (3.7%) had AKI requiring renal replacement therapy, with no in-hospital mortality.

Conclusion AKI is a frequent complication of trauma, and trauma patients presenting with fractures and have prolonged hospital stay require closer monitoring and care.

Keywords AKI, Incidence, Trauma, Risk factors, Outcomes, Nigeria

*Correspondence:
Chinedu O. Udeze
chynedu2001@gmail.com
[1]Nephrology Division, Department of Internal Medicine, Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, Nigeria
[2]Department of Medicine, College of Medicine, University of Nigeria, Ituku-Ozalla/ University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria

Introduction

Acute kidney injury (AKI) usually occurs as a sudden decline in renal function leading to the retention of various waste products the kidneys should usually remove [1]. AKI is estimated to occur in the global community's 20–200 million population, 7–18% of hospital patients, and approximately 50% of intensive care unit patients [3]. An estimated 2 million people worldwide die of AKI every year, and AKI survivors are at increased risk of developing chronic kidney disease (CKD) and end-stage renal disease (ESRD) -conditions that carry a high economic, societal, and personal burden [3].

The 2012 Kidney Disease Improving Global Outcomes (KDIGO) criteria defined AKI as any of the following: Increase in Serum Creatinine (SCr) by ≥ 26.5 µmol/l within 48 h; or Increase in SCr to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior seven days; or Urine volume <0.5 ml/kg/h for 6 h [2].

Most causes of AKI in developing countries are related to volume-responsive "pre-renal", obstetric, infectious, trauma, or toxic processes [4]. Acute Kidney Injury may cause organ failure in trauma patients who survive, and it is strongly associated with poor outcomes and higher mortality rates [3].

AKI in trauma patients may follow renal hypo perfusion (from haemorrhagic shock), rhabdomyolysis, renal injury, abdominal compartment syndrome, or the nephrotoxic effects of therapies [5]. Other factors include older age, comorbidities such as diabetes mellitus, and chronic kidney disease [5].

Trauma is tissue injury due to violence or accident accountable for initiating hypothalamic–pituitary–adrenal axis, immunologic and metabolic responses responsible for restoring homeostasis [6]. Traumatic injuries cause physical injuries suddenly and require immediate medical attention [4]. Trauma is the highest cause of morbidity and mortality in persons below 40 years of age and third for all ages, behind cardiovascular diseases and cancer [7]. The causes of trauma vary from region to region. However, road traffic accidents (RTA) are the leading cause of injury-related deaths worldwide [7]. In Nigeria, RTAs are the third leading cause of death, usually from trauma-related deaths, and are the most common cause of disability [7]. Acute kidney injury is common after significant trauma and is associated with a prolonged length of hospital stay and increased mortality [10].

This study aimed to determine the incidence and risk factors of AKI in trauma patients and the short-term (30 days) outcome of patients who developed trauma-related AKI at the Accident and Emergency Department of a tertiary institution in Nigeria.

Materials and methods

Study design and setting

This was a hospital-based cohort study of trauma patients admitted to the Accident and Emergency Unit of Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA) between December 2021 and June 2022. Patients included in the study were adults aged between 18 and 65 years presenting with a traumatic injury. Trauma patients with a known history of kidney disease, discharged or death within 24 h of presentation, pregnancy, and those who refused to consent to the study were excluded.

Study procedures

One hundred and eighty-six eligible, consenting adults were consecutively enrolled. For each enrolled patient, the incidence of AKI was assessed using the 2012 KDIGO criteria i.e. "an increase in Serum Creatinine (SCr) by ≥ 26.5 µmol/l within 48 hours of presentation". Each AKI patient was followed up for up to 30 days or until discharge or death (if it occurred before 30 days). Written informed consent was obtained, and a structured questionnaire was administered to obtain information on the patient's socio-demographic data and information related to the trauma. The patients underwent physical examination, including measuring vital signs and calculating their Revised Trauma Score (RTS).

Serum urea and creatinine estimation was done at presentation, after 48 h for all enrolled patients; while all AKI patients had additional followed up tests on, day 5, day 8, and at discharge or 30 days later. This required drawing 5 millilitres of venous blood and dispensed into a plain bottle for analysis. Haemoglobin (Hb) and White blood cell (WBC) count estimation was done at presentation, 48 h, and discharge or 30 days later, using 5mls of venous blood drawn and dispensed into an EDTA bottle for analysis.

Hemoglobin estimation and WBC were carried out using the Mythic 18 hematology analyzer, a fully automated 18-parameters hematology analyzer from Switzerland. The serum urea and creatinine analysis were performed with a Hitachi model 917 multichannel analyzer (Roche Diagnostics, Indianapolis, IN).

Study outcomes

The primary outcome was the development of AKI following traumatic injury, based on KDIGO 2012 diagnostic criteria; i.e. "an increase in Serum Creatinine (SCr) by ≥ 26.5 µmol/l within 48 hours of presentation" [2].

Other (secondary) outcomes reported in this study were defined as;

Rapid reversal of AKI: This occurs when there is a complete reversal of the AKI as defined by KDIGO criteria within 48 h of AKI onset [2, 3].

Persistent AKI: The continuance of the AKI by SCr (serum creatinine) or UO (urine output) criteria (as defined by KDIGO criteria) beyond 48 h from AKI onset to less than seven days [2, 3].

Acute kidney disease (AKD): This is defined as a condition in which AKI stage 1 or greater (as defined by KDIGO) is present ≥ 7 days but < 90 days after exposure to an AKI-initiating event [2, 3].

Recovery: Recovery from AKI – is defined as a reduction in peak AKI stage (based on KDIGO criteria) and can be further refined by a change in SCr, GFR, injury biomarkers, and repair and/or return of renal reserve [2, 3].

Recovery from AKI in patients treated with Kidney replacement therapy (KRT) – is defined as > 14 days of independence from RRT [2, 3].

The final study outcome was determined on day 30, or discharge or mortality, if any, occurred earlier. Day 0 was defined as the calendar day of the Emergency Department presentation.

Definitions

Anaemia: According to the World Health Organization (WHO), anaemia is defined as haemoglobin (Hb) levels < 12.0 g/dL in women and < 13.0 g/dL in men. Overall, in men, normal Hb, mild anaemia, moderate anaemia and severe anaemia were defined as Hb level of ≥ 13 g/dL, 11–12.9 g/dL, 8–10.9 g/dL and < 8 g/dL, respectively. For women, normal Hb, mild anaemia, moderate anaemia and severe anaemia were defined as Hb level of ≥ 12 g/dL, 11–11.9 g/dL, 8–10.9 g/dL, and < 8 g/dL, respectively.

Hypertension: Hypertension was defined as persistently elevated systolic and or diastolic blood pressure equal to or greater than SBP 140mmHg and DBP 90mmHg in an adult.

Hypotension: Hypotension was defined based on the biometric parameters of the blood pressure measurement; i.e., changes in systolic blood pressure to less than 90 mmHg or mean arterial pressure of less than 65 mmHg, or a decrease in diastolic blood pressure to less than 40 mmHg.

Statistical analysis

The data was analysed using a commercially available Statistical Package for Social Sciences (IBM, SPSS statistics for Windows, version 26.0 Armonk, NY. IBM corp).

Quantitative variables were summarised using the mean and standard deviation if the data was normally distributed or the median and range if the data was skewed. A comparison of two quantitative groups that were normally distributed was done using the t-test or analysis of variance (ANOVA). A comparison of two groups of skewed quantitative data was made with the Mann-Whitney U test (i.e., the median between 2 groups); the Kruskal-Wallis test was used for more than two groups.

Qualitative/Categorical variables were summarised using frequency and percentages. Comparisons of two or more categorical variables were done using the Chi-square test; however, low sample sizes of subgroups with cells less than five were analysed with Fisher's exact test. Univariate analysis assessed the factors associated with the outcome variable (occurrence of AKI).

The multivariate logistic regression model included variables with unadjusted p-values ≤ 0.1 from the univariate analysis. The multivariate logistic regression analysis gave the adjusted odds ratios of the predictor variables (risk factors/determinants) with their 95% confidence intervals. All p-values were two-sided, and $p < 0.05$ were considered statistically significant.

Results

Demographic and clinical characteristics of the study participants

A total of 186 eligible trauma patients were recruited during the study period (Fig. 1). Overall, 155 (83.3%) of the study participants were males, while 31 (16.7%) were females, giving a male-to-female ratio of 5:1. The mean age of the study population was 35.3 ± 11.1 years. Overall, 117 (62.9%) of the aetiology of the trauma cases was RTA, followed by gunshot injuries 49 (26.3%) and assault 14 (7.5%). There was a significant association between sex and the aetiology of trauma, $p < 0.001$. The most common mode of transportation involved in RTA was motorcycle use, 77 (65.8%). Table 1 shows the other demographic characteristics of the study participants.

Findings from examination and laboratory parameters of trauma patients at baseline

Overall, the mean temperature, pulse rate, respiratory rate, systolic blood pressure, diastolic blood pressure and revised trauma score did not differ between male and female patients (all $p > 0.05$). The haemoglobin level on day 0 (zero) was significantly lower in females (males 11.8 ± 2.1 vs. females 10.7 ± 2.3 g/dl, $p = 0.02$). The white blood cell count on day 30/discharge was lower in both males and females compared to the values at presentation and on day 2. These white blood cell count values at day 30/discharge were significantly lower in females ($p = 0.01$). All other laboratory parameters were similar among the male and female participants, irrespective of the day assessed (see Table S1).

Clinical characteristics of enrolled trauma patients at presentation

Clinically, 132 (71.0%) patients had bruises and abrasions, 88 (47.3%) had head injuries, 58 (31.2%) had different types of fractures, and 18 (9.7%) had spinal cord

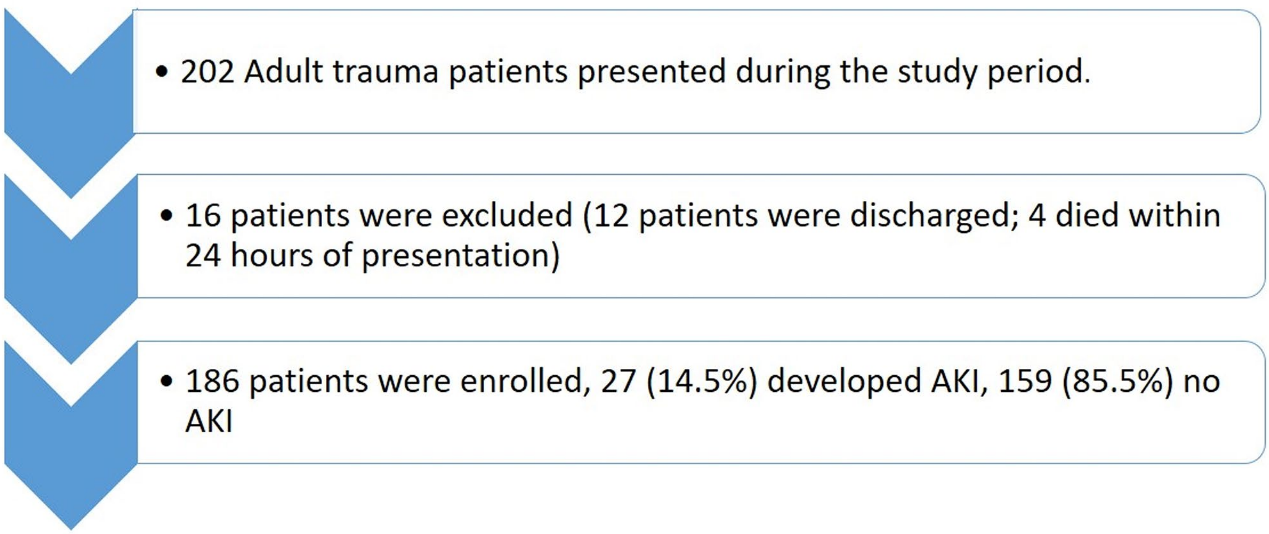

Fig. 1 Flow chart of enrolled trauma patients who presented to AEFUTH, Abakaliki, Nigeria

injuries (see Table 2). There were no sex differences in the proportion of trauma patients who had bruises and abrasions ($p = 0.19$), head injury ($p = 0.36$), spinal cord injury ($p = 0.51$), and fractures ($p = 0.89$) (see Table S2). A higher proportion of female patients had bradycardia (0 vs. 6.5%; $p = 0.01$), systemic hypertension (35.5% vs. 22.6%; $p < 0.001$), as well as moderate- or severe anaemia ($p = 0.02$).

The triage outcome using RTS was grouped under "immediate" in 129 (69.4%) of the trauma patients; there were no sex differences in the triage outcome ($p = 0.12$) as shown in Table S2.

Clinical characteristics of trauma patients and AKI incidence

The incidence of AKI varied minimally according to the anatomical sites affected by trauma, the aetiology of the trauma and the mode of transportation of patients who had road traffic accident (see Tables 2 and 3). A statistically significant relationship between the site of injury and incidence of AKI was seen among those who had fractures ($p < 0.001$).

There was a significant difference in AKI incidence according to the pulse rate of the patients studied (p < 0.001). Compared to patients with regular pulse or bradycardia, patients with tachycardia had a higher incidence of AKI (p < 0.001). Also, there was a significant association between patients' blood pressure and the incidence of AKI ($p = 0.02$). Analysis showed that compared to patients with normal blood pressure, patients with either hypertension or hypotension had a higher incidence of AKI.

Also, the incidence of AKI varied minimally according to most of the treatment modalities given at presentation to the trauma patients (Table 4). A statistically significant relationship between the treatment modality and incidence of AKI was seen among those who received blood transfusion ($p = 0.04$) or had splint cast ($p = 0.02$).

In this study, most patients were admitted for less than two weeks. Of 131(70.4%) patients who stayed less than two weeks in the hospital, 3(11.1%) had AKI. Compared to 24(12.9%) out of the patients who stayed longer than four weeks, 15 (55.6%) had AKI. This was seen to be statistically significant, ($p < 0.001$).

Short-term outcome of AKI management

There was a rapid reversal of AKI in 12 (44.4%) patients, persistent AKI occurred in 11 (40.7%), and acute kidney disease was reported in 4 (14.8%) patients (Fig. 2).

Regarding the short-term (30-day) final outcome following treatment of the AKI: 25 of the patients who had developed AKI were managed using supportive therapy, while KRT was prescribed for two patients; however, only one could afford to have it. Among the treated patients, 26 (96.3%) recovered fully, while 1 (3.7%) had AKI requiring KRT. There was no in-hospital mortality.

Factors associated with AKI among trauma patients

This study showed (Table 5) that patients who had trauma complicated by limb fractures were 7.46 times more likely to develop AKI compared to those without fractures with 95% CI (1.26–55.01). In addition, compared to patients admitted for less than two weeks, AKI patients were more likely to stay for more than 2 weeks on admission. Overall, compared to patients admitted for less than 2 weeks, AKI patients were 10.37 times more likely to stay for 2–4 weeks. Similarly, AKI patients were 19.84 times more likely to stay for more than 4 weeks.

Table 1 Baseline demographic characteristics of the study participants

Variables	Total 186 (%)	Male 155 (%)	Female 31 (%)	*p*-value
Age group (years)				0.83
18–24	32 (17.2)	26 (16.8)	6 (19.4)	
25–34	66 (35.5)	55 (35.5)	11 (35.5)	
35–44	50 (26.9)	40 (25.8)	10 (32.3)	
45–54	21 (11.3)	19 (12.3)	2 (6.5)	
55–64	13 (7.0)	11 (7.1)	2 (6.5)	
≥ 65	4 (2.2)	4 (2.6)	0 (0.0)	
Mean ± SD (age)	35.3 ± 11.1	35.6 ± 11.39	33.9 ± 9.89	0.45*
Marital status				0.26
Single	79 (42.5)	63 (40.6)	16 (51.6)	
Married	107 (57.5)	92 (59.4)	15 (48.4)	
Occupation				0.43
Artisan	12 (6.5)	11 (7.1)	1 (3.2)	
Drivers	29 (15.6)	25 (16.1)	4 (12.9)	
Farmer	31 (16.7)	23 (14.8)	8 (25.8)	
Student	23 (12.4)	17 (11.0)	6 (19.4)	
Trader	59 (31.7)	51 (32.9)	8 (25.8)	
Others	32 (17.2)	28 (18.1)	4 (12.9)	
History of Hypertension				0.07
Yes	4 (2.2)	2 (1.3)	2 (6.5)	
No	182 (97.8)	153(98.7)	29 (93.5)	
Aetiology of trauma				< 0.001
Assault	14 (7.5)	12 (7.7)	2 (6.5)	
Burns	2 (1.1)	0 (0)	2 (6.5)	
Fall from height	2 (1.1)	2 (1.3)	0 (0)	
Gunshot injury	49 (26.3)	45 (29.0)	4 (12.9)	
Machete cut	2 (1.1)	0 (0)	2 (6.5)	
RTA	117 (62.9)	96 (61.9)	21 (67.7)	
Transportation type (in RTA)	(*n* = 117)	(*n* = 97)	(*n* = 20)	0.07
Bus	21 (17.9)	16 (16.7)		
Car	10 (8.5)	5 (5.2)		
Motorcycle	77 (65.8)	66 (68.8)		
Pedestrian	5 (4.3)	5 (5.2)		
Tricycle	2 (1.7)	2 (2.1)		
Truck	2 (1.7)	2 (2.1)		

χ2 = Chi-square test. The P-values were based on the Chi-square test. *= p-value based on the student's t-test.; IQR = interquartile range, **Mann-Whitney U test

Table 2 Comparison of clinical features in patients with and without AKI

Variables	Total 186 (%)	No AKI 159 (%)	AKI 27 (%)	*p*-value
Bruises/abrasions				0.19
No	54(29.0)	49(90.7)	5(9.3)	
Yes	132(71.0)	110(83.3)	22(16.7)	
Fractures				< 0.001
No	128(68.8)	118(92.2)	10(7.8)	
Yes	58(31.2)	41(70.7)	17(29.3)	
Perineum				0.41
No	182(97.8)	155(85.2)	27(14.8)	
Yes	4(2.2)	4(100)	0(0)	
Spinal cord injury				0.33
No	168(90.3)	145(86.3)	23(13.7)	
Yes	18(9.7)	14(77.8)	4(22.2)	
Head injury				0.75
No	98(52.7)	83(84.7)	15(15.3)	
Yes	88(47.3)	76(86.4)	12(13.6)	
Face/Scalp				0.35
No	156(83.9)	135(86.5)	21(13.5)	
Yes	30(16.1)	24(80.0)	6(20.0)	
Others (not listed above)				0.01
No	183(98.4)	158(86.3)	25(13.7)	
Yes	3(1.6)	1(33.3)	2(66.7)	
Multiple sites of injury				0.8
No	101 (54.3)	87 (86.1)	14 (13.9)	
Yes	85 (45.7)	72 (84.7)	13 (15.3)	

P-values were all based on the Chi-square test. SIRS – Systemic Inflammatory Response Syndrome

Discussion

The demographic profile of the research participants was primarily young adult males. This may be related to the most typical cause of trauma in this study being RTA, mostly involving commercial motorcycles, usually driven by young males. The commonest cause of trauma necessitating presentation to the Emergency Unit is RTA. This indicate the need for continual public education on road traffic rules and regulations as well as safe driving of motorcycles and other vehicles. Also, there is a need to strengthen (manpower and equipment) law enforcement agencies to enforce the law against road traffic offenders, and advocate the building and regular maintenance of roads.

The socio-demographic characteristics of trauma patients varies in the literature. Perkins et al. in the United Kingdom (UK) found male preponderance (81.1%), with a median age of 35 years, among adult trauma patients presenting to a UK major trauma centre [5]. In Malawi, Bjornstad et al. reported a median age of 32 years among their study population, and 86.5% of the patients admitted were males. In Tanzania, Muhamedhussein et al. reported that 56.4% of polytrauma patients who presented to their Emergency Department were aged between 26 and 40 years and 92.3% were males [9]. In southwest Nigeria, a retrospective analysis of 1078 patients seen at the Accident and Emergency Unit documented a mean age of 31 years and male predominance of 61.6% [10]. This age group comprises most communities' most active and working segment [10, 11]. The male preponderance may not be due to female underrepresentation alone since females constitute 16.7% of the index study population. However, the male gender is said to be a risk factor for AKI for possible biological

Table 3 Comparison of aetiology of trauma, RTA mode of transportation, and key parameters in patients with and without AKI

Variables	Total 186 (%)	No AKI 159 (%)	AKI 27 (%)	*p*-value
Aetiology of trauma				0.79
Assault	14 (7.5)	12 (85.7)	2 (14.3)	0.98
Burns	2 (1.1)	2 (1.3)	0 (0.0)	-
Fall from height	2 (1.1)	2 (1.3)	0 (0.0)	-
Gunshot injury	49 (26.3)	44 (27.7)	5 (18.5)	0.32
Machete cut	2 (1.1)	2 (1.3)	0 (0.0)	-
RTA	117 (62.9)	97 (61.0)	20 (74.1)	0.19
RTA Mode of transportation	117 (%)	97 (%)	20 (%)	0.50
Bus	21 (17.9)	17 (17.5)	4 (20.0)	0.79
Car	10 (8.5)	7 (7.2)	3 (15.0)	0.26
Motorcycle	77 (65.8)	66 (68.0)	11 (55.0)	0.26
Pedestrian	5 (4.3)	3 (3.1)	2 (10.0)	0.16
Tricycle	2 (1.7)	2 (2.1)	0 (0.0)	-
Truck	2 (1.7)	2 (2.1)	0 (0.0)	-
Pulse rate				< 0.001
Normal	135 (72.6)	128 (80.5)	7 (25.9)	< 0.001
Less than 60	2 (1.1)	2 (1.3)	0 (0.0)	-
More than 100	49 (26.3)	29 (18.2)	20 (74.1)	< 0.001
Blood pressure				0.02
Normal	129 (69.4)	116 (73.0)	13 (48.1)	0.01
Hypertension	46 (24.7)	36 (22.6)	10 (37.0)	0.11
Hypotension	11 (5.9)	7 (4.4)	4 (14.8)	0.03
Haemoglobin status				0.43
Normal	67 (36.0)	61 (38.4)	6 (22.2)	0.11
Mild anaemia	53 (28.5)	44 (27.7)	9 (33.3)	0.55
Moderate anaemia	57 (30.6)	47 (29.6)	10 (37.0)	0.44
Severe anaemia	9 (4.8)	7 (4.4)	2 (7.4)	0.50
Triage outcome				0.14
Delay	9 (4.8)	8 (5.0)	1 (3.7)	
Immediate	129 (69.4)	113 (71.1)	16 (59.3)	
Urgent	48 (25.8)	38 (23.9)	10 (37.0)	
Duration of hospital stay				< 0.001
Less than two weeks	131 (70.4)	128 (80.5)	3 (11.1)	< 0.001
2–4 weeks	31 (16.7)	22 (13.8)	9 (33.3)	< 0.001
30 days/discharge	24 (12.9)	9 (5.7)	15 (55.6)	< 0.001

$\chi 2$ = Chi-square test. *P-values based on Fisher's Exact Test; RTA- Road traffic accident

Table 4 Comparison of treatment modalities given at presentation and incidence of AKI in trauma patients in AEFUTH, Abakaliki

Variables	Total 186 (%)	No AKI 159 (%)	AKI 27 (%)	*p*-value
Infusion				0.27
No	7 (3.8)	7 (100)	0 (0)	
Yes	179 (96.2)	152 (84.9)	27 (15.1)	
CPR				0.56
No	184 (98.9)	157 (85.3)	27 (14.7)	
Yes	2 (1.1)	2 (100)	0 (0)	
Analgesics/antibiotics				0.56
No	2 (1.1)	2 (100)	0 (0)	
Yes	184 (98.9)	157 (85.3)	27 (14.7)	
Blood transfusion				0.04
No	182 (97.8)	157 (86.3)	25 (13.7)	
Yes	4 (2.2)	2 (50.0)	2 (50.0)	
Splint cast				0.02
No	121 (65.1)	109 (90.1)	12 (9.9)	
Yes	65 (34.9)	50 (76.9)	15 (23.1)	
Antiseizure medications				0.39
No	178 (95.7)	153 (86.0)	25 (14)	
Yes	8 (4.3)	6 (75.0)	2 (25)	
Wound suturing				0.16
No	31 (16.7)	29 (93.5)	2 (6.5)	
Yes	155 (83.3)	130 (83.9)	25 (16.1)	
Chest tube insertion				0.56
No	184 (98.9)	157 (85.3)	27 (14.7)	
Yes	2 (1.1)	2 (100)	0 (0)	
Neck collar applied				0.98
No	172 (92.5)	147 (85.5)	25 (14.5)	
Yes	14 (7.5)	12 (85.7)	2 (14.3)	
NG tube insertion				0.18
No	180 (96.8)	155 (86.1)	25 (13.9)	
Yes	6 (3.2)	4 (66.7)	2 (33.3)	
Management of AKI				
Supportive treatment				< 0.001
No	161 (86.6)	159 (98.8)	2 (1.2)	
Yes	25 (13.4)	0 (0.0)	25 (100.0)	
Renal replacement therapy				0.001
No	184 (98.9)	159 (86.4)	25 (13.6)	
Yes	2 (1.1)	0 (0.0)	2 (100.0)	

P-values were all based on the Chi-square test. CPR – Cardiopulmonary resuscitation, NG – Nasogastric

or environmental reasons [12, 13]. Males are more active physically, more prone to risk-taking and perceived to have less health-seeking behaviour than females [14, 15]. Males have higher mortality rates irrespective of age, but females do worse in disease severity, disability and other health outcomes [14].

The incidence of AKI following trauma in this study was 14.5%, which is similar to findings in other studies. Bjornstad et al. reported an incidence of 14.4% (32/223) developed AKI among patients [8]. In Egypt, a study of 105 adult polytrauma patients admitted into an

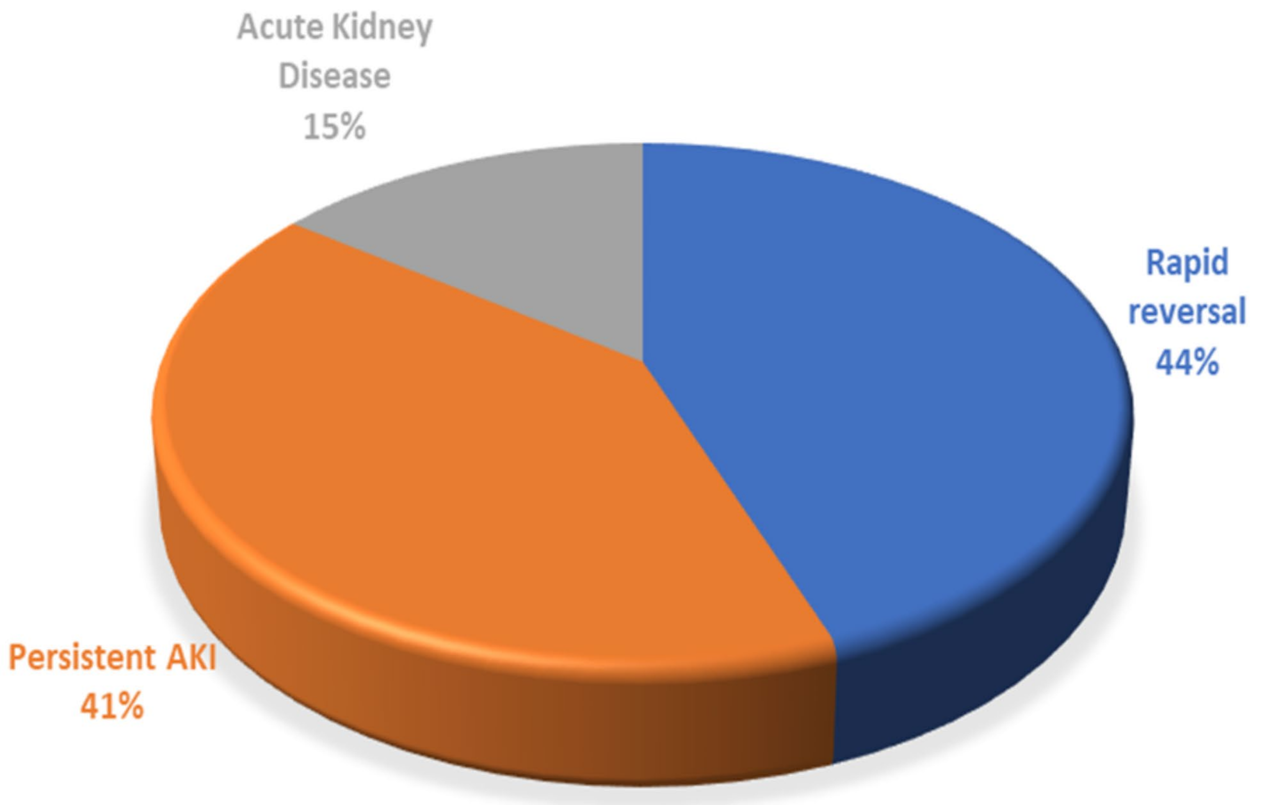

Fig. 2 Overall secondary outcome of trauma patients who developed AKI that presented to AEFUTH, Abakaliki, Nigeria

Emergency ICU showed an incidence of AKI up to 50.5%, and a retrospective study of 633 trauma patients in South Africa revealed an overall AKI incidence of 15% [16, 17]. In Nigeria, a study of 204 patients by Okunola et al. in an intensive care unit, some from trauma-related causes, showed that 40 (19.6%) of the 204 patients managed during the period had acute renal failure [18].

In this study, 58 of the trauma patients had different types of fractures, with 17 developing AKI. This finding was statistically significant and an independent predictor of AKI following multivariate regression analysis. Fractures from trauma have a myriad of clinical consequences, including AKI. The incidence of AKI varies with the type and location of the fracture [19]. Although this study did not classify the fractures according to type, for instance, Porter et al. in the UK reported an AKI incidence of 24% following hip fracture from trauma [19]. Buchele et al. in Germany found trauma-related AKI occurred in 6.1% of patients with femoral fractures [20]. Clinical outcomes also vary with fractures occurring in the same anatomical region. For example, persons with femoral neck fractures rarely face significant blood loss, whereas femoral shaft fractures can result in life-threatening haemorrhagic shock [19, 20]. Also, patients who developed trauma-related AKI complicated by fractures had more prolonged waiting times till surgery, longer time for fractures to heal or unite, and overall increased length of hospital stay [19, 20]. Future studies in our setting need to investigate the relationship between the incidence AKI and fracture types and location.

The occurrence of AKI among trauma patients was independently associated with longer duration of hospital stay. In this study, patients who stayed longer on admission likely had more severe injuries, which increased their likelihood of having AKI and the need for additional care during follow-up, necessitating a longer duration of hospital stay. Similarly, Perkins et al. reported in their study that trauma patients with AKI who were older, with

Table 5 Multivariable logistic regression of factors associated with AKI among trauma patients seen at AEFUTH, Abakaliki

Variables	AKI	Crude OR (95% C. I.)	Adjusted OR (95% C. I.)	Adjusted *p*-value
Blood transfusion				
No	25 (13.7)	1	1	
Yes	2 (50.0)	6.28 (1.08–46.63)	1.51 (0.12–20.99)	0.71
BP Classification				
Normal	13 (10.1)	1	1	
Hypertension	10 (22.2)	2.55 (1.03–6.31)	1.20 (0.33–3.76)	0.91
Hypotension	4 (36.4)	5.10 (1.31–19.78)	3.53 (0.48–11.20)	0.38
Duration of hospital stay				
Less than two weeks	3 (2.3)	1	1	
2 to 4 weeks	9 (29.0)	6.08 (2.22–13.45)	10.37 (6.97–18.42)	< 0.001
More than four weeks	15 (62.5)	14.02 (4.34–26.81)	19.84 (7.23–29.22)	< 0.001
Fractures				
No	10 (7.8)	1	1	
Yes	17 (29.3)	4.90 (2.07–11.54)	7.46 (1.26–55.01)	0.04
Triage Outcome				
Delay	1 (11.1)	1	1	
Immediate	16 (12.4)	1.13 (0.13–9.67)	2.31 (0.19–26.56)	0.56
Urgent	10 (20.8)	2.11 (0.24–18.86)	3.71 (0.29–24.35)	0.45

OR = odds ratio, C.I = confidence interval, BP = Blood pressure, SIRS = Systemic Inflammatory Response Syndrome

higher comorbidity index, more severe injuries, and more significant physiological derangement, required more critical care and extended hospital stays [5]. Wenjun et al., Zyada et al., and Bjornstad et al. reported a more extended median hospitalisation in those who developed AKI when compared to those who did not [8, 17, 21].

Patients were followed up for 30 days, and this study had no in-hospital mortality. The mortality outcome of this index study differs from the findings reported by other studies, probably resulting from differences in the patient population studied. In this study, most of the patients presented with less severe trauma, and those who developed AKI responded well to supportive therapy.

Perkins et al. found a mortality rate of 26.4% among trauma patients who developed AKI in a United Kingdom major trauma centre [5]. Al-Thani et al. reported an in-hospital mortality of 65% among trauma patients that developed AKI compared to 3.2% among non-AKI trauma patients [22]. Podoll et al. found 30-day mortality of 29.6% among critically ill trauma patients with AKI compared to a mortality rate of 9.2% for the entire cohort [23]. It is reported that AKI survivors are at increased risk for chronic kidney disease (CKD) and late death. (24–25)

Follow-up in this study was done for 30 days (short term); a longer duration of follow-up may have revealed whether the lone patient receiving kidney replacement therapy at the time the study ended recovered or progressed to CKD.

This study had some limitations. It was a hospital-based cohort study; thus, the risk factors identified did not mean causation, and it did not account for the community incidence of AKI following trauma. Secondly, we found that the occurrence of fracture was a risk factor for AKI. However, we did not differentiate the types of fracture according to the site of body involved. Given the findings of the study, future studies will benefit from further description of the anatomical locations of the fractures associated with AKI. There was no standardised treatment protocol used for managing all trauma patients, and the incidence of AKI in this study may have been underestimated due to the exclusion of patients who were discharged or died within 24 h of presentation.

Conclusion

About one-seventh of trauma patients presenting to the emergency unit of AEFUTH, Abakaliki, developed AKI, and the predictors for the development of AKI were traumatic injuries complicated by fracture and prolonged duration of hospital stay. There was no in-hospital mortality. Prompt and appropriate management of the AKI ensured that only one AKI patient still required KRT at the end of the follow-up period; trauma patients presenting with fractures need to be closely monitored for the occurrence of AKI.

Abbreviations

AKI	Acute kidney injury
AEFUTHA	Alex Ekwueme Federal University Teaching Hospital Abakaliki
AKD	Acute Kidney Disease
CKD	Chronic Kidney Disease
Hb	Haemoglobin
ICU	Intensive Care Unit
KDIGO	Kidney Disease Improving Global Outcomes
KRT	Kidney Replacement Therapy
RTS	Revised Trauma Score
SCr	Serum Creatinine

UK	United Kingdom
UO	Urine Output
WBC	White Blood Cell

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12882-025-04062-x.

Supplementary Material 1

Acknowledgements
We are deeply grateful to the Management and staff of Alex Ekwueme Federal University Teaching Hospital Abakaliki, Ebonyi State, Nigeria for their invaluable support and generous permission to collect data at Accident and Emergency Unit of the hospital.

Author contributions
COU and IIU conceptualised and designed the study with input from MUN, OFA, OJN, ACA, CO, CI, and NAI. Data analysis and interpretation was conducted by COU, IIU, CO, MUN and NAI with input from OFA, OJN, ACA, and CO. All authors provided input into the writing and editing of the manuscript. All authors read and approved the final manuscript.

Funding
This research was funded by the researchers, there was no external funding or grant received for this study.

Data availability
Due to privacy issues, the dataset used and/or analyzed for this current study is available from the corresponding author upon reasonable request. This manuscript is part of the Fellowship Dissertation project of the first author (COU) submitted to the West African College of Physicians, Abuja, Nigeria.

Declarations

Ethics approval and consent to participate
This study was carried out in accordance with the Declaration of Helsinki; and the Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital Abakaliki, Ebonyi State, Nigeria granted approval for the study (Ref: REC Approval Number: 12/10/2021–01/12/2021). All study participants gave a signed and written informed consent before enrolment into the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 3 July 2024 / Accepted: 7 March 2025
Published online: 13 March 2025

References

1. Sushrut SW, Joseph VB. Acute Kidney Injury. In Kasper DL, Fauci AS, Hauser SL, Jameson JL, Longo DL, editors. Harrison's principles of internal medicine. 19th ed. McGraw-Hill Education. 2015:1799–1811.
2. Kidney Disease: Improving Global Outcomes (KDIGO), Acute Kidney Injury Work Group. KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl. 2012;2:1–138.
3. Chawla LS, Bellomo R, Bihorac A, Goldstein SL, Siew ED, Bagshaw SM, et al. Acute kidney disease and renal recovery: consensus report of the acute disease quality initiative (ADQI) 16 workgroup. Nat Rev Nephrol. 2017;13(4):241–57.
4. Cerdá J, Bagga A, Kher V, Chakravarthi RM. The contrasting characteristics of acute kidney injury in developed and developing countries. Nat Clin Pract Nephrol. 2008;4(3):138–53.
5. Perkins ZB, Captur G, Bird R, Gleeson L, Singer B, O'Brien B. Trauma-induced acute kidney injury. PLoS ONE. 2019;14(1):e0211001.
6. Dumovich J, Singh P. Physiology, trauma. In: StatPearls. StatPearls Publishing; 2022 [cited 2022 Oct 3]. https://www.ncbi.nlm.nih.gov/books/NBK538478/
7. Onyemeachi N, Ofoma UR. The public health threat of road traffic accidents in Nigeria: a call to action. Ann Med Health Sci Res. 2016;6(4):199–204.
8. Bjornstad EC, Smith ZH, Muronya W, Munthali CK, Mottl AK, Marshall SW, Golightly YM, Gibson K, Charles A, Gower EW. High risk of acute kidney injury in Malawian trauma patients: a prospective observational cohort study. BMC Nephrol. 2021;22(1):1–10.
9. Muhamedhussein MS, Manji M, Nungu KS, Ruggajo P, Khalid K. Prevalence and risk factors of acute kidney injury in polytrauma patients at muhimbili orthopedic institute, Tanzania. Afr J Emerg Med. 2021;11(1):74–8.
10. Thanni LOA, Kehinde OA. Trauma at a Nigerian teaching hospital: pattern and documentation of presentation. Afr Health Sci. 2006;6(2):104–7.
11. Yadollahi M. A study of mortality risk factors among trauma referrals to a trauma centre, Shiraz, Iran, 2017. Chin J Traumatol. 2019;22(4):212–8.
12. Kahindo CK, Mukuku O, Wembonyama SO, Tsongo ZK. Prevalence and factors associated with acute kidney injury in sub-Saharan African adults: a review of the current literature. Int J Nephrol. 2022;15:5621665.
13. Aylward RE, Pazi S, Niekerk M, Ensor J, Baker D. Risk factors and outcomes of acute kidney injury in South African critically ill adults: a prospective cohort study. BMC Nephrol. 2019;20(1):1–11.
14. Morrow EH. The evolution of sex differences in disease. Biol Sex Differ. 2015;6:1–7.
15. Kim Y, Park I, Kang S. Age and gender differences in health risk perception. Cent Eur J Public Health. 2018;26(1):54–9.
16. Skinner DL, Hardcastle TC, Rodseth RN, Muckart DJ. The incidence and outcomes of acute kidney injury amongst patients admitted to a level I trauma unit. Injury. 2014;45(1):259–64.
17. Zyada AMA, Mohammed HAK, Salah AAE. Incidence and risk factors of acute kidney injury in trauma patients in Zagazig university hospital. Res Opin Anesth Intensive Care. 2019;6(1):95–107.
18. Okunola OO, Arogundade FA, Sanusi AA, Akinsola A. Acute renal failure in the intensive care unit: aetiological and predisposing factors and outcome. West Afr J Med. 2009;28(4):240–4.
19. Büchele G, Rehm M, Halbgebauer R, Rothenbacher D, Huber-Lang M. Trauma-related acute kidney injury during inpatient care of femoral fractures increases the risk of mortality: a claims data analysis. Am J Med Open. 2022;8:100009.
20. Porter CJ, Moppett IK, Juurlink I, Nightingale J, Moran CG, Devonald MAJ. Acute and chronic kidney disease in elderly patients with hip fracture: prevalence, risk factors and outcome with development and validation of a risk prediction model for acute kidney injury. BMC Nephrol. 2017;18(1):1–11.
21. Shijun LI, Wenjun TW. Trauma-related acute kidney injury. Chin J Nephrol Dialysis Kidney Transpl. 2021;5(30):491–6.
22. Al-Thani H, Ramzee AF, Asim M, El-Menyar A. Predisposing factors and outcome of acute kidney injury after blunt trauma: a 10-year study. J Surg Res. 2023;284:193–203.
23. Podoll AS, Kozar R, Holcomb JB, Finkel KW. Incidence and outcome of early acute kidney injury in critically ill trauma patients. PLoS ONE. 2013;8(10):e77376.
24. Lai WH, Rau CS, Wu SC, Chen YC, Kuo PJ, Hsu SY, Hsieh CH, Hsieh HY. Post-traumatic acute kidney injury: a cross-sectional study of trauma patients. Scand J Trauma Resusc Emerg Med. 2016;24(1):1–7.
25. Kashiouris M, Plataki M, Kor DJ, Gajic O, Casey ET. Risk factors for development of acute kidney injury in critically ill patients: a systematic review and meta-analysis of observational studies. Crit Care Res Pract. 2012;2012:691013.

Publisher's note