International Journal of Biomedical Research
ISSN: 0976-9633 (Online); 2455-0566 (Print)
Journal DOI: https://doi.org/10.7439/ijbr
CODEN: IJBRFA

Original Research Article

Severe acute kidney injury among children in a tertiary health facility in North-Western Nigeria: Clinical profile and outcome

Fatima Bello Jiya* and Paul Kehinde Ibitoye

Department of Paediatrics, Usmanu Danfodiyo University Sokoto / Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

Abstract

Objectives: To determine the profile of children with severe acute kidney injury (AKI) at the point of admission into Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, the demographic factors associated with AKI severity, the outcome of cases, and factors associated with hospital mortality.
Methods: A 2-year prospective cross-sectional survey of children aged one month to 14 years admitted into Emergency Paediatric Unit (EPU) of UDUTH Sokoto with the diagnosis of severe (stage 3) AKI as defined by Kidney disease improving global outcome (KDIGO).
Results: Forty- four (1.4%) of the 3,050 children had severe AKI. They were 29(65.9%) males and 15(34.1%) females. Mean age at presentation was 3.61±2.1 years. Twenty- seven (61.4%) were from a low socio-economic family status and both parents had no formal education in 33 (75.0%) of the cases. Majority 33(75.0%) of them presented late (more than 72 hours of onset of illness) to EPU. The commonest features were fever 34(77.3%), and oliguria or anuria 33(75.0%). The commonest abnormal electrolytes were metabolic acidosis 42(95.5%), and Hyponatraemia 28(63.6%). Sepsis was the commonest 13(29.5%) cause of severe AKI. Twenty seven (61.4%) were discharged, 15(34.1%) died, 2(4.5%) left against medical advice. Mortality was associated with late presentation, diagnosis of sepsis, fluid overload, bleeding diasthesis, severe hyperkalaemia, and requirement for dialysis.
Conclusion: The commonest cause of severe AKI was sepsis and mortality from severe AKI was high.
Keywords: Severe acute kidney injury, children, Sokoto, profile, mortality factors.

***Correspondence Info:**
Dr. Fatima Bello Nma Jiya
Department of Paediatrics,
Usmanu Danfodiyo University Sokoto, Nigeria
Phone: 08033224608

***Article History:**
Received: 12/10/2020
Revised: 09/12/2020
Accepted: 10/12/2020
DOI: https://doi.org/10.7439/ijbr.v11i12.5524

QR Code

How to cite: Jiya F. B. and Ibitoye P. K. Severe acute kidney injury among children in a tertiary health facility in North-Western Nigeria: Clinical profile and outcome. *International Journal of Biomedical Research* 2020; 11(12): e5524. DOI: 10.7439/ijbr.v11i12.5524 Available from: https://ssjournals.com/index.php/ijbr/article/view/5524

1. Introduction

Acute kidney injury (AKI) is a medical emergency with the potential of a devastating outcome in affected individuals, if not detected and treated early. Attempts have been made over the years to harmonize the definition of AKI in order to aid early identification and prompt management of attending complications [1]. One of such efforts is by the Kidney disease improving global outcome (KDIGO) with a criteria, which defined AKI as any of the following: increase in serum creatinine (SCr) by ≥0.3 mg/dl (≥26.5 µmol/l) within 48 hours; or increase in SCr to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or urine volume <0.5 ml/kg/hour for 6 hours. According to KDIGO criteria for severity staging, severe AKI refers to 3.0 times baseline SCr or increase in SCr to ≥4.0 mg/dl; or initiation of renal replacement therapy; or in patients < 18 years old, a decrease in estimated glomerular filtration rate (eGFR) to <35 ml/min per 1.73 m^2; or urine output <0.3ml/kg/hour for ≥ 24hours or anuria for ≥12 hours [2].

Severe AKI has been reported as the commonest form of AKI in less well resource countries [3-6]. Factors such as lack of basic social amenities, lack of skills in the detection of earlier forms of AKI at community level, late presentation, dearth of trained health personnel, inadequate facilities and technologies for intervention, as well as lack of social insurance schemes dedicated to kidney diseases have been attributed to the trend and outcome of AKI in these regions [7-10]. Mortality from AKI is more often related to the severity of the disease and the underlying

predisposing aetiology [4,5,11], worse so in the setting of constrained resources where other competing needs exist. For better outcomes in the management of AKI to be achieved, efforts towards early identification of risk factors and less severe forms of AKI with a view of prompt and adequate intervention is paramount, to prevent a more likely devastating outcome if allowed to deteriorate to the late stage and severe form of AKI [5,9].

There appeared to be an increase in the cases of AKI in the study location, with the affected children presenting more with features suggestive of severe form of AKI. The focus on children with severe AKI at presentation in EPU of UDUTH became imperative because unfortunately, they represent the cases in which the earlier stages were un-recognized at home or were misdiagnosed at other primary or secondary health facilities before presentation to UDUTH. Although already at high risk of complications and mortality, the risk becomes even higher when such cases are missed at presentation in a tertiary health facility with human resources considered competent enough to intervene promptly and adequately. Our objectives were to determine the clinical pattern and the electrolyte profile of children with severe AKI at the point of admission into the EPU of UDUTH Sokoto, to determine the demographic factors associated with AKI severity, the outcome of cases, and the factors associated with hospital mortality. We sought to use the information generated from this study as a guide in recognizing the features of severity in AKI cases, and to emphasize the promptness that is needed in the adequate management of identified cases in the study location and possibly beyond.

2. Material and Methods

2.1 Study Area:

The study was conducted at the EPU of the Department of Paediatrics, UDUTH Sokoto. The hospital is a tertiary health facility located in Sokoto, the Capital of Sokoto State, North – Western Nigeria. The hospital receives patients referred from Sokoto, Kebbi, Zamfara, Niger and Katsina States of Nigeria and neigbhouring Niger and Benin Republics. The EPU of UDUTH is a 25 bedded unit designed to admit emergency medical conditions occurring in children aged 1 month to less than15 years, with an average annual admission rate of 1,500 patients. Critically ill children are also often admitted into the EPU because of limited bed space and child friendly lifesaving equipment in the intensive care unit (ICU) of UDUTH, in addition to the inability of the caregivers to afford the cost of care in the ICU setting. Children with clinical and/or laboratory features suggestive of renal diseases are often managed by the Paediatric Nephrology Unit of the Department of Paediatrics, UDUTH Sokoto.

2.2 Study design and subjects

The study was a prospective cross-sectional survey of children with the diagnosis of AKI consecutively admitted into EPU of the department of Paediatrics UDUTH, over a 2- year period from December 2017 to November 2019. The inclusion criteria for subjects were age 1 month to 14 years, informed written consent from the caregiver and assent from children aged above 7 years, and the presence of severe (stage 3) AKI as defined by KDIGO [2]. Severity staging of AKI was based on KDIGO staging but for the purpose of this study, only serum creatinine was used to stage severity as there was no adequate information on the urine output of the patients at the point of admission into the EPU of UDUTH. Serum creatinine was measured using the modified Jaffe method and the Glomerular filtration rate was estimated using the Schwartz formula [12].Children with stages 1 and 2 AKI, and those with chronic kidney disease as defined by National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines for Chronic Kidney Disease In Children and Adolescents[13], were excluded from the study. Presentation to the hospital after 72 hours of onset of illness was considered as late presentation in this study.

2.3 Data collection

Subjects that satisfied the inclusion criteria were recruited into the study. Designed pretested questionnaires were used to document information obtained from the subjects and or caregivers which included; age, gender, address, ethnicity and socio-economic status was determined using Oyedeji classification [14] in which there is a scale for scoring the level of education and occupation of caregiver and the mean of the scores to the nearest whole number gives the socio-economic class assigned to the child. A score of one and two, three, and four and five represents high, middle, and low socioeconomic classes respectively. Other information sought were history suggestive of kidney pathology such as reduction in urine output, non-passage of urine, frequency, urgency, hesitancy, pain while passing urine, change in colour of urine, passage of blood in urine, facial or generalized body swelling, and nonspecific features of systemic diseases like fever, vomiting, passage of loose stools, malaise, myalgia, arthralgia, arthritis, skin changes, headache, convulsion, loss of consciousness as well as histories of medications, surgical intervention and previous renal disease. Physical examination (general and systemic) of the subjects was carried out and urine output in ml/kg/hour was noted. Relevant laboratory work up included serum electrolytes, urea and creatinine, urinalysis and urine microscopy and culture in children making urine, spot urine protein creatinine ratio, serum uric acid, complete blood count, peripheral blood film, serum proteins and albumin, serum calcium, magnesium and phosphate and renal ultrasound scan. Other investigations included screening for endemic diseases such as thin or thick blood film for malaria

parasite, hepatitis B and C serology, screening for Human Immunodeficiency Virus (HIV), antistreptolysin O titre and haemoglobin electrophoresis as indicated. The underlying identifiable disease conditions causing AKI among the subjects were treated in addition to conservative management of complications such as fluid retention, hyperkalaemia, hyponatraemia, metabolic acidosis, uraemia, hypertension and anaemia. The indications for dialysis in this study were complications that were refractory to conservative treatment which included severe fluid overload manifesting as uncontrolled hypertension, pulmonary oedema or congestive cardiac failure, severe hyperkalaemia (K^+ > 6.5mmol/l or > 5.5- 6.5mmol/l with ECG changes), hyponatraemia (Na^+ < 120mmol/l), severe metabolic acidosis with bicarbonate < 12mmol/l and persistent features of uraemia such as seizures, bleeding diasthesis, altered sensorium and abnormal behaviour [15]. Subjects were monitored continuously by re-assessing their clinical features and laboratory parameters, with adjustments of treatment plans made as necessary. The duration of hospital stay was also noted. Subjects that were discharged were subsequently followed up at the Paediatric Nephrology clinic of UDUTH at intervals and were re-evaluated after 3 months of initial diagnosis, to determine if they had no kidney disease or have progressed to chronic kidney disease.

2.4 Ethics statement:

Ethical approval for the study was sought and obtained from the Health Research and Ethics Committee of UDUTH Sokoto before the commencement of the study. Written informed consent was obtained from the parents or caregivers of the children and assent was sought from children of sufficient age. The data obtained were treated with utmost confidentiality.

2.5 Data analysis

Statistical package for social sciences (SPSS) version 23.0 was used to analyze the data. Data entered was carefully checked to eliminate multiple or wrong entries and outliers. The prevalence of AKI was presented as percentage while the age distribution of the subjects was analyzed and expressed as mean and standard deviation. Frequency distribution tables and chart were used to illustrate results. Chi square test was used to determine the association between two categorical variables and Fischer's exact test was used as applicable. The level of statistical significance was set at 5%, which is p-value < 0.05.

3. Results

3.1 Demographics of children studied

Forty- four (1.4%) out of the 3,050 children admitted during the study period were diagnosed of severe AKI, giving a prevalence of severe AKI of 14.4 cases per 1000 children. They comprised of 29(65.9%) males and 15(34.1%) females with M:F ratio of 1.9:1. Their ages ranged between 3 months and 14 years with mean age at presentation of 3.61±2.1 years. Majority (40.9%) of the patients were 5-10 years of age. Twenty- seven (61.4%) of the children were from a low socio-economic family status and both parents had no formal education in 33 (75.0%) of the cases (Table I).

Table I: Socio-demographic profile of studied subjects

Socio-demographic characteristics	Frequency (%)
Age range (years)	
< 5	15 (34.1)
5-10	18 (40.9)
>10	11 (25.0)
Mean (SD)	3.61±2.1
Gender	
Male	29 (65.9)
Female	15 (34.1)
Social status	
High	05 (11.3)
Middle	12 (27.3)
Low	27 (61.4)
Parent's educational status	
Mother	
Yes	15 (34.1)
No	29 (65.9)
Father	
Yes	23 (52.3)
No	21 (47.7)
Both parents	
Yes	11 (25.0)
no	33 (75.0)

3.2 Clinical and electrolyte profile of studied subjects

Majority 33(75.0%) of the patients had symptoms for more than 72 hours and were managed at home or in a primary health facility before presentation to EPU of UDUTH. Late presentation was significantly (p=0.03) commoner among children of uneducated mothers (Table II). The commonest clinical features at presentation were fever 34(77.3%), oliguria or anuria 33(75.0%), vomiting 26(59.1%), body swelling 19(43.2%), diarrhea 16(36.4%) convulsion 14(31.8%), and loss of consciousness 11(25.0%). Hypertension was present in 18(40.9%) of the children. All patients had eGFR of <35mls/min/1.73m² with 32(72.7%) of them having eGFR of <15mls/min/1.73m². The commonest electrolyte derangements were metabolic acidosis in 42(95.5%), Hyponatraemia in 28(63.6%), and hyperkalemia in 9(20.5%) of the patients. Twelve (27.3%) and 3(6.8%) patients had severe metabolic acidosis and hyperkalaemia respectively (Table III). The average duration of hospital admission was 14 days with a range of 1-31 days.

Table II: Relationship between Demographics and late presentation.

Factors	Chi square (X^2) test or Fischer's Exact test	p-value
Age	8.20	0.22
Gender	0.30	0.44
Socio-economic status	1.60	0.43
Mother's educational status	**0.30**	**0.03**
Father's educational status	0.30	0.50

Table III: Clinical and serum electrolyte pattern of study participants.

Characteristics	Frequency (%)
Clinical features*	
Fever	34 (77.3)
Oliguria/ anuria	33 (75.0)
Body swelling	19 (43.2)
Vomiting	26 (59.1)
Diarrhoea	16 (36.4)
Headache	07 (15.9)
Convulsion	14 (31.8)
Loss of consciousness	11 (25.0)
Cough	09 (20.5)
Difficulty in breathing	09 (20.5)
Bleeding †	08 (18.2)
Pain**	07 (15.9)
Anorexia	04 (9.1)
Irrational behaviour	03 (6.8)
Hypertension	18 (40.9)
eGFR< 15mls/min/1.73m²	44 (100.0)
eGFR< 15mls/min/1.73m²Pallor	32 (72.7)
Pallor	06 (13.6)
Serum electrolyte profile ***	
Sodium: Range (135-149mmo/l)	
Normal	12 (27.3)
Hyponatremia	28 (63.6)
Hypernatremia	04 (09.1)
Potassium: Range (3.5-5.2mmol/l)	
Normal	27 (61.4)
Hypokalaemia	08 (20.5)
Hyperkalaemia	09 (18.2)
Chloride: Range (96-106mmol/l)	
Normal	12 (27.3)
Hypochloraemia	28 (63.6)
Hyperchloraemia	04 (09.1)
Bicarbonate: Range (21-31mmol/l)	
Normal	02 (04.5)
Acidosis	42 (95.5)
Severe acidosis (Bicarbonate < 12mmol/l)	12 (27.3)
Alkalosis	00 (00.0)

Key:

* Participants had more than one clinical features

† Bleeding in form of haematuria, epistaxis, and haematemesis

** Pain in form of dysuria, myalgia, and arthralgia

***Participants had more than one electrolyte pattern

3.3 Disease conditions causing severe Acute Kidney Injury

The most common causes of severe AKI (figure I) were sepsis 13(29.5%), acute glomerulonephritis 7(15.9%), acute pyelonephritis 7(15.9%), and malaria 5(11.4%). Sepsis as a cause of severe AKI was commoner 8(61.5%) among children below 5 years of age while all 7(100%) cases of acute glomerulonephritis and 6(85.7%) of acute pyelonephritis were aged 5 years and above. There was no age predilection in the occurrence of severe AKI from malaria.

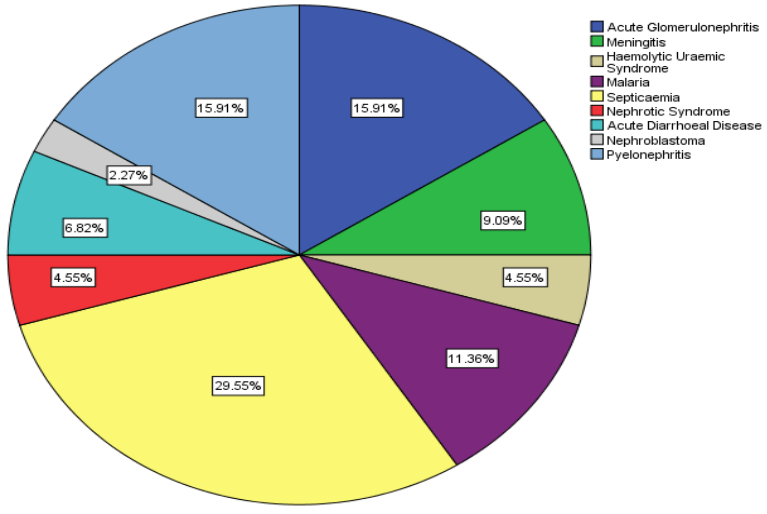

Figure 1: Disease conditions causing Severe Acute Kidney Injury.

3.4 Outcome of cases and factors associated with mortality

Of the 44 patients with severe AKI, 27(61.4%) were discharged, 15(34.1%) died, and 2(4.5%) left with their parents against medical advice. Though not significant (p=0.49), mortality was highest among those aged > 5 years 12(80%) compared to children aged below 5 years 3(20%). Mortality was also highest among children with the diagnosis of sepsis 8(53.3%) and lowest among those with malaria 1(6.7%). None of those diagnosed with acute pyelonephritis succumbed to severe AKI. The commonest factors associated with hospital mortality (Table IV) were late presentation (p=0.01), symptoms of persistent fever (p=0.04), and breathlessness (p=0.02), aetiologic diagnosis of sepsis (p=0.03), fluid overload (p=0.03), bleeding diasthesis (p=0.02), severe hyperkalaemia (p=0.05), and requirement for dialysis (p=0.01).

Table IV: Factors associated with Mortality

Characteristics	Chi square (X^2) test or Fischer's Exact test	p-value
Age (<5 years or ≥ 5 years)	5.47	0.49
Gender	0.35	0.55
Social status	0.62	0.73
Late presentation	**7.59**	**0.01**
Fever	**3.87**	**0.04**
Vomiting	0.31	0.40
Body swelling	2.62	0.10
Breathlessness	**5.34**	**0.02**
Anuria	0.91	0.26
Oliguria	0.84	0.29
Unconsciousness	2.73	0.09
Pallor	0.78	0.32
Diagnosis of Sepsis	**16.90**	**0.03**
Severe hyponatraemia (Na+ <125mmo/l)	1.14	0.57
Severe acidosis (HCO_3 < 12mmol/l)	2.53	0.10
Severe Hyperkalaemia (K+ > 6.5mmol/l)	**5.99**	**0.05**
Anaemia (Haematocrit< 21%)	3.28	0.07
White blood cell count > 15,000mm^3		
Bleeding diasthesis	**5.29**	**0.02**
Fluid overload	**5.34**	**0.03**
Requirement for Dialysis	**12.30**	**0.01**

3.5 Follow up at three months post discharge

Of the 27 cases of severe AKI that were discharged, 18 (66.7%) had no clinical or laboratory evidence of kidney disease based on the normal findings on general and systemic physical examination, urinalysis, serum creatinine, estimated GFR, and abdominal ultrasound sonograms. Seven patients (25.9%) were lost to follow up visits and 2 (7.4%), (one case each of nephrotic syndrome and pyelonephritis) developed features of chronic kidney disease stage II as defined by KDOQI clinical practice guidelines [13].

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