Original Article

Community-Acquired Acute Kidney Injury in Critically Ill Children as Seen in the Emergency Unit of a Tertiary Hospital in Enugu, Southeast Nigeria

CC Obichukwu, OI Odetunde[1], JM Chinawa[1], HU Okafor[1], DK Adiele[1], BC Ibe[1]

Department of Paediatrics, Enugu State University Teaching Hospital, [1]Paediatric Nephrology Unit, Department of Paediatrics, College of Medicine, University of Nigeria/University of Nigeria Teaching Hospital, Enugu, Nigeria

Date of Acceptance:
10-Jan-2017

Abstract

Background: Acute kidney injury (AKI) has been shown to be common in critically ill patients with associated very poor outcome. There is paucity of data regarding its epidemiology, particularly in developing countries. This study aims to assess the presence of AKI among critically ill children to determine its prevalence, outcome, and outcome determinants in children suffering from AKI. **Patients and Methods:** This is a cross-sectional observational study of critically ill children admitted to the children emergency unit of University of Nigeria Teaching Hospital, Ituku Ozalla, Enugu. Critically ill children suffering from AKI were identified and classified using the pediatric RIFLE criteria. **Result:** A total of 300 children were studied. One hundred and eighty (60%) were males. The prevalence of AKI in the study population was 56%. Factors associated with AKI included age <5 years (OR = 3.618; 95% CI = 2.100–6.235; $P < 0.001$), inability to drink (OR = 2.866; 95% CI = 1.723-4.766; $P < 0.001$), tachycardia (OR = 2.111; 95% CI = 1.071-4.163; $P = 0.031$), unconsciousness (OR = 3.128, 95% CI = 1.303-7.511; $P = 0.011$), and hypotension (OR = 2.619; 95% CI = 1.008–6.804; $P = 0.048$). The odds of death increased with increasing severity of AKI among those who had pRIFLE-F, who were 24 times more likely to die than those with no AKI (OR = 24.38; 95% CI = 5.702-104.194; $P = 0.001$). **Conclusion:** The prevalence of AKI in the study population was unacceptably high. The risk factors to its occurrence can be determined from epidemiologic and clinical data, and therefore, clinicians attending to critically ill patients should identify those with AKI for early intervention to reduce the expected poor outcomes associated with its occurrence.

Keywords: *Acute kidney injury, critically ill children, Nigeria*

Introduction

Acute kidney injury (AKI) is a common phenomenon in critically ill patients, especially among those admitted to the intensive care unit.[1-3] The prevalence of AKI in critically ill children varies considerably from developed to developing countries, with seemingly higher incidence in developed compared to developing countries.[4] Community-acquired AKI is often caused by specific conditions (e.g., gastroenteritis, infections, nephrotoxins) in developing countries.[5] In contrast, hospital-acquired AKI is more common in developed countries and urban areas of some developing countries.[6,7]

There is paucity of data regarding the prevalence of AKI among children in the developing countries and worse still in critically ill population.[4] Available data has showed the prevalence of 30.6% in Brazil,[7] and 30.7-82.9% in Nigeria.[8,9]

The factors contributing to this varying prevalence include lack of data in most developing countries, along with the fact that most studies did not define AKI based on the current proposed definition and classification systems.[4] Even after the proposed definition and classification systems for AKI were published, lack of uniformity regarding definition makes it difficult to

Access this article online

Quick Response Code:

Website: www.njcponline.com

DOI: 10.4103/njcp.njcp_293_16

Address for correspondence: Dr. OI Odetunde, Paediatric Nephrology Unit, Department of Paediatrics, College of Medicine, University of Nigeria/University of Nigeria Teaching Hospital, Enugu, Nigeria.
E-mail: odetoyintola@yahoo.co.uk

How to cite this article: Obichukwu CC, Odetunde OI, Chinawa JM, Okafor HU, Adiele DK, Ibe BC. Community-Acquired acute kidney injury in critically Ill children as seen in the emergency unit of a tertiary hospital in Enugu, Southeast Nigeria. Niger J Clin Pract 2017;20:746-53.

establish the true incidence of the condition, to compare studies on AKI, especially in critically ill patients, and to draw conclusions based on them.[10]

Critically ill children are at an increased risk of renal hypoperfusion, hypoxic–ischemic renal injury, severe infections, and exposure to various nephrotoxins including drugs. Moreover, AKI in severely ill patients has been shown to be associated with increased morbidity and mortality.[1-3]

Identifying a critically ill child with risk factors of developing AKI at presentation to the emergency room is a major challenge facing clinicians and healthcare personnel, especially in resource poor settings.

Several studies in both the developed and developing countries have documented poor outcomes in critically ill patients with AKI, in whom the risk of mortality increases quite significantly with increasing severity of kidney injury.[6]

In our emergency room setting, it is not a common practice to assess AKI in the critically ill children, despite the overwhelming evidence of the poor outcome associated with its occurrence. There is also paucity of data from the developing countries, in particular on this subject, and we know that the first step in solving any problem is to first define the problem and its characteristics.

This study, therefore, aims at assessing the presence of AKI in critically ill children at presentation to the emergency room of a tertiary hospital to determine its prevalence, the outcome, and the determinant factors in children with AKI. The outcome of this study is expected to contribute to the pool of knowledge required to stimulate a reorientation in practice by physicians attending to critically ill children so as to reduce the morbidity and mortality that could be associated with AKI among such children.

Patients and Methods

Setting

This study was carried out in the children emergency unit of University of Nigeria Teaching Hospital (UNTH) Ituku-Ozalla in Enugu state, south-east Nigeria. Enugu state has a population of approximately 3.5 million people.[11]

The hospital is among the tertiary hospital facilities providing multidisciplinary medical care with a total bed capacity of approximately 1000. The children emergency unit of UNTH has a total bed capacity of 26, with average patient admissions of 1200 per annum.

Patients

We define our participants included this study as children with critical illness and identifiable degree of AKI on presentation to the children emergency room after initial assessment by one of the researchers in conjunction with the primary staff of the unit. Initial resuscitation and stabilization were carried out, and within 48 hours of stabilization, the patients were transferred to the children's ward for further medical care. There was no operational pediatric intensive care unit in UNTH during the study period; therefore, all critically ill children were managed at the children emergency room and subsequently in the children's ward following stabilization.

Study design

This is a cross-sectional observational study of critically ill children who presented at the children's emergency unit of UNTH. We define critically ill children as those with an acute life-threatening condition wherein death may occur if urgent measures are not performed to preserve life. Acute Dialysis Quality Initiative (ADQI)[12] and Pediatric RIFLE (pRIFLE) criteria which recognized 5 levels of renal impairment in order of increasing severity designated as Risk of renal injury, Injury to the kidney, Failure of renal function, Loss of renal function, and End stage kidney disease (RIFLE) was used to identify and classify critically ill children with different degrees of AKI.[13] The inclusion criteria were age between 1 month and 18 years; children who presented with signs and symptoms of critical illness[14,15] and were admitted to the children emergency room; and children whose parents provided an informed consent. All neonates; patients admitted to the children's emergency room for observation who are usually discharged within 12 hours of admission; and children whose parents failed to give informed consent were excluded from the study.

Participants' enrollment

The children who met the inclusion criteria for this study were consecutively enrolled until the sample size was reached. At presentation to the emergency unit, a case record form was used to record the name, age, and gender of each patient. A brief history of the patient's illness was obtained from the caregiver, and a physical examination was conducted to document the presenting symptoms and signs. The socioeconomic class of each child using that of his/her parents was determined using the classification system proposed by Oyedeji *et al*.[16]

Laboratory assessment

Serum creatinine was assayed using the Jaffe method[17] (using Randox creatinine by Randox laboratories Ltd, United Kingdom). The serum creatinine (in mg/dl) and height or length (in centimeters) of each patient at the time of presentation to the emergency room were used to calculate the estimated GFR of the patient using Schwartz equation[18] as follows: GFR (ml/min/1.73 m^2) = K × height (cm)/serum creatinine (mg/dl), where K is a constant as follows: 0.45 for term infants up to 1 year, 0.55 for children up to 13 years and adolescent females, 0.70 for adolescent males. The original Schwartz equation was used in this study because the institution where the study was carried out did not have facilities for enzymatic method of serum creatinine determination that is calibrated to be IDMS traceable. In this study, none of the patients had a measured serum creatinine value which was documented in the past 3 months prior to presentation; expected baseline GFR was therefore determined for all children aged less than 15 years using the upper limit of the age-based normative value for serum creatinine as published by Schlebusch *et al.*;[19] for all children aged 15–18 years, the upper limit of adult age, and gender-based normative value was considered, as published by Mazzachi *et al.*[20] These values were substituted in the Schwartz equation[18] to determine the baseline GFR for each patient. Use of age-based normative values for serum creatinine to back calculate the expected baseline GFR has been documented to have statistically significant agreement with the baseline value determined using the serum creatinine of the patient in the past 3 months prior to hospitalization.[10]

The estimated GFR of each patient at presentation was compared to the expected baseline GFR for the child to determine whether there was any AKI.

Those who had AKI were determined using the creatinine criteria of the pRIFLE classification, as modified by Ackan-Arican *et al.*[13]

Patients identified to have acute kidney injury were referred to the paediatric nephrology unit of UNTH for follow up. The following outcome measures were determined – length of hospital stay and mortality. Length of hospital stay was determined by calculating the number of days from the date of admission to the emergency room to the date of discharge home either from the emergency room or from the children's ward, or till the patient died. Mortality was determined if the patient died while on admission either in the emergency room or in the children's ward. No patient was referred out of UNTH.

Data analysis

The data generated was first recorded in a case record form, and subsequently, coded and transferred to an electronic database software, the Statistical Package for Social Sciences (SPSS for window 17.0) for analysis.

Descriptive statistics, which included mean and standard deviation, were used to analyze continuous variables, whereas frequencies and percentages were used to analyze categorical variables and presented in tables and charts.

Logistic regression, including backward stepwise logistic regression analysis, was used to test for factors associated with AKI, whereas logistic regression analysis and chi-square test were used to test for outcome determinants of AKI.

Independent sample *t*-test was used to compare the mean length of hospital stay for patients who had AKI and those who did not have, as well as for patients who died while on hospital admission and those who survived. One-way analysis of variance (ANOVA) was used to compare the mean length of hospital stay between the various pRIFLE categories (pRIFLE – R, I, and F). All analyses were performed at 0.05 level of significance.

Ethical approval for this study was obtained from the Health Research and Ethics Committee (HREC) of the UNTH, Ituku-Ozalla, Enugu, Nigeria. Written informed consent was obtained from the parents whose children were enrolled in the study after the procedure had been explained to them in a language that was well-understood by them. The collected data were kept in strict custody of the investigators

Results

A total of 300 critically ill children were enrolled in the study, out of which 180 (60.0%) were males and 120 (40.0%) were females (M:F = 1.5:1). Two hundred and six (68.7%) children were less than 5 years old, whereas 94 (31.3%) were 5 years old and above. The median age was 2.0 years (range 2 months to 16 years), whereas the mean age was 4.0 ± 4.2 years. The median height/length of the study population was 88.0 cm (range 53.0-178.0 cm); mean height was 96.8 ± 30.7 cm. Sixty-three patients belong to the upper class, whereas 123 (41) patients belonged to the lower class and 114 (38) to the middle class [Table 1]. The estimated GFR (eGFR) of the study population ranged from 5.5 to >100 ml/min/1.73 m^2. The mean eGFR was 78.2 ± 39.4 ml/min/1.73 m^2 whereas the median eGFR was 74.0 ml/min/1.73 m^2.

Table 1: Gender and socioeconomic class of the study population.

Gender	*N* (%)
Males	180 (60)
Females	120 (40)
Socioeconomic class	*N* (%)
Upper	63 (21)
Middle	114 (38)
Lower	123 (41)

The baseline GFR (bGFR) of the study population ranged from 25.4 to >100 ml/min/1.73 m^2. The mean bGFR was 99.69 ± 21.04 ml/min/1.73 m^2 whereas the median bGFR was 104.0 ml/min/1.73 m^2. Table 2 shows the eGFR and the bGFR of the study population.

Out of the 300 critically ill children studied, 132 (44%) had less than 25% decline of their eGFR from baseline, and therefore, were classified as having normal renal function; whereas 168 (56%) children had 25% or more decline of their eGFR from baseline, and therefore, had evidence of AKI, as defined by the pRIFLE criteria [Table 3]. This gives a prevalence of AKI in the study population of 56%. The mean eGFR of the study population with AKI was 54.4 ± 20.8 ml/min/1.73 m^2, which was significantly lower than the mean eGFR for those without AKI, which was 108.6 ± 36.5 ml/min/1.73 m^2 (t = 16.209, P < 0.001). Out of the 168 patients with AKI, 95 (56.6%) had a decline of their eGFR between 25 and 50% (mean 34.4 ± 7.4) from baseline, and were classified as having pRIFLE-R category of AKI. Fifty-nine (35.1%) had a decline of their eGFR between 50 and 75% (mean 57.5 ± 5.4) from baseline, and were classified as having pRIFLE-I category of AKI. Fourteen (8.3%) had a decline of their eGFR above 75% (mean 79.1 ± 5.4) from the baseline, and were classified as having pRIFLE-F category of AKI [Table 4].

Majority of the patients with AKI were below 5 years of age, as shown in Table 4. AKI was common in patients who were less than 5 years old (mean 3.0 ± 3.4 years) compared to those who were 5 years and older (mean 5.3 ± 4.8 years) (t = 4.882; P < 0.001). The gender distribution and socioeconomic status of subjects with AKI and those without AKI study population are presented in Table 5.

The mean estimated glomerular filtration rate for the study population with AKI compared to those without AKI. Patients with AKI had lower mean GFR when compared with those without AKI, which was statiscally signiifcant. For those with AKI, mean GFR incresed with age till the age of 5 years, which was statistically significant (P < 0.001) [Table 6]. Table 7 shows that age less than 5 years is the most probable predictor of AKI whereas hypotension is the least probable predictor.

Outcome of the 300 patients studied is shown in Figure 1. The mean length of hospital stay for those who were alive in the study population was 6.8 ± 5.4 days, whereas the mean length of hospital stay for those who died was 3.7 ± 3.6 days (t = 2.906, P = 0.004).

The mean length of hospital stay in the study population for those who had AKI was 6.2 ± 4.5 days, whereas the mean length of hospital stay for those without AKI was 6.6 ± 6.3 days (t = 0.715, P = 0.475). The mean

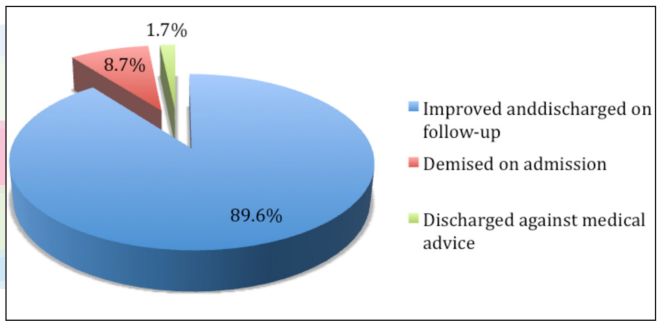

Figure 1: Outcome in the study population

Table 2: Estimated GFR and bGFR of the study population.

Age	*n* (%)	eGFR Mean ± SD	bGFR Mean ± SD	*t*	*P* value
2 months to <1 year	82 (27.3)	49.85 ± 20.34	70.91 ± 10.51	10.954	<0.001
1 to <3 years	88 (29.3)	71.85 ± 30.03	110.59 ± 11.01	13.014	<0.001
3 to <5 years	36 (12.0)	83.99 ± 29.76	118.89 ± 8.74	6.912	<0.001
5 to <7 years	22 (7.3)	92.90 ± 24.57	106.86 ± 6.64	2.498	0.021
7 to <9 years	21 (7.0)	102.81 ± 40.24	111.53 ± 11.36	0.920	0.369
9 to <11 years	15 (5.0)	99.46 ± 39.49	103.59 ± 6.59	0.408	0.690
11 to <13 years	17 (5.7)	116.99 ± 55.21	105.08 ± 14.91	0.964	0.350
13 to <15 years	12 (4.0)	125.11 ± 39.46	110.65 ± 17.33	1.091	0.299
15 to 18 years	7 (2.3)	121.99 ± 66.55	103.23 ± 16.44	0.734	0.491

Table 3: Range of decline in eGFR from baseline in the study population, N = 300

Range of decline (%)	Frequency (%)	Mean ± SD
0 to <25	132 (44.0)	6.2 ± 7.8
25 to <50	95 (31.7)	34.4 ± 7.4
to <75	59 (19.7)	57.5 ± 5.4
>75	14 (4.6)	79.1 ± 5.4

Table 4: Age of the study population with and without AKI

Age	AKI n (%)	No AKI n (%)	Total n (%)
2 months to <1 year	50 (29.8)	32 (24.2)	82 (27.3)
1 to <3 years	63 (37.5)	25 (18.9)	88 (29.3)
3 to <5 years	23 (13.7)	13 (9.8)	36 (12.0)
5 to <7 years	6 (3.6)	16 12.1)	22 (7.3)
7 to <9 years	9 (5.4)	12 (9.1)	21 (7.0)
9 to <11 years	7 (4.2)	8 (6.1)	15 (5.0)
11 to <13 years	6 (3.6)	11 (8.3)	17 (5.7)
13 to <15 years	2 (1.2)	10 (7.6)	12 (4.0)
15 to 18 years	2 (1.2)	5 (3.8)	7 (2.3)
Total	168 (100.0)	132 (100.0)	300 (100)

Table 5: Gender and socioeconomic class of study population with and without AKI

	AKI n = 168 (%)	No AKI n = 132 (%)	χ^2	*P* value
Gender				
Male	109 (64.9)	71 (53.8)	3.790	0.052
Female	59 (35.1)	61 (46.2)		
Socioeconomic class				
Upper	35 (21.0)	28 (21.2)	1.090	0.580
Middle	59 (35.3)	54 (40.9)		
Lower	73 (43.7)	50 (37.9)		

Table 6: Estimated GFR the study population with and without AKI

Age	AKI Mean ± SD	No AKI Mean ± SD	*t* value	*P* value
2 months to <1 year	37.79 ± 14.51	68.67 ± 12.15	9.994	<0.001
1 to <3 years	56.87 ± 18.42	109.61 ± 17.81	12.225	<0.001
3 to <5 years	67.44 ± 19.55	113.27 ± 20.70	6.616	<0.001
5 to <7 years	67.15 ± 16.05	102.55 ± 19.87	3.894	0.001
7 to <9 years	66.91 ± 13.87	129.73 ± 30.98	5.646	<0.001
9 to <11 years	66.63 ± 13.47	128.19 ± 30.69	4.892	<0.001
11 to <13 years	64.31 ± 14.91	145.73 ± 46.83	4.093	0.001
13 to <15 years	76.40 ± 16.55	134.85 ± 35.22	2.231	0.050
15 to 18 years	48.75 ± 61.16	151.28 ± 44.19	2.549	0.051

Table 7: Factors associated with AKI in the study population (logistic regression analysis)

	AKI					
Predictors	Yes (%)	No (%)	B	P- value	OR	95% CI
Age (<5 years)	206 (68.7)	94 (31.3)	1.286	<0.001	3.618	2.100–6.235
Inability to drink/breastfeed	144 (48)	156 (52)	1.053	<0.001	2.866	1.723–4.766
Tachycardia	260 (86.7)	40 (13.3)	0.747	0.031	2.111	1.071–4.163
Unconsciousness	35 (11.7)	265 (88.3)	1.140	0.011	3.128	1.303–7.511
Hypotension	28 (9.3)	272 (90.7)	0.963	0.048	2.619	1.008–6.804

length of hospital stay for patients who had pRIFLE-R category of AKI was 6.0 ± 4.4 days, for those with pRIFLE-I category was 6.6 ± 4.6 days, and for those with pRIFLE-F category was 6.1 ± 5.3 days. The degree of severity of AKI did not significantly lead to longer length of hospitalization (F = 0.295, P = 0.745).

Two hundred and ninety-five patients were analyzed for 5 years and discharged against medical advice; it could not be ascertained whether these patients died or not. Out of the 295 who were analyzed, 26 (8.8%) died. Out of the 26 patients who died, 22 (84.6%) had AKI at the time of presentation. Patients with AKI were five times

Table 8: Acute kidney injury and mortality in the study population, $N = 295$

Renal function	Alive n (%)	Dead n (%)	Total	χ^2	P
No AKI	125 (96.9)	4 (3.1)	129 (100)	29.126	<0.001
Risk	88 (92.6)	7 (7.4)	95 (100)		
Injury	48 (84.2)	9 (15.8)	57 (100)		
Failure	8 (57.1)	6 (42.9)	14 (100)		
Total	269 (91.2)	26 (8.8)	295 (100)		

more likely to die than those without AKI (OR = 4.81; 95% CI = 1.61-14.35; $P = 0.005$).

Out of the 295 patients analyzed, 88 (92.6%) who had pRIFLE-R category of AKI survived whereas 7 (7.4%) who had pRIFLE-R category of AKI died. Forty-eight (84.2%) patients who had pRIFLE-I category of AKI survived, whereas 9 (15.8%) who had pRIFLE-I category of AKI died. Similarly, 8 (57.1%) patients who had pRIFLE – F category of AKI survived, whereas 6 (42.9%) with pRIFLE-F category of AKI died, as illustrated in Table 8.

The association between the severity of kidney injury and patient mortality was determined for the patients in the study population (excluding those discharged against medical advice). The various degrees of kidney injury were subjected to logistic regression analysis to determine their extent of association with patient mortality. The odds of death increased with increasing severity of kidney injury, pRIFLE-R (OR = 2.59; 95% CI = 0.735-9.095; $P = 0.139$), pRIFLE-I (OR = 6.09; 95% CI = 1.793-20.712; $P = 0.004$), pRIFLE-F (OR = 24.38; 95% CI = 5.702-104.194; $P = 0.001$). Table 1: Gender and socioeconomic class of the study population. Table 2: Estimated GFR and bGFR of the study population Table 3: Range of decline in eGFR from baseline in the study population, N = 300 Table 4: Age of the study population with and without AKI Table 5: Gender and socioeconomic class of study population with and without AKI Table 6: Estimated GFR the study population with and without AKI Table 7: Factors associated with AKI in the study population (logistic regression analysis) Table 8: Acute kidney injury and mortality in the study population, N = 295

Discussion

This study has revealed that a substantial proportion of critically ill children who were admitted to the children emergency room of UNTH have some degree of AKI at the time of presentation. Majority of the critically ill patients in this study were males. This compares favorably with findings by other authors from other centers in the region[8,9] and in developed countries.[14,21]

A greater proportion of the patients in this study were aged less than 5 years. This agrees with reports by other authors in developing countries[7-9] and in developed countries.[10] This further strengthens the emphasis by the World Health Organization[15] on the vulnerability of this age group to severe forms of diseases and the need to identify signs and symptoms of severe illness in them early to forestall undesirable outcomes.

This study adds to the pool of data in support of the fact that the prevalence of AKI is high and probably rising, especially in critically ill patients. Although there are few studies on AKI in the critically ill children, especially in the sub-Saharan Africa, high prevalence of AKI, as found in this study, compares favorably with the reports by Esezobor *et al*.[9] in south-west Nigeria, Freire *et al*.[7] in Brazil, and in developed countries by Ackan Arikan *et al*.[13] and Alkandari *et al*.[21] Low prevalence of AKI was reported at another tertiary hospital in South-west Nigeria by Olowu *et al*.,[8] which is contrary to the findings in this study. This variation in prevalence rates could be due to geographical differences and methodology. The exact time of onset of AKI could not be ascertained in the present study because those patients who had AKI had already developed some degree of AKI prior to presentation to the emergency room of UNTH. This suggests a possibility of community-acquired AKI. Comparable findings of patients presenting to hospitals having developed AKI prior to presentation to the hospital were also reported by other authors in south-west Nigeria.[8,9] This further raises concerns about the possibility of a high burden of AKIy in the communities.

Studies from developed countries[3,14,21] have shown that most cases of AKI in critically ill children occurred during hospitalization, especially in the intensive care setting (so called hospital-acquired AKI). This contrasts with the findings in this study, and other studies from other parts of the developing world.[8,9] This could be explained by the poor health seeking behavior and reliance on over the counter medications, which is characteristic of most people in developing countries. It has been shown that some of the over the counter medications, especially nonsteroidal anti-inflammatory drugs[22] and herbal medications[8,23] are nephrotoxic.

Most of the patients in this study had mild impairment of renal function (presenting with pRIFLE R and I categories of kidney injury), while a few had severe renal impairment (presenting with pRIFLE-F category of kidney injury). This compares favorably with findings by other authors in Brazil[7] and developed countries,[14,21] and tends to conform with the natural progression of AKI as a dynamic process, progressing through degrees of severity from pRIFLE – R to F.[11] There is, however, a disagreement in this regard with the findings of two other authors from south-west Nigeria,[8,9] where most of the patients in their series presented with the worst categories of AKI – i.e., AKIN stage 3 and pRIFLE – F.

The increased odds of developing AKI if the patient was aged less than 5 years, as found in the present study, compares favorably with the findings of Aydin *et al*.[24] and Zapittelli *et al*.[10] in developed countries. Presence of hypotension in critically ill children in this study portends a significantly increased risk of developing AKI. The odds of developing AKI in a child presenting with hypotension was approximately three times compared to those with normal blood pressure. Similar finding has been documented in south-west Nigeria by Olowu *et al*.[8] Hypotension as a risk factor for AKI development predisposes the patient to renal hypoperfusion, tubular necrosis, and possibly irreversible kidney injury.[24] Other risk factors associated with development of AKI, as shown in this study, differ from those reported by other authors. This could be explained by the differences in the study population and the inclusion and exclusion criteria of various studies.

This study showed that critically ill children who died while on admission in the emergency room did so within three days of admission, irrespective of whether they have AKI or not. Although this finding is merely descriptive, it may have brought to fore the constraints experienced in our health facility to meet the needs of critically ill children. This is evident bearing in mind that there was no pediatric intensive care unit operational in the hospital at the time of this study. Moreover, the significantly shorter duration of hospitalization for those patients who died may also have been due to the contribution of various comorbidities and the severity of the primary illness in such patients. This study, however, did not control for various comorbidities and the PRISM scores of the study population. AKI having no impact on the length of hospital stay, as shown in this study, contrasts with findings in developed countries both in critically ill adults[25] and children,[3,14,21] where AKI had been shown to be independently associated with increased length of hospitalization. Although the finding in this study is mainly descriptive, the reason for this disagreement may be attributed to lack of facilities for critical care management such that the children with or without AKI did not have the chance to live long enough to be evaluated and treated.

The increased odds of death in a patient with AKI, and more so with increasing severity of kidney injury in this study, compares favorably with the findings by other authors both in critically ill adults[25] and children.[3,14,10] Although the cause of death in these patients could be multifactorial, and as such the findings are mainly descriptive, it suggests strongly the possibility of AKI as a potent contributor to patient mortality, especially in the setting of critical illness. Further studies controlling for other comorbidities and severity of illness will be required to assess the independent contribution of AKI to patient mortality in critically ill children.

Conclusion

This study has shown that community-acquired AKI is common among critically ill children admitted to the emergency room, as it was contrawise to that of the developed countries where hospital-acquired AKI is common. It has also shown that the factors associated with AKI development can easily be identified from clinical symptoms and signs as well as patient's age. Meticulous evaluation of every critically ill child will, therefore, be very pertinent for early identification of those who may have AKI. The outcome in terms of mortality in critically ill pediatric patients in our study may have been as catastrophic as seen in developing countries, with those presenting with the worst degree of AKI having the worst outcome.

Financial support and sponsorship

Nil.

Conflict of Interest

There are no conflicts of interest.

References

1. Kolhe NV, Stevens PE, Crowe AV, Lipkin GW, Hawon DA. Case mix, outcome and activity for patients with severe acute kidney injury during the first 24 hours after admission to an adult general critical care unit: Application of predictive models from a secondary analysis of the ICNARC case mix programme Database. Crit Care 2008;12(Suppl): S2.
2. Hostea EA, Clermont G, Kersten A, Venkataraman R, Angus DC, De Bacquer D, *et al.* RIFLE criteria for acute kidney injury are associated with hospital mortality in critically patients: A cohort analysis. Crit Care 2006;10:R73.
3. Schneider J, Khemani R, Grushkin C, Bart R. Serum creatinine as stratified in the RIFLE score for acute kidney injury is associated with mortality and length of stay for children in the pediatric intensive care unit. Crit Care Med 2010;38:933-9.
4. Mehta RL, Pascual MT, Soroko S, Savage BR, Himmelfarb J, Ikizler TA, *et al.* Spectrum of acute renal failure in the intensive care unit: The PICARD experience. Kidney Int 2004;66:1613-21.
5. Prakash J, Singh TB, Ghosh B, Malhotra V, Rathore SS, Vohra

R, *et al.* Changing epidemiology of community acquired acute kidney injury in developing countries: Analysis of 2405 cases in 26 years from eastern India. Clin Kidney J 2013;6:150-5.
6. Mehta RL, Kellum JA, Shah SV, Molitoris BA, Ronco C, Warnock DG, Levin A. Acute Kidney Injury Network: Report of an initiative to improve outcome in acute kidney injury. Crit Care 2007;11:R31.
7. Freire KMS, Bresolin NL, Farah ACF, Carvalho FLC, Goes JEC. Acute kidney injury in children: incidence and prognostic factors in critically ill patients: Course completion monograph presented to the Intensive Medicine Association, Florianopolis (SC), Brazil, for certification in the pediatric intensive care medicine residency program. Rev Bras Ter Intensiva 2008;22:166-74.
8. Olowu WA, Adefehinti O, Bisiriyu AL. Hospital acquired acute kidney injury in critically ill children and adolescents. Saudi J Kidney Dis Transpl 2012;23:68-77.
9. Esezobor CI, Ladapo TA, Osinaike B, Lesi FA. Pediatric acute kidney injury in a tertiary hospital in Nigeria: Prevalence, causes, and mortality rate. PLoS One 2012;7:e51229.
10. Zappitelli M, Parikh CR, Akcan-Arican A, Washburn KK, Moffett BS, Goldstein SL. Ascertainment and epidemiology of acute kidney injury varies with definition interpretation. Clin J Am Soc Nephrol 2008;3:948-54.
11. National population commission of Nigeria 2006Provisional census figures. Census news 2006 31:14.
12. Bellomo R, Ronco C, Kellum JA, Mehta RL, Palversky P. Acute renal failure: Definition, outcome measures, animal models, fluid therapy and information technology needs- the second international consensus conference of the Acute Dialysis Quality Initiative (ADQI) group. Crit Care 2004;8:204-12.
13. Akcan-Arikan A, Zapittelli M, Loftis LL, Washburn KK, Jefferson LS, Goldstein SL. Modified RIFLE criteria in critically ill children with acute kidney injury. Kidney Int 2007;71:1028-35.
14. McLean B, Zimmerman JL. Recognition and assessment of the seriously ill patient in; Fundamental Critical Care Support; Society of Critical Care Medicine 4th ed;. 2007;1-10.
15. World Health Organization Handbook: Integrated Management of Childhood Illness (IMCI). 2005;13-56.
16. Oyedeji GA. Socioeconomic and cultural background of hospitalized children in Ilesha. Nig J Paediatr 1985;12:111-27.
17. Calcreath DF. Liver andkidney function tests. In: Clinical Chemistry; A fundamental textbook. WB Saunders; 2005. pp. 225-53.
18. Schwartz GJ, Brion LP, Spitzer A. The use of plasma creatinine concentration for estimating Glomerular filtration rate in infants, children and adolescents. Pediatr Clin North Am 1987;34:571-90.
19. Schlebusch H, Liappis N, Kalina E, Klein G. Creatinine and ultrasensitive CRP: Reference intervals from infancy to childhood J. Lab Lab Med 2002;26:341-6.
20. Mazzachi BC, Peake MJ, Ehrhardt V. Reference range and method comparison studies for enzymatic and Jaffe creatinine assays in plasma and serum and early morning urine. Clin Lab 2000;46:53-5.
21. Alkandari O, Eddington AK, Hyder A, Garvin F, Ducrest T, Gottesman R, *et al.* Acute kidney injury is an independent risk factor for pediatric intensive care unit mortality, longer length of stay and prolonged mechanical ventilation in critically ill children: A two- center retrospective cohort study. Crit Care 2011;15:R146.
22. Patzer L. Nephrotoxicity as a cause of acute kidney injury in children. Pediatr Nephrol 2008;23:2159-73.
23. Chijioke A, Adebirigbe A, Olarenwaju TO, Adekoya AO, Prevalence of acute renal failure due to exogenous nephrotoxins in Ilorin. Trop J Nephrol 2007;2:43-8.
24. Aydin SI, Seiden HS, Blanfox AD, Parrell VA, Choudhury T, Punnoose A, *et al.* Acute kidney injury after surgery for congenital heart disease. Ann Thorac Surg 2012;94:1589-95.
25. Ricci Z, Cruz D, Ronco C. The RIFLE criteria and mortality in acute kidney injury: A systematic review. Kidney Int 2008;73:538-46.