Outcomes of Children with Acute Kidney Injury Admitted with Critical Illness to a Tertiary Hospital, in, in a sub-Saharan African country

A research paper submitted to Addis Ababa University Tikur Anbessa Specialized Hospital College of Health Science, for the prerequisite of sub specialty in pediatrics nephrology

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ABSTRACT

Background

Pediatric acute kidney injury (AKI) is increasingly recognized as a major cause of morbidity and mortality among hospitalized children, especially in low- and middle-income countries. Limited diagnostic capacity and delayed recognition often contribute to poor outcomes. Despite growing attention to AKI in adults, data in the pediatric population remain sparse in sub-Saharan Africa. This study aimed to determine treatment outcomes, describe the clinical patterns of pediatric AKI, and identify determinants using the Phoenix criteria.

Methods

A hospital-based cross-sectional study was conducted among 360 pediatric patients admitted to the tertiary pediatric intensive care units. Demographic, clinical, and laboratory data were collected using a structured checklist. AKI was diagnosed and staged using the Phoenix (KDIGO-based) criteria, which incorporate changes in serum creatinine and urine output. Data were analyzed using SPSS version 26. Descriptive statistics were presented as frequencies and percentages, and associations between AKI and potential determinants were assessed through bivariate and multivariable logistic regression. A p-value <0.05 was considered statistically significant.

Results

The overall prevalence of AKI was 28%, with stage 1, stage 2, and stage 3 comprising 7.5%, 11.1%, and 9.4% of cases, respectively. AKI was most common among children aged 1–5 years and slightly more prevalent in males. Sepsis was the most significant determinant, associated with a more than twofold increased risk of AKI (AOR = 1.26, $p < 0.001$). Additional factors associated with AKI included hypotension, shock, use of nephrotoxic medications, and underlying malignancy. Among children with AKI, 63.5% presented with oliguria or anuria. The mortality rate among AKI patients was 45.4%, compared to 9.5% in non-AKI patients. Only 1.9% of those who met dialysis criteria received renal replacement therapy, reflecting limited access to specialized care. At discharge, 18.6% of AKI patients had fully recovered kidney function, whereas 32.1% showed residual renal impairment.

Conclusion

Pediatric AKI is common in hospitalized children and is strongly associated with sepsis, hemodynamic instability, and exposure to nephrotoxins. The high mortality and low renal recovery rates highlight the urgent need for early recognition, improved fluid and sepsis management, and expanded access to renal replacement therapies. Strengthening hospital-based AKI surveillance and nephrology consultation systems could reduce preventable AKI-related deaths in children.

Keywords: acute kidney injury, pediatrics, determinant factors, mortality, Phoenix criteria, sub-Saharan Africa

1. INTRODUCTION

1.1 Background

Pediatric Acute kidney injury (AKI), a serious clinical condition marked by a rapid decline of renal function leading to retention of wasted product and disruption of electrolytes and fluid balance, it is associated with a high risk of developing chronic kidney disease (CKD) and end-stage renal disease (ESRD), it is a global health burden with high morbidity and mortality(1)(2).

The frequency and triggers of AKI in low resource setting are different from those of more developed countries (3). Among hospitalized children, AKI rates vary between 0.34%-5% in some reports but the incidence can climbs to 30-50% in children with critical illness, making it one of the commonest complication in pediatric intensive care unit (4).

Some studies have reported AKI to be 30-70% of the admitted children (4,6,7), with roughly 5% of those patients requiring acute RRT (8). Even if the survival has improved modestly ,the absolute number of death due to AKI continues to rise as the incidence is increasing (5,9-11).

Children with critical illness who developed AKI have significant worse outcome with high mortality, ICU stay which is prolonged, and greater morbidity. The risk rises with the severity of AKI(3).

Common morbidities include hypertension, neurologic disorders, fluid and electrolytes imbalances, and coagulopathy ,with mortality rates ranging from 16-63% in published data(6). To diagnose AKI currently it rest on acute drop of glomerular filtration rate, reflected by an acute increase of creatinine or a fall in urine output in defined interval (6-8). In Recent time , many biomarkers have been developed and proposed for the diagnosis of AKI, and these are in various stages of development and validation (9-12). Nevertheless, it is not clear whether a single or multiple biomarker approach is necessary to diagnose the complicated and multifactorial aspects of AKI (7).

Acute kidney injury has different causes in low-income countries, where acute tubular necrosis secondary to sepsis, gastroenteritis with dehydration, primary renal diseases such as hemolytic uremic syndrome, and acute glomerulonephritis are more likely (8). At Tikur Anbessa specialized Hospital (TASH) a study found that 18.2 children admitted to PICU developed

AKI,in those children 19.1 were stage 1,52.8 were stage 2 of AKI,and 27.8 were stage 3,and 16.7 needed RRT. Independed risk factors to develop AKI were severe sepsis and septic shock (9).

It is estimated that less than 5% of patients eligible for dialysis can access it In Sub-Saharan Africa. Thus, many patients in low-income regions who have AKI and need RRT will not survive because of financial issues or the lack of available treatment centers. Other patients who have AKI are at risk of developing CKD, which is associated with long-term comorbidities and impacts the socioeconomic status of developing countries (10).

A similar study in Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia, Acute kidney injury is common in patients with critical illness, especially those with sepsis which is severe and septic shock. Patients with AKI had longer PICU stay, and the risk of hospital mortality was 6 times higher for children with AKI (8).

1.2 Statement of the Problem

AKI ranges from mild creatinine elevation to kidney failure requiring RRT,and even a small rise in serum creatinine are associated with poor outcomes(2). Adults who are critically ill ,34% developed AKI ,and in hospital mortality was up to 62% (11).

Data on Pediatric acute kidney injury has increased substantially ,showing a clear association for patients with AKI for longer hospital stay, more mechanical ventilation need, and increased death rates(12).

Contrary to ancient belief, especially to severe AKI stage, renal recovery is far from universal. The morbidity and mortality related to AKI among children with critical illness in Ethiopia are limited. This knowledge gap hinders prioritization and planning for renal care services, particularly in light of numerous competing health priorities.

Unrecognized, AKI inevitably causes morbidity and mortality, some of which may have been preventable. Underdiagnosed AKI is possible because sometimes there are no reagents in the health facility for performing kidney function tests in sick children. On the other hand, the health workers may not consider the possibility of AKI being an additional morbidity in a child's illness. Even after identifying AKI, health workers in daily practice are left frustrated because they feel helpless when a patient who needs urgent life-saving Renal Replacement Therapy

cannot access it. AKI has the potential of becoming CKD and End end-stage kidney disease, which requires even more resources to manage. Given the high morbidity and mortality of AKI, it is necessary to investigate prognostic markers, which will detect patients who may benefit from prompt treatment (13).

1.3. Significance of the study

This study provide baseline information regarding the outcomes of children with acute kidney injury admitted with critical illness among admitted patients in TASH. Results obtained from this study can help to improve the clinical care,guide interventions. Researchers can use the findings of this study for planning further large-scale studies. The findings of this survey will serve as a stepping stone for other researchers, educators, policymakers, governmental, and nongovernmental organizations to initiate activities and strengthen the utilization of available resources to improve outcomes of AKI.

1.4 Conceptual framework

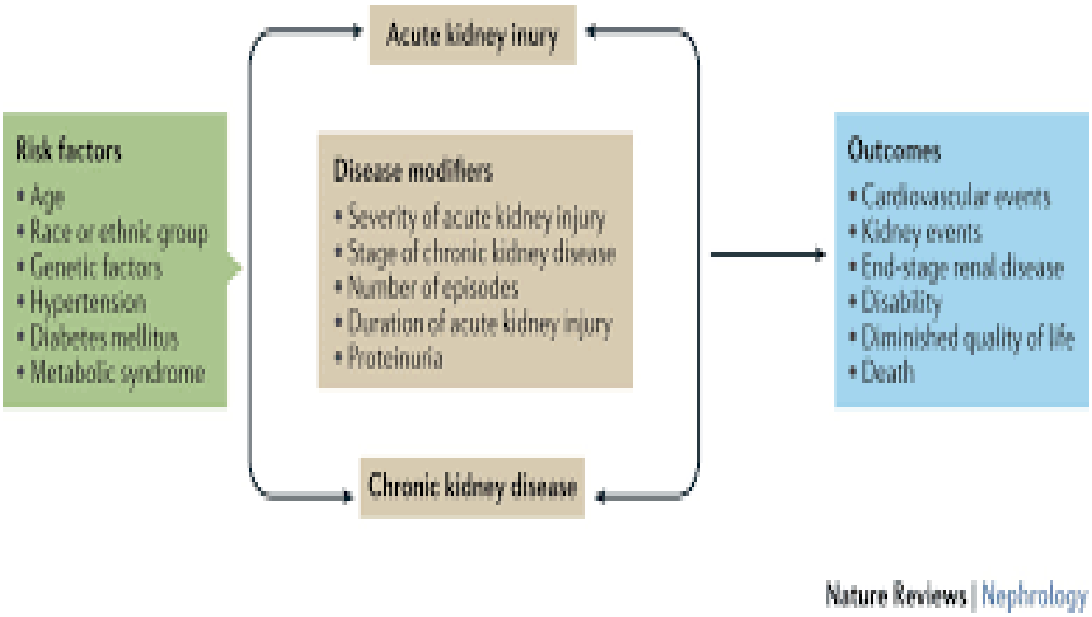


Figure 1Conceptual framework of outcomes of children with acute kidney injury admitted with critical illness to the tertiary hospital, Addis Ababa, Ethiopia.

2. LITERATURE REVIEW

The causes of Acute kidney injury are classified as pre-renal, intrinsic, and post renal. Pre-renal etiologies are the most common, but as injury persists ,intrinsic causes become more predominate (11.1% for transient AKI,13.2 for persistent AKI, and 22.6% for acute kidney disease) (14) .Mortality is highest in acute kidney disease patients (16.42%),it is followed by transient AKI(14.66%)and persistent acute kidney injury(9.81%).The following factors are associated with higher mortality: renal microvascular changes, acute tubular necrosis, serum proteins, low hemoglobin and platelets (14)

An Indian study of 252 children, their findings are 40.1% had AKI, with 37.9% reaching pRIFLE risk,35.9% injury, and 26.2% who have reached Failure. In AKI group, the admission PRISM III score was higher (3)

A nationwide Taiwanese cohort 60338 children reported AKI incidence of 1.4% ,with risk factors including the use of extracorporeal membrane oxygenation, mechanical ventilation or vasopressors, intrinsic renal diseases, sepsis, and age more than 1 year. In this study of the AKI cases, 46.5% were due to sepsis, in this patients 36.1% have been on renal RRT, and the mortality rate was 44.2%. (15).

Study done in sub–Saharan Africa among 3881 records, of which 41 did not meet the inclusion criteria, including 1403 adult patients and 1937 pediatric patients. Acute kidney injury in sub-Saharan Africa is severe, with 1042 (66%) of 1572 children and 178 (70%) of 253 adults needing dialysis in studies reporting dialysis need (10). Only 666 (64%) of 1042 children (across 11 studies) and 58 (33%) of 178 adults (across four studies) received dialysis when needed. Overall mortality was 34% in children and 32% in adults, but rose to 73% in children and 86% in adults when dialysis was needed but not received. Major barriers to access to care were out-of-pocket costs, erratic hospital resources, late presentation, and female sex(10)

A study done on Outcome of Acute Kidney Injury in Sudanese Children shows Common causes of AKI were sepsis 202 (30.8%), acute glomerulonephritis 75 (11.5%), and obstructive uropathy due to stones 56 (8.5%). The most common dialysis modality used was PD, 343 (52.4%), and peritonitis was reported in 53 (15.4%) patients. Recovery from AKI was achieved in 450

(68.9%) children, 37 (5.7%) went into chronic kidney disease (CKD), 33 (5.1%) were referred to the pediatric surgery, and 194 (29.7%) died (17).

A study done in pediatric PICU of Spain shows a total of 139 cases of AKI were analyzed. RRT was necessary in 60.1% of cases. Mortality rate was 32.6%. At PICU discharge, RRT was necessary in 15% of survivors. Thrombocytopenia and low creatinine clearance values were prognostic markers of RRT at PICU discharge. High values of platelets, serum creatinine and weight were associated with higher survival (18).

A retrospective study done pediatric patients admitted with renal diseases at the University of Gondar Hospital (UoGH). A total of 456 patients comprising 231 (50.7%) females and 225 (49.3%) males, were studied. The majority (37.7%) of patients were below 5 years of age. Renal diseases accounted for 3.6% of all admissions during the 2 years. Common renal problems were urinary tract infection (UTI) (29%), acute glomerulonephritis (AGN) (24.1%), nephrotic syndrome (18.6%), acute kidney injury (AKI) (14.3%), nephroblastoma (9%), and chronic kidney diseases (CKD) (2.4%). Finally, 71.9% were discharged improved and 10.5% died. The highest case fatality rates were in patients with rapidly progressive glomerulonephritis (36.7%) followed by CKD (36.4%), and AKI (21.5%) (20)

3. OBJECTIVES

3.1. General objective

To determine the prevalence, outcomes and determinants factors of AKI in critically ill children admitted to PICU at TASH, Ethiopia 2024.

3.2. Specific objectives

- To establish the prevalence of AKI among critically ill children in PICU at TASH.
- To identify predictors of AKI in this population
- To describe the outcomes of AKI in theses patients

4. METHODOLOGY

4.1. Study Area and Setting

The study was carried out in the pediatrics ICU of TASH in Addis Ababa, Ethiopia.

4.2. Study Design and Study Period

This retrospective, facility-based, cross-sectional study was conducted at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. All children aged one day to 15 years admitted over2 years to PICU of TASH, Addis Ababa, Ethiopia.

Inclusion and exclusion criteria

4. Inclusion criteria

All Children who developed AKI as defined by KIDGO criteria and were admitted with critical illness to the PICU.

4. Exclusion criteria

Children who are critically ill but known to have CKD or who have a urinary tract malformation.

4.3. Source and Study Population

4.3.1. Source population

All children admitted to PICU of TASH in the study period. (What is that study period?

4.3.2 Study population

All children who were admitted with critical illness to the PICU and developed AKI during the study period.

4.4. Sample size determination and Sampling procedure

Sample size was determined and data were collected retrospectively.

4.1. Sample size determination

The required sample size was calculated based on a single population formula. Therefore, by applying the following formula, the sample size was calculated as shown below.

$$n = \frac{z^2 p (1-p)}{d^2}$$

Where n=the required sample size, Z= standard score corresponding to 95% CI =1.96 P=18.2 % of children study participants critical ill at PICU had AKI and other of the study are not, (16) and D=margin of error 5%

$$n\ (1) = \frac{(1.96)^2 \text{ X } 0.18\ (1-0.18)}{(0.05)^2} = 219$$

By adding 10% non-response rate,

the required sample size was 241

We have added 119 patients to increase the power of the study to reach to 360 patients

4.5. Study variables

4.5.1. Dependent variables

Prevalence of AKI among children.

4.5.2. Independent variables

- Socio-demographic factor
- Comorbidity Underlying disease:
- Investigation
- Imaging
- Treatment factor:

4.6. Operational definitions and definitions of terms

i. Operational definitions

KDIGO defines AKI in children as any of the following: (1)

Increase in serum creatinine by > 0.3mg/dl (26.5µmol/L) within 48 hours; or increase in serum creatinine to > 1.5 times baseline, which is known or presumed to have occurred within 7 days; or urine volume < 0.5ml/kg/hour for 6 hours

a. Newborns are considered to have renal failure if the serum creatinine concentration is >1.5 mg/dL (133 micro mol/L) or increases by at least 0.2 to 0.3 mg/dL (17 to 27micro mol/L) per day.

b. KDIGO staging of AKI

Stages	Glomerular filtration rate (GFR) criteria	Urine Output (UO) criteria
1	Serum creatinine* 1.5to 1.9 Or Increase > 0.3mg/dl (26.5 mmol/L) within 48 hours	UO< O.5ml/kg/hour for 6hours
2	Serum creatinine* 2 to 3	UO < 0.5ml/kg/h for 12hours
3	Serum creatinine * 3 Or Serum creatinine > 4mg/dl (350mmol/l) in the setting of acute increase of at least 0.5mg/dl (44mmol/l) or initiation of Renal replacement therapy	UO < 0.3ml/kg/h for 24hours Or anuria for 12hours

Sepsis: is microbial invasion of blood bloodstream (probable or documented) with early signs of circulatory compromise (tachycardia, tachypnea, peripheral vasodilation and fever or hypothermia) to full circulatory collapse with multi-organ failure (21).

Tachypnea: is defined by WHO as breathing faster than 60 breaths/min by an infant younger than 30 days of age, faster than 50 breaths/min by 2 to 12-month-old, and faster than 40 breaths/min by infants through the second year of life (23).

Tachycardia: New born >190/min; Infant >160beats/min; Toddler >130 beats/min ;Preschooler >120 beats/min ;Six years old >115beats/min; Eight years olds >110 beats/min; Ten years old >110beats/min; Twelve years old(boys) >105 beats/min ;Twelve years old(girls)>110 beats/min; Fourteen years old(girls)>105 beats/min; fourteen years old(boys) >100beats/min; Sixteen years old(girls)>100beats/min ; Sixteen years old(boys)>95 beats/min (23).

Nephrotoxic drugs: Drugs and agents considered to cause nephrotoxicity include non-steroidal anti-inflammatory drugs, antibiotics, amphotericin-B, antiviral agents, angiotensin converting enzyme inhibitors, calcineurin inhibitors, radiocontrast media, and cytostatic agents (24).

Hypertension: Children's blood pressure above the 95th percentile for the same age, sex, and height (22).

4.7. Data Collection method and tools

Structured questionnaires were used to extract data from medical records. The tool, adapted from previous research, captured sociodemographic information, pre-admission characteristics, clinical features, investigations, underlying diseases, and outcomes. The questionnaire was in English.

4.8 Data Quality Control

A structured, validated questionnaires were employed. data collectors and supervisors have been trained for half a day. A pre-test was done on 5% of the total calculated sample size. The filled questionnaires were checked for completeness to ensure the quality of data. Both the PI and recruited supervisors were responsible for supportive supervision on the spot.

4.9. Data processing and analysis

After data collection, each questionnaire was checked for completeness and consistency. Data was entered in Epidata version, then the raw data was transported to SPSS version 25. Different frequency tables, graphs, and descriptive summaries were used to describe the study variables.

4.10. Ethical Considerations

Ethical approval was secured from the Research and Ethical Committee of the College of Health Sciences, Addis Ababa University Department of Pediatrics and Child Health.

5. RESULTS

Socio-demographic characteristics

A total of 360 critically ill pediatric patients were included in the study. The mean age was 62.2 ± 51.3 months, with a median of 48 months. Most participants were males (58.3%), while females accounted for 41.7%. More than half of the children (54.7%) resided in rural areas, and 45.3% were from towns.

Regarding parental education, 9.2% of caretakers had no formal education, 31.9% had completed primary school, 29.2% had attained secondary education, and 29.7% had university-level education.

Clinical presentation and admission characteristics

The most frequent reasons for admission of the critically ill pediatric patients were infections/sepsis (25.3%), followed by oncologic/hematologic malignancies (20.8%), and other miscellaneous causes (18.1%). Cardiac or cardiovascular conditions accounted for 6.1%, renal disorders for 7.2%, and respiratory disorders for 6.7% of admissions, as shown in Table 1.

A total of 280 children (77.8%) were referred from another health facility, with varying durations of prior hospitalization (most commonly 1–5 days). Socio-demographic characteristics and clinical profile of study participants can be found in Table 1.

Table 1 Socio-demographic characteristics and reasons for hospital admission among study participants (n=360)

Characteristic	**Category**	**Frequency (n)**	**Percentage (%)**
Age (months)	Mean ± SD	62.2 ± 51.3	
	Median	48	
Sex	Male	210	58.3
	Female	150	41.7
Residence	Rural	197	54.7

	Urban / Town	163	45.3
Caretaker education	No formal education	33	9.2
	Primary school	115	31.9
	Secondary school	105	29.2
	University / Higher education	107	29.7
Referral status	Referred from another facility	280	77.8
	Direct admission	80	22.2
Duration of prior hospitalization (referred cases)	1–5 days	Most common	—
Reason for admission	Infections / Sepsis	91	25.3
	Oncology / Hematologic malignancies	75	20.8
	Other / Miscellaneous	65	18.1
	Renal disorders	26	7.2
	Respiratory disorders	24	6.7
	Cardiac / Cardiovascular	22	6.1
	Neurologic disorders	22	6.1
	Surgical / Post-operative / Trauma	18	5.0
	Metabolic / Endocrine	12	3.3
	Nutrition-related	5	1.4
Comorbidities	Congenital heart disease	14	6.1
	Chronic liver disease	10	4.3
	Chronic kidney disease	8	3.5
	Malnutrition	9	3.9
	Hematologic malignancy	3	1.3
	None	319	82.2

Among patients with comorbid conditions, 14 (6.1%) had congenital heart disease, 10 (4.3%) had chronic liver disease, and 8 (3.5%) had chronic kidney disease. Malnutrition was present in 9 (3.9%) patients, while only 3 (1.3%) had hematologic malignancies.

Clinical Presentations of the critically ill pediatric patients

Fever was the most frequently reported symptom (n = 155, 67.4%), followed by vomiting (n = 118, 51.3%) and decreased urine output (n = 91, 39.6%). Swelling of the body was observed in 73 (31.7%) of patients, while diarrhea and cough were noted in 68 (29.6%) and 60 (26.1%) patients, respectively. Abdominal pain and respiratory distress were recorded in 46 (20.0%) and 35 (15.2%) patients. Less common symptoms included seizures (n = 13, 5.7%) and loss of consciousness (n = 11, 4.8%).

Table 2 below shows the distribution of vital signs and selected laboratory findings among study participants. Tachycardia was observed in 126 (54.8%) patients, while hypotension occurred in 28 (12.2%). Hypertension was recorded in 17 (7.4%). Fever ≥38°C was documented in 98 (42.6%) cases.

Among laboratory parameters, anemia was identified in 102 (44.3%) of participants, and leukocytosis in 63 (27.4%). Thrombocytopenia occurred in 41 (17.8%), while elevated liver transaminases were found in 36 (15.7%) patients. Proteinuria was noted in 52 (22.6%), and hematuria in 44 (19.1%). Electrolyte abnormalities included hyponatremia (n = 56, 24.3%) and hyperkalemia (n = 38, 16.5%).

Table 2 Vital signs and laboratory findings among critically ill pediatric patients

Parameter	**Frequency (n)**	**Percent (%)**
Tachycardia	126	54.8
Hypotension	28	12.2
Hypertension	17	7.4
Fever (≥38°C)	98	42.6
Anemia	102	44.3
Leukocytosis	63	27.4

Thrombocytopenia	41	17.8
Elevated liver transaminases	36	15.7
Proteinuria	52	22.6
Hematuria	44	19.1
Hyponatremia	56	24.3
Hyperkalemia	38	16.5
Serum Creatinine Measurement time	**Mean ± SD (mg/dL)**	**Range (min–max)**
Baseline (1st measurement)	1.31 ± 3.07	0 – 22
48 hours	1.63 ± 3.30	0 – 22
At discharge	0.79 ± 1.87	0 – 18

Renal Function Parameters

Serum creatinine was measured for 335 patients at baseline, 258 at 48 hours, and 275 at discharge. The mean creatinine level at the first measurement was 1.31 ± 3.07 mg/dL (range = 0–22 mg/dL). At 48 hours, the mean value increased slightly to 1.63 ± 3.30 mg/dL, while at discharge it decreased to 0.79 ± 1.87 mg/dL.

Glomerular filtration rate (GFR) was recorded for 104 patients (28.9%) at baseline and 110 patients (30.6%) at discharge. The mean estimated GFR at baseline was 108.36 ± 65.2 mL/min/1.73 m². At discharge, mean GFR was 100.46 ± 68.6 mL/min/1.73 m².

Approximately two-thirds of recorded GFR values at both time points were above 90 mL/min/1.73 m², though a wide range was observed, including markedly reduced and supranormal values, consistent with the heterogeneous severity of kidney function across the cohort.

Serum Electrolytes

Potassium levels were available for 327 patients at baseline, 262 at 48 hours, and 264 at discharge. The mean baseline potassium was 4.44 ± 1.09 mmol/L (range = 0–9 mmol/L). At 48

hours, mean potassium was 5.89 ± 25.52 mmol/L, while at discharge it stabilized at 4.41 ± 1.59 mmol/L.

Serum sodium was measured for 329 patients at baseline, 266 at 48 hours, and 268 at discharge. The mean sodium concentration at baseline was 136.58 ± 14.14 mmol/L (range = 1–205 mmol/L). At 48 hours, mean sodium remained comparable at 136.46 ± 16.13 mmol/L (range = 4–198 mmol/L), while at discharge, the mean increased slightly to 138.00 ± 13.50 mmol/L (range = 1–245 mmol/L).

White Blood Cell Count (WBC)

White blood cell count was documented for 349 participants at baseline, 298 at 48 hours, and 293 at discharge. At baseline, the mean WBC was 12,463 ± 36,002 cells/mm^3 (range = 0–460,450 cells/mm^3). At 48 hours, the mean increased markedly to 256,230 ± 4,176,497 cells/mm^3, while at discharge it declined to 11,919 ± 42,777 cells/mm^3.

Hemoglobin (HGB):

The mean initial hemoglobin concentration was 11.7 g/dL (SD = 2.9), with values ranging from 3 g/dL to 20 g/dL. Approximately two-thirds of the children (67%) had hemoglobin levels between 9–13 g/dL, reflecting a moderate degree of anemia among the cohort. At 48 hours, mean hemoglobin was 10.7 g/dL (SD = 2.9), and at discharge, it remained similar (10.66 g/dL, SD = 2.8).

Hematocrit (HCT):

The mean baseline hematocrit was 32.3% (SD = 9.0; range = 8–68%). Values at 48 hours and at discharge were 31.8% (SD = 13.2) and 30.7% (SD = 8.1), respectively. A mild downward trend was observed during the hospital stay, consistent with ongoing hemodilution or red cell loss in some patients.

Red Cell Indices (MCV and MCH):

Baseline mean corpuscular volume (MCV) was 78.4 fL (SD = 12.7), remaining relatively stable at 48 hours (77.9 fL) and discharge (78.9 fL). Mean corpuscular hemoglobin (MCH) was 27.6 pg (SD = 8.2) at admission, slightly increasing to 28.0 pg at discharge. These findings indicate that the majority of patients exhibited normocytic normochromic indices, suggesting anemia of inflammation rather than iron deficiency.

Platelet Counts:

Platelet data were available for all participants at baseline and for 295 (82%) at 48 hours. The mean platelet count at 48 hours was 256,727/μL (SD = 188,268; range = 1–882,000). Considerable variability was observed, with a subset of patients exhibiting thrombocytopenia (<150,000/μL), potentially reflecting sepsis-related or AKI-associated hematological derangements.

Urine Analysis:

Urine dipstick analysis revealed hematuria in 23.3% of children, while 59.4% had no hematuria. Urinalysis was not performed in approximately 14% of cases. Proteinuria or other abnormalities were identified in a smaller proportion. Qualitative dipstick results indicated trace to +3 protein levels in multiple samples, consistent with glomerular involvement or early tubular dysfunction in AKI.

Overall, the laboratory profile of the cohort demonstrates a high prevalence of anemia, modest platelet variation, and substantial urinary abnormalities consistent with kidney injury.

Infectious and Inflammatory Markers

Blood Culture & CRP

Blood culture data were available for all 360 participants. Nearly half (48.9%) had positive growth, while 17.8% had negative culture. The most frequent isolates were coagulase-negative staphylococci (CONS, 4.2%), Gram-negative rods (1.1%), E. coli (0.8%), and Klebsiella species

(1.7%). CRP levels were recorded for 99 children (27.5%). The most common CRP values were between 1 and 15 mg/L, representing low-to-moderate inflammatory activity across measured cases.

Radiologic Findings

With regards to kidney size and morphology, ultrasound results were available for all 360 children. Normal kidney size was noted in 82.8%, increased size in 3.9%, and reduced size in 2.5%. Cortical–Medullary Differentiation was good in 84.7% of cases and poor in 4.4%.

Additional findings were recorded in 21.4% of patients. Among these, bilateral echogenic kidneys, hydronephrosis, and renal masses were the most common. Suggestive features of chronic kidney disease (CKD) were identified in 9.2%, while 78.6% had no CKD features.

Comorbidities and Clinical Management

Comorbidities were documented for all 360 participants. The most frequent conditions were anemia (16.1%), malnutrition (4.2%), cancer within the last five years (13.6%), and cardiovascular diseases (8.6%). A subset presented multiple comorbidities, most often combinations of anemia, malnutrition, and hypertension.

Of all patients, 77.5% received IV fluids. The predominant fluid used was normal saline (73.3%), followed by D5/10 (3.1%) and Ringer's lactate (1.7%). Fluid volumes were documented for all patients, most commonly 1–2 L/24 h during the AKI course. Diuretics were used in 24.2% of children. Furosemide was the main diuretic (25.0% overall), while spironolactone and thiazides were infrequently prescribed.

Prevalence and staging of AKI

According to the KDIGO criteria, 28% (n = 101) of the children were diagnosed with acute kidney injury (AKI). Among these, stage 1, stage 2, and stage 3 comprised 7.5%, 11.1%, and 9.4% of cases as shown in figure 2.

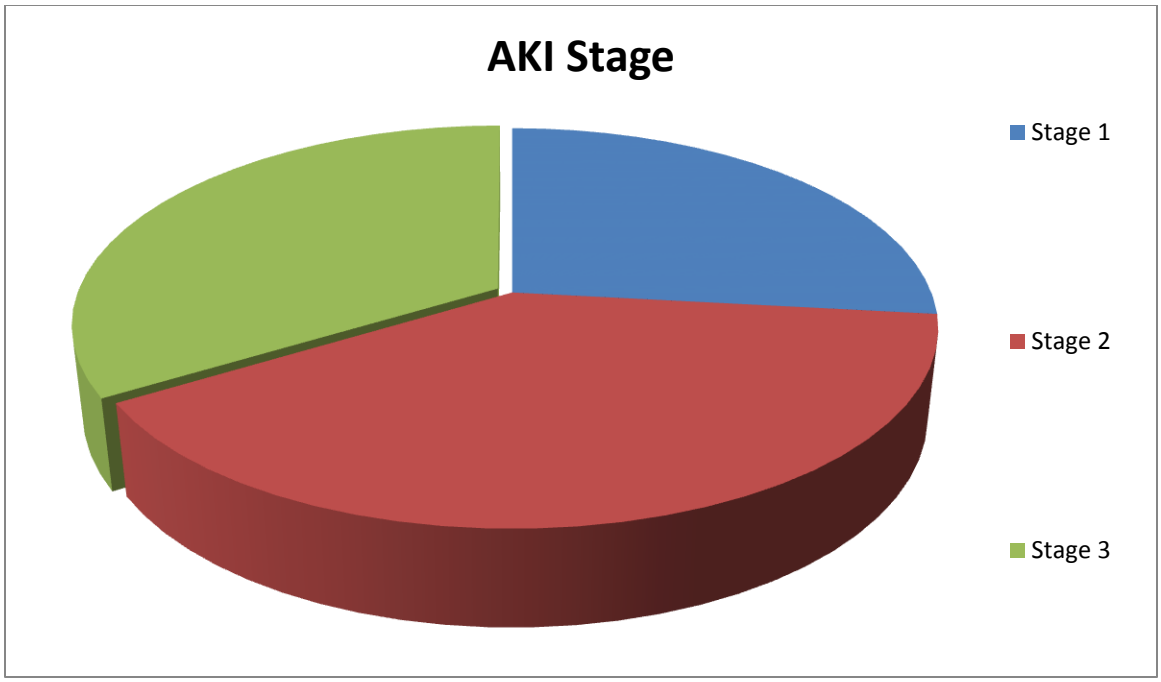


Figure 2 Staging of acute kidney injury (AKI)

Distribution of AKI by Demographic Characteristics

AKI prevalence was higher among females (n=55) compared to males (n=46) By age category, the highest number of AKI occurred among children above 60 months (n=46), followed by 12 to 59 months years (n=43) and below 1 year (12)(Table 3).

Table 3 AKI and clinical variable Distribution by Demographic Variables

Variable	**Category**	**AKI: No n (%)**	**AKI: Yes n (%)**	**Total n (%)**
Age	<12 months	26 (10.0%)	12 (11.9%)	38 (10.6%)
	12–59 months	120 (46.3%)	43 (42.6%)	163 (45.3%)
	≥60 months	113 (43.6%)	46 (45.5%)	159 (44.2%)
Sex	Male	55 (21.2%)	46 (45.5%)	184

				(51.1%)
	Female	204 (78.8%)	55 (54.5%)	176 (48.9%)
Sepsis	Yes	68 (26.3%)	50 (49.5%)	118 (32.8%)
	No	191 (73.7%)	51 (50.5%)	242 (67.2%)
Vasopressors Administered	Yes	35 (13.5%)	37 (36.6%)	72 (20.0%)
	No	203 (78.4%)	61 (60.4%)	264 (73.3%)
	Not documented	21 (8.1%)	3 (3.0%)	24 (6.7%)
Total		**259 (100%)**	**101 (100%)**	**360 (100%)**

AKI and Clinical Characteristics

AKI occurrence varied across several clinical parameters. It was more frequent among patients with fever (56.1%), vomiting (51.4%), and oliguria or anuria (63.5%). Children with comorbidities such as malignancy (72.1%), sepsis (68.5%), or shock (61.9%) had higher AKI prevalence compared with those without these conditions. Mechanical ventilation and vasopressor use were also strongly associated with AKI presence.

Dialysis and Renal Replacement Therapy

Among 360 participants, 14.2% were eligible for dialysis, but only 1.9% underwent treatment. Of those dialyzed, peritoneal dialysis was used in 2.2% of cases and hemodialysis in 0.3%. The

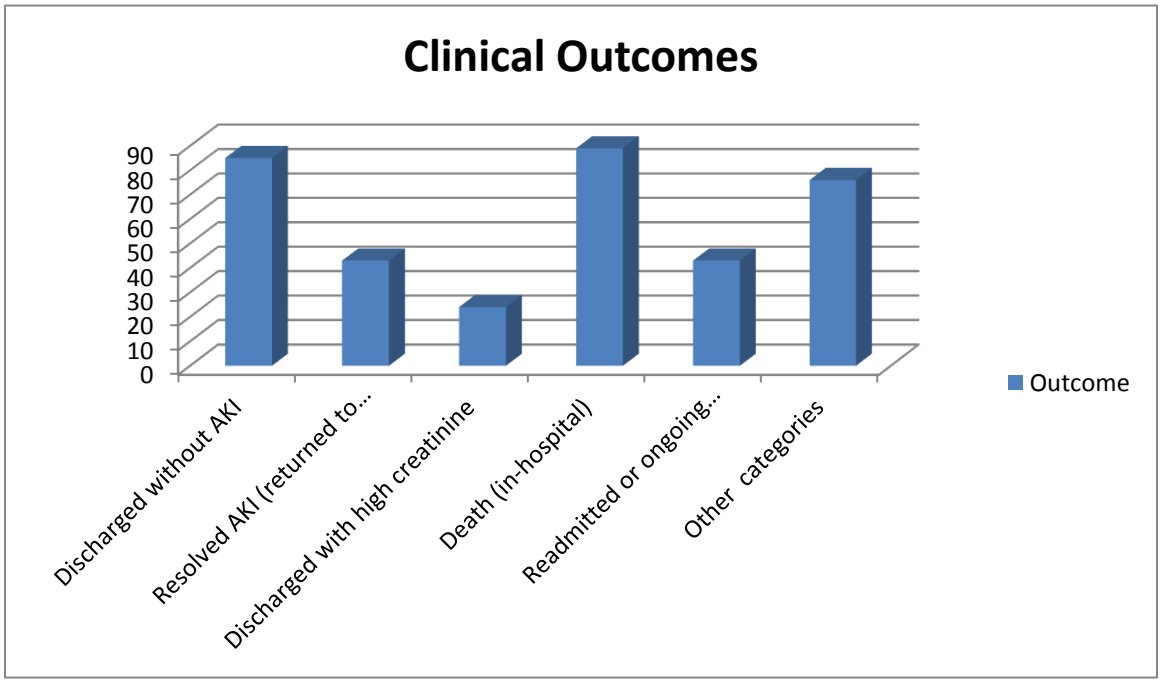
main indications for dialysis were hyperkalemia (2.2%), altered mental status (0.8%), and fluid overload (0.6%), alone or in combination.

Eighty-seven children (24.2%) required mechanical ventilation. Vasopressors were administered in 20.0% of patients, while 73.3% did not require them.

Clinical Outcomes

Outcome data were available for all 360 patients among which 28.1% had AKI. At discharge, 23.6% were discharged without AKI, 11.9% achieved full renal recovery (resolved AKI), and 24.7% died during admission. A further 6.7% were discharged with persistently high serum creatinine, and 11.9% required readmission or continued inpatient care.

Figure 3 Clinical outcomes of the AKI patients



AKI and Clinical Outcomes

Mortality was significantly higher among patients with AKI (45.4%) than those without (9.5%). Complete renal recovery occurred in 18.6% of AKI patients, while 32.1% had residual renal impairment at discharge.

Factors Associated with AKI among the Critically Ill Pediatric Patients

Bivariate logistic regression analyses

In a bivariable logistic regression, association was sought between AKI and dependent variables. A cutoff of 0.2 was used to identify variables with potential association. Sepsis, Antibiotic initiation, hospital stay, and ICU stay were significantly associated with Aki and were further moved to multivariable regression for potential confounders.

Multivariable logistic regression analyses

On multivariable logistic regression, variables with p value of 0.05 or less considered significant. Sepsis was significantly associated with increased odds of AKI, with a p-value of 0.000 and an adjusted odds ratio (AOR) of 1.263 (95% CI: 1.132–1.523). This indicates that patients with sepsis had a 26.3% higher likelihood of developing AKI compared to those without sepsis.

Antibiotic administration within the first hour was not statistically significant (p = 0.210), with an AOR of 0.659 (95% CI: 0.343–1.266). Length of hospital stay showed a borderline significant inverse association with AKI (p = 0.043), with an AOR of 0.987 (95% CI: 0.975–1.000). This suggests that each additional day of hospital stay was associated with a 1.3% reduction in the odds of developing AKI, although the effect size is minimal. ICU stay was significantly associated with an increased risk of AKI, with a p-value of 0.001 and an AOR of 1.054 (95% CI: 1.022–1.088). This Each additional day in the ICU increased the odds of AKI by 5.4%, highlighting ICU stay as a notable risk factor (Table 4).

Table 4 Bivariable and multivariable logistic regression analysis of factors associated with pediatric AKI

Variable	**Bivariable p-value**	**COR (95% CI)**	**Multivariable p-value**	**AOR (95% CI)**
Total bilirubin	0.287	1.42 (0.75–2.69)	—	—
Sepsis	**<0.001 ***	1.36 (1.23–1.59)	**0.000***	1.263 (1.132–1.523)
Pathogen identified	0.371	1.30 (0.73–2.32)	—	—

Antibiotics within 1 h	**<0.001 ***	0.39 (0.24–0.62)	0.210	0.659 (0.343–1.266)
Hospital stay	**0.049 ***	0.988 (0.977–1.000)	**0.043***	0.987 (0.975–1.000)
ICU stay	**0.075***	1.022 (0.998–1.046)	**0.001***	1.054 (1.022–1.088)
Outcome	0.993	1.18(1.110- 1.342)	0.982	1.31 (1.091 - 1.503)
Comorbidities	**0.001***	**1.142(1.112-1.411)**	**0.011***	**1.231(1.115-1.690)**
Length of stay in Hospital	**0.049***	**0.988(0.977, 1.000)**	**0.012**	**0.972(0.952,0.994)**
Length of stay in the ICU	**0.075***	**1.022(0.998, 1.046)**	**0.000**	**1.119(1.051-1.190)**

In the bivariable analysis, comorbidities showed a statistically significant association with pediatric AKI (COR = 1.142, 95% CI: 1.112–1.411; p = 0.001). In the multivariable logistic regression analysis, comorbidities remained independently associated with pediatric AKI, with children who had comorbid conditions having higher odds of developing AKI (AOR = 1.231, 95% CI: 1.115–1.690; p = 0.011)

Linear Regression Analyses with Length of Stay in the ICU as Dependent Variable

A univariable linear regression analysis was conducted to examine the association between acute kidney injury (AKI) and intensive care unit (ICU) length of stay. A diagnosis of AKI was significantly associated with a longer ICU stay. Specifically, patients with AKI spent an average of 3.61 additional days in the ICU compared with patients without AKI (B = 3.61, SE = 1.68, t = 2.14, p = .033). The intercept indicated an estimated ICU length of stay of 6.11 days for patients without AKI.

Table 5 Univariable Linear regression analysis between Length of Stay in the ICU as Dependent Variable and AKI

Predictor	**B**	**SE**	**β**	**t**	**p**	**95% CI for B**
Constant	6.11	0.92	—	6.65	< .001	[4.30, 7.91]
AKI Diagnosis (Yes vs No)	3.61	1.68	0.12	2.14	.033	[0.30, 6.93]

A multivariable linear regression analysis was performed to identify predictors of intensive care unit (ICU) length of stay. After adjusting for age and total hospital length of stay, a diagnosis of acute kidney injury (AKI) was independently associated with a significantly longer ICU stay. Specifically, patients with AKI spent an average of 5.27 additional days in the ICU compared to those without AKI (B = 5.27, SE = 1.64, t = 3.20, p = .002).

Table 6 Multivariable Linear regression analysis between Length of Stay in the ICU as Dependent Variable and AKI

Predictor	**B**	**SE**	**β**	**t**	**p**	**95% CI for B**
Constant	−1.73	1.51	—	−1.14	.254	(−4.71, 1.25)
AKI Diagnosis (Yes vs No)	5.27	1.64	0.17	3.20	.002	(2.03, 8.50)
Age (years)	−0.06	0.16	−0.02	−0.37	.714	(−0.37, 0.25)
Hospital Length of Stay (days)	0.29	0.03	0.55	10.27	< .001	(0.24, 0.35)

Linear Regression Analyses with Duration of Stay in the Hospital as Dependent Variable

A linear regression analysis was conducted to examine whether a diagnosis of acute kidney injury (AKI) predicted length of hospital stay. The overall model indicated that AKI diagnosis was a marginally significant predictor of hospital length of stay. Specifically, patients diagnosed with AKI had, on average, a 6.16-day shorter hospital stay compared to patients without AKI (B = −6.16, SE = 3.13, t = −1.97, p = .050). The 95% confidence interval narrowly excluded zero

(−12.31 to −0.01), suggesting a weak but statistically borderline association. The intercept indicated an estimated hospital stay of 27.51 days for patients without AKI.

Table: 7 Univariable Linear regression analysis between Length of Stay in Hospital as Dependent Variable and AKI

Predictor	**B**	**SE**	**β**	**t**	**p**	**95% CI for B**
Constant	27.51	1.67	—	16.47	< .001	(24.22, 30.79)
AKI Diagnosis (Yes vs No)	−6.16	3.13	−0.11	−1.97	.050	(−12.31, −0.01)

A multivariable linear regression analysis was conducted to identify predictors of total hospital length of stay. After adjusting for age and intensive care unit length of stay, a diagnosis of acute kidney injury (AKI) was independently associated with a significantly shorter hospital stay. Specifically, patients with AKI had, on average, a 10.86-day shorter hospital length of stay compared with patients without AKI (B = −10.86, SE = 3.05, t = −3.56, p < .001). This likely reflects unmeasured clinical factors such as early mortality, transfer to other facilities, or differences in discharge disposition, rather than a protective effect of AKI.

Table 8: Multivariable Linear regression analysis between Length of Stay in Hospital as Dependent Variable and AKI

Predictor	**B**	**SE**	**β**	**t**	**p**	**95% CI for B**
Constant	22.58	2.44	—	9.27	< .001	(17.79, 27.38)
AKI Diagnosis (Yes vs No)	−10.86	3.05	−0.19	−3.56	< .001	(−16.86, −4.85)
Age (years)	−0.05	0.29	−0.01	−0.15	.878	(−0.63, 0.53)
ICU Length of Stay (days)	1.02	0.10	0.54	10.27	< .001	(0.82, 1.21)

6. DISCUSSION

In this study, AKI affected 28%(101) of our critically ill pediatric cohort (stages 1–3 distributed at 7.5%, 11.1%, and 9.4% respectively), a burden somewhat lower than reported in similar settings. For example, Naik et al. found AKI in 40.9% of Indian PICU patients (using pRIFLE criteria)(3), and Abebe et al. observed 32% of Ethiopian children with AKI reaching stage 3(19). Differences in AKI definition (KDIGO vs. pRIFLE), patient populations, and referral patterns likely account for these variations. Consistent with prior reports, our AKI cases clustered in toddlers and young children (37% in age 1–5 years) and were more frequent in males. The relatively lower proportion of stage-3 AKI in our study (9.7%) versus reports such as Abebe et al. (32%) may reflect earlier recognition or selection biases in our setting (19).

We identified sepsis as a key determinant of AKI. In multivariate analysis, sepsis increased AKI odds (AOR ≈1.26; $p<0.001$), and 68.5% of septic patients in our cohort developed AKI. This aligns with large pediatric cohorts showing sepsis as a major AKI trigger(9). Chang et al. similarly reported sepsis (and related interventions such as mechanical ventilation and vasopressor use) among independent risk factors for AKI in critically ill children (15)). In our cohort, shock and malignancy also showed high AKI prevalence in bivariate analysis, reflecting that multi-organ failure states and oncologic illnesses predispose to renal injury. Notably, intensive care exposures were strongly linked to AKI: 78% of ventilated children and 74% of those on vasopressors had AKI. These findings corroborate reports that hemodynamic instability and organ-support therapies in the PICU increase AKI risk.

AKI was associated with dramatically worse outcomes. Mortality among children with AKI was 45.4%, far exceeding the 9.5% mortality in non-AKI patients. This excess mortality is higher than in some series (for instance, 32.6% in a Spanish PICU cohort (18) and 30% in Sudanese AKI patients) (17) but similar to reports in resource-limited settings (sub-Saharan African AKI mortality 34%–44%)(10)). The low rate of renal recovery in our AKI patients (only 18.6% normalized creatinine by discharge) and high rate of residual dysfunction (32.1% had persistently elevated creatinine) underscore the severity of illness; for comparison, 68.9% of Sudanese children recovered from AKI (17). Our data suggest that limited access to renal replacement therapy (only 1.9% of eligible patients received dialysis) may contribute to these outcomes. This treatment gap is well documented in Africa: Olowu et al. noted that although

66% of children with AKI needed dialysis, only 64% received it, and mortality approached 73% when indicated dialysis was not given(10).

This study found that comorbidities and length of ICU stay were independently associated with increased odds of pediatric acute kidney injury (AKI), consistent with prior evidence that underlying illnesses, sepsis, and critical disease severity significantly predispose children to AKI (1–5,13,15). Comorbid conditions reduce renal reserve and increase exposure to hemodynamic instability and nephrotoxic medications, key mechanisms in AKI pathogenesis (2,5,7). In this study, acute kidney injury (AKI) was consistently associated with longer intensive care unit (ICU) length of stay in both univariable and multivariable analyses, suggesting that AKI is an independent marker of increased critical care utilization. In contrast, AKI was associated with shorter total hospital length of stay indicating that ICU stay may mediate the relationship between AKI and overall hospitalization. Although statistically significant, the inverse association between AKI and hospital length of stay is counterintuitive and likely reflects unmeasured clinical factors such as early mortality, transfer to other facilities, or differences in discharge disposition, or in-hospital mortality rather than a protective effect of AKI. Together, these findings suggest that patients with AKI experience a more ICU-intensive hospital course.

These findings have several implications. The high AKI prevalence and its association with sepsis and critical illness indicators highlight the need for vigilant renal monitoring in at-risk children. Early identification of AKI (e.g. through urine output tracking and creatinine monitoring in septic and hemodynamically unstable patients) could allow prompt interventions. The mortality impact also emphasizes improving supportive care: ensuring timely fluids, hemodynamic support, and, importantly, expanding access to dialysis for children in need. Finally, the observed residual renal impairment at discharge suggests the importance of follow-up to identify and manage evolving chronic kidney disease in pediatric AKI survivors.

CONCLUSION

In summary, AKI was common among critically ill children in this study and was driven largely by sepsis and intensive care factors, with a high associated mortality. These results underscore the urgency of early AKI recognition, aggressive management of sepsis, and investment in renal support resources in pediatric ICUs.

RECOMMENDATION:

Given the high prevalence of AKI and its strong association with sepsis, shock, and intensive care interventions, early identification and vigilant monitoring of at-risk children are critical. It is recommended that routine tracking of serum creatinine and urine output should be implemented for all critically ill pediatric patients, particularly those with sepsis or hemodynamic instability. Optimized fluid and hemodynamic management, guided by standardized protocols, may reduce AKI incidence and severity. The extremely limited access to dialysis highlights an urgent need to expand pediatric renal replacement therapy capacity, including training in peritoneal dialysis for resource-limited settings. Furthermore, structured post-discharge follow-up is essential to detect residual renal dysfunction and prevent progression to chronic kidney disease.

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8. ANNEXES

8.1. Questionnaire English Version:

Consent form

College of health science

Instrument one; Questionnaire

Dear respondents my name is Dr Gustave KAREMERA MULINDWA *the purpose of this questioner is to collect data for the research project entitled* the outcomes of children with acute kidney injury admitted with critical illness among admitted patient in TASH hospital, Ethiopia: (2024 gc). *It is believed that each item will be highly valuable to design possible intervention strategies and to improve outcome among patient with AKI patient. Thus be honest and cooperative to provide relevant information to expedite effective remedies*.

The information that will be obtained from this questionnaire is only used for the accomplishment of the purpose of research.

Thanks in advance

Part I Socio Demographic Data

1. Patient ID…… Phone number……..
2. Age……wt. -------- Ht--------- MUAC
3. Sex…….
4. Address: A. Rural B. Town
5. Education level of caretakers: □ non education □ primary school □ secondary school □University ……
6.

Part II pre admission characteristics

7. Date of admission…….
8. Reason for admission……
9. Date of diagnosis of AKI…….
10. KDIGO AKI staging: □stage 1 □stage 2 □ Stage 3
11. Referred from district hospital/other health facility □yes □No
12. If yes number of days spent at that facility □ …….
13. Where AKI was diagnosed: □TASH □ other government hospital □Private clinic/hospital □ others
14. Drugs/Treatments used before admission: □ None □Furosemide □ Antihypertensive □others
15. IV fluids before admission: □None□ Normal saline□ Ringer lactate □ D5% □ others

Part III. CRITICALLY ILL

1. ▪ Sepsis □yes □No
2. If yes, indicate SIRS criteria used

□WBC > 12,000 or < 4,000 □ Tachycardia □To > 38c 0r <36c □Tachypnea

3. ▪ Critically ill child**:** Critically ill child is the child with any of the following emergency signs:

□ Obstructed breathing/severe respiratory distress

□ Central cyanosis

□ Rapid and weak pulse

□ Cold and blue hands

□ Capillary refill time >3secondes

□ Lethargy/Unconsciousness

□ Sunken eyes

□ Very slow skin pinch.

□ Active convulsions

Part IV. PRESENTING SYMPTOMS

□ Not producing urine for more than 12 hours (Anuria)

□ Not producing urine for more than 6 hours (Oliguria)

□ Fever (T >37.7)

□ Shortness of breath

□ Abdominal swelling

□ Lower limb swelling

□ Altered mental status (reduced GCS)

□ Abnormal bleeding

□ Generalized body weakness

□ Nausea / Vomiting

□ Abdominal pain/ discomfort

Part V. SIGNS

VS: BP……..HR…….RR……..SPO2……..T^{o}…… Height……..Weight……

Edema: □ None □ Grade I Grade II □ Generalized

Examination of systems (others than vital signs)

Respiratory system: □ Crepitation □ Rhonchi □ Other abnormalities

Cardiovascular systems: □ Presence of organic murmur□ Presence of cardiomegaly□ Other abnormalities

Abdomen: □ Hepatomegaly□ Splenomegaly □ Ascitis □ Others abnormalities

Central Nervous Systems: □ GCS Meningeal signs □ Cranial nerve palsies □Other abnormalities

Other abnormalities:

Part VI. LAB INVESTIGATIONS

Exam\Date	1st measurement	48hrs measurement	At discharge				
Creat							
K							
Na							
Glucose							
WBC							
RBC							
Hb							
Hct							
MCV							
MCH							
Platelets							

BF for malaria							
Proteinuria							
Hematuria							
Other results of urine Dipstick							

▪ Calculated GFR at baseline……ml/min/1.73m^2

▪ Calculated GFR at discharge……ml/min/1.73m^2

▪Blood culture (if available)…….

▪CRP…….

Part VII.IMAGING

Kidney size: □ Normal □ Reduced □ Increased

Cortical medullary differentiation □ good □ poor

Other significant findings……

Suggestive features of CKD □yes □No

PART VIII. COMORBIDITIES

1. History of cardiovascular diseases □Yes □No

□CHF □ Valvular disease □ CHD □ Dilated CMP

2. Diabetes □Yes □No

3. Hypertension □Yes □No

4. HIV □Yes □No

5. Malnutrion □Yes □No

6. Anemia □Yes □No

7. Cancer in last 5 years □Yes □No

8. Chronic liver disease/ Cirrhosis □Yes □No

9. other mentioned ……..

PART IX. MANAGEMENT

IV fluids: □Yes □No

Kind of fluids used □ Normal Saline □Ringer lactate □Dextrose

Number of litters/24h used during the course of AKI, ……

Specify, NS……., RL……., D5/10……

Use of diuretics □ Yes □ No

Specify □ Furosemide □ Thiazides □ Other

Eligible for Dialysis: □ Yes □ No

Treated with Dialysis: □ Yes □ No

Dialysis modality □ hemodialysis □ Peritoneal dialysis

Dialysis indications

□ Hyperkalemia

□ Fluid overload

□ Altered mental status

□ Metabolic acidosis

Other mention ……..

Part X OTHER DIAGNOSIS

……

Part XI IN HOSPITAL OUTCOME AT DISCHARGE

□ Resolved AKI (Back to baseline creatinine) □ Discharged with high serum creatinine □ Death

Date of discharge/ death……..

Length of hospital stay in days……

Appointment date for follow up……./……../……..

Name of research assistant…….

Signature……

THANK YOU!!!