DOI: https://doi.org/10.53350/pjmhs2115113400

ORIGINAL ARTICLE

Outcome and Incidence of Acute Kidney Injury among Hospitalized Children

SHAHEEN MASOOD[1], RIFFAT FARRUKH[2], QAMAR RIZVI[3], IBRAHIM SHAKOOR[4], AMBER NASEER[5], SARWAT SULTANA[6]
[1]*Assistant Professor Pediatrics, Karachi Medical and Dental College, Karachi*
[2]*Assistant professor, Department of pediatrics, Karachi medical and dental college Abbasi Shaheed Hospital Karachi*
[3] *Professor, Department of Pharmacology, Jinnah Medical and Dental College, Karachi*
[4]*Professor, Department of Pediatric, Karachi Medical & Dental College and Abbassi Shaheed Hospital Karachi*
[5]*Senior Registrar, Department of Paediatric, Karachi Medical & Dental College and Abbasi Shaheed Hospital Karachi*
[6]*Asst Professor Community Medicine Department, Karachi Medical & Dental College Karachi*
Correspondence to: Shaheen Masood, Email: shaheentaqi1@gmail.com, Cell: +92-335-1244650

ABSTRACT

Background and purpose: Data on the epidemiology of acute kidney injury (ARI) in Asia come primarily from studies conducted in large tertiary hospitals with nephrology departments. Little is known about what happens in primary care settings without nephrology, especially in the paediatric population. The aim of this study is to describe the epidemiology, outcome and risk factors of ARF in children admitted in pediatric department.

Place and Duration: In the Pediatric Medicine and Nephrology department of Abbasi Shaheed Hospital for one-year duration from August 2020 to August 2021.

Methods: We prospectively examined children aged 2 to 14 whose guardians gave the consent for the study and were admitted in the Pediatric ward. We identified children with risk factors for AKI on admission and then tested them for AKI using the 2012 Creatinine-based Modified General Kidney Disease Improvement (KDIGO) criteria to improve overall outcomes. Participants with AKI were followed up to discharge. The subject of interest was the need and access to dialysis and renal recovery on discharge from the hospital.

Results: A total of 74.3% (n = 116) out of the 156 patients admitted during the study period were at risk of ARF. Of the 156 registered participants, 51.9% (n = 81) were males with a mean age of 5 years. Although comorbid conditions were rare, sickle cell anaemia and malnutrition were the most common. Most of the children were hypotensive (n = 89; 57.1%), with mean systolic and diastolic blood pressures of 81 mmHg and 42 mmHg, respectively. The mean urine output was 0.79 ml / kg / hr. Thirteen patients (8.33%) had urine dipstick anomalies. Anaemia was common (n = 72, 46.2%) and 32 (20.5%) had severe anaemia. Leucocytosis was detected in 26.3% of patients, and a platelet count below 100,000 / mm3 in 24 (15.4%) patients. In total, 21 of 156 participants had AKI for an incidence of 13.5%. The only patient with an indication for dialysis (uremic encephalopathy and anuria> 24 hours) died without dialysis due to a delay in transfer to a dialysis centre (due to lack of resources). Of the 20 survivors in the AKI group, 15 (71.4%) had complete improvement in kidney function The median hospitalization time was significantly longer in participants with stage 3 AKI.

Conclusions: ARF risk factors are very common in children admitted in the hospitals. At least one in 10 children presenting with AKI risk factors will have AKI. AKI is largely caused by community-acquired diseases that can be prevented, such as diarrheal diseases and malaria. Efforts should be made to educate about risk assessment, prevention, early diagnosis and treatment of AKI in children.

Keywords: AKI; epidemiology; risk factors and outcome.

INTRODUCTION

Acute kidney injury (ARI) is a common disease that affects approximately 13.3 million people annually worldwide[1]. Longer hospital stays are associated with higher healthcare costs and poorer patient outcomes, such as death, cardiovascular disease and chronic kidney disease. In high-income countries, in-hospital AKI is more common, affecting older patients admitted to the intensive care unit with a heavy burden of comorbidities, and is primarily the result of diagnostic or therapeutic procedures for comorbidities[2-3]. In addition, under these conditions, a high incidence of ARF has been reported in children and is generally associated with subsequent cardiac surgery, sepsis, multiple organ failure and exposure to nephrotoxic agents. In low-income countries, data on AKI epidemiology is sparse, although it is believed to be high, and about 85% of people may have AKI. In Asia, AKI is often acquired in the community. Young people are most affected and mortality is high due to delays in admission, diagnosis and care[5]. Olowej et al. reported all mortality as 34% in children and 32% in adults; the proportion increased to 73% in children and 86% in adults, whether or not dialysis was required. In fact, most cases of AKI are treated by people who are not nephrologists and are unfamiliar with the risk factors and early symptoms of the disease, contributing to late diagnosis and poor treatment, especially in children[6-7]. Bhojani et al. They found that only 26% of paediatric AKI is diagnosed in the UK[8]. The outlook may be worse in low- and middle-income areas where a lack of access to adequate health care, a lack of dialysis centres and financial constraints are more common[9-10]. In addition, the available data on the epidemiology of ARF in these areas are based primarily on studies in large specialized tertiary hospitals providing nephrology services. Little is known about paediatric AKI in healthcare settings, often in primary care settings that do not have nephrology services[11-12]. The aim of this study is to describe the epidemiology, outcome and risk factors of ARF in children admitted in pediatric department

MATERIAL AND METHODS

This study was held in the Pediatric Medicine and Nephrology department of Abbasi Shaheed Hospital for one-year duration from August 2020 to August 2021.We prospectively screened children 2 to 14 years of age on admission to identify risk factors for ARF. Children who gave consent with parental consent and who had AKI risk factors were included in the study. Children diagnosed with chronic kidney disease were excluded from the study.

For each participant and at enrolment, we collect relevant sociodemographic and clinical data after a full clinical trial. We perform urine analysis with a dipstick and monitor urine output. Urine was collected in a container for conscious children who could express themselves while urinating, and a flow / urinary catheter was used for unconscious patients. A random venous blood sample was then taken for serum creatinine analysis and repeated 48 hours later for AKI diagnosis. Serum creatinine determination was performed using the enzymatic method of spectrophotometry. All participants were followed until death or discharge from hospital. In addition, the severity, probable mechanism, and aetiology of AKI were determined in participants with AKI, and serum creatinine was performed on discharge to assess renal regeneration. For subjects without AKI, AKI screening was

performed in the presence of risk factors for the event or decreased urine output. Laboratory parameters such as white blood cell count, haemoglobin level or possibly a malaria test were recorded. AKI was defined according to modified serum creatinine according to Global Outcomes for Renal Disease Improvement (KDIGO) 2012 and classified using the KDIGO 2012 severity classification. The following definitions were used: - AKI was defined according to the following criteria: decrease or increase in serum creatinine ≥ 0. 3 mg / dL in 48 hours. At least 50% increase in baseline creatinine (creatinine on admission) during hospitalization. The diagnosis of prerenal AKI was based on a history, symptoms of hypovolemia with a urine dipstick test gravity> 1020, a urea / creatinine ratio greater than 30, and normalization of renal function with volume expansion. Anuria is defined for a urine volume of 2.5 ml / kg / h. -Acute tubular necrosis was determined grounded on history, urine dipstick test gravity, presence of risk factors and polyuric phase recovery. The partial improvement was noted as at least a 50% decrease in serum creativity without normalizing at discharge and complete discovery as normalization of serum creatinine on discharge. – Nephrotoxins are exposure to nephrotoxic drugs such as aminoglycosides, non-steroidal anti-inflammatory drugs (NSAIDs), conventional drugs or iodinated contrast agents. Sepsis is diagnosed on the basis of evidence-related or suspected infection-related systemic inflammatory response syndrome. The diagnosis of malaria was based on fever and a positive thick blood smear or a rapid antigen test for Plasmodium falciparum. Severe malaria is defined according to WHO criteria. Anaemia is defined as a haemoglobin level of 10,000 cells / mm3. The study was approved by the Ethical Committee. Data analysis was performed with the SPSS version 22 statistical package. Continuous data were summarized as mean ± standard deviation or median, respectively (interquartile range 25-75 IQR), with categorical data as percentage.

RESULTS

A total of 74.3% (n = 116) out of the 156 patients admitted during the study period were at risk of ARF. Of the 156 registered participants, 51.9% (n = 81) were males with a mean age of 5 years. Although comorbid conditions were rare, sickle cell anaemia and malnutrition were the most common. The main risk factors for ARF were volume depletion, sepsis and nephrotoxins exposure (Table 1).

Table 1: socio-demographic characteristics, comorbidities and risk factors

Variable	Effective (N=156)	Percentage
Sex		
Male	81	51.9%
Female	75	48.1
Age		
2-6 years	84	53.8
6-12 years	45	28.9
12-14 years	27	17.3
Residency		
Urban	144	92.3
Rural	12	7.7
Comorbidity		
None	142	91.1
Malnutrition	9	5.8
Sickle cell anaemia	3	1.9
HIV infection	0	0
Down syndrome with cardiac malformation	2	1.3
Risk factor of AKI		
Sepsis	134	85.9
Volume depletion	96	61.5
Nephrotoxins (n=52) Aminoglycoside	31	19.9
Traditional medicines	24	15.4
NSAIDS	4	2.6
Anaemia with decompensation	21	13.5
Sickle cell crisis	3	1.9
Decompensated heart failure	2	1.3
Lymphoma	1	0.64

Half of the patients (n = 79, 50.6%) had more than 2 risk factors. The main diagnosis on admission was infections, especially severe malaria (Table 2).

Table 2: clinical features of patients

Variable	Effective (N=156)	Percentage
Admission diagnosis		
Infections (n=148)		
Severe malaria*	86	55.1
Community acquired Pneumonia	15	9.6
Pharyngitis / otitis	10	6.4
Febrile diarrhea	14	8.9
Meningitis	5	3.2
Urinary tract infection	10	6.4
Erysipelas/myositis	2	1.3
Septic arthritis	3	1.9
Tuberculosis	2	1.3
Herpes Zooster	2	1.3
Appendicitis	1	0.64
Indeterminate sepsis	3	1.9
Non-infectious (n=8)		
Sickle cell crisis	3	1.9
Decompensated heart failure	2	1.3
Paracetamol intoxication	2	1.3
Lymphoma	1	0.64
Clinical parameters		
Hypotension	89	57.1
Dehydration	60	38.5
Oliguria/anuria	7	4.5
urinary dipstick parameters		
Proteinuria	12	7.7
Haemoglobinuria	10	6.4
Leukocyturia	7	4.5

Table 3: Complete blood count data

Variable	Median	[25TH - 75TH Interquartile range]
Haemoglobin level (g/dL)	9.7	[7.1-11.6]
White blood cell count (cell/mm3)	8100	[5650-12564]
Platelet count (cell/mm3)	161210	[121050-259790]

Table 4: outcome and characteristics of AKI patients

Variable	Frequency (n=21)	Percentage
Type of AKI		
Community-acquired AKI	17	81
Hospital-acquired AKI	4	19
Severity of AKI		
Stage 1	7	33.3
Stage 2	6	28.6
Stage 3	8	38.1
Mechanism of AKI		
Pre-renal	13	61.9
Acute tubular necrosis	8	38.1
Etiologic factors		
Diarrhoea/ vomiting	10	47.6
Malaria (n=8)		
Black water fever	3	14.3
Dehydration	5	23.8
Nephrotoxins (n=4)		
Aminoglycosides	2	9.5
Traditional medicines	2	9.5
Sepsis (n=5)		
Bronchopneumonia	3	14.3
Urinary tract infection	1	4.8
Sepsis of unknown aetiology	1	4.8
Outcome at hospital discharge		
Alive with complete renal recovery	15	71.4
Alive with partial renal recovery	3	14.3
Left against medical advice in AKI stage 1	2	9.5
Death	1	4.8

Most of the children were hypotensive (n = 89; 57.1%), with mean systolic and diastolic blood pressures of 81 mmHg and 42 mmHg, respectively. The mean urine output was 0.79 ml / kg / hr. Thirteen patients (8.33%) had urine dipstick anomalies. Anaemia

was common (n = 72, 46.2%) and 32 (20.5%) had severe anaemia. Leucocytosis was detected in 26.3% of patients, and a platelet count below 100,000 / mm3 in 24 (15.4%) patients (Table 3).

In total, 21 of 156 participants had AKI for an incidence of 13.5%. Participants with AKI were much older and more likely to have febrile diarrhea than those without AKI. AKI was prerenal in 13 of 21 cases (Table 4).

Two hospital cases of ARF have been associated with the use of aminoglycosides. The only patient with an indication for dialysis (uremic encephalopathy and anuria> 24 hours) died without dialysis due to a delay in transfer to a dialysis centre (due to lack of resources). Of the 20 survivors in the AKI group, 15 (71.4%) had complete improvement in kidney function, and 3 had partial improvement after discharge from hospital when they were the host.

The median hospitalization time was significantly longer in participants with stage 3 AKI (stage 1 = 2 [1-4] days; stage 2 = 4 [3-5] days; stage 3 = 7 [5-11] days; p = 0.031 and with hospital acquired AKI (community acquired = 4 [2-6] days; inpatient 9 (6-11)] days; p = 0.032).

DISCUSSION

Referrals of children to regional hospitals around us indicate a high prevalence of ARF risk factors, including sepsis, hypovolaemia and frequent use of nephrotoxins. The incidence of ARF among patients at risk was 13.5%. The most common causes were malaria and gastrointestinal loss. Mortality was low (4.8%), and 71.4% of them achieved complete kidney recovery on discharge from hospital. We found that 74.3% of paediatric admissions were at risk of AKI, suggesting that more than 2/3 of children admitted to the Hospital may develop AKI[11-12]. As noted in previous reports on paediatric ARF in tertiary -hospitals in Pakistan and other resource-constrained regions, sepsis, malaria, and hypovolemia were the main risk factors for ARF in our environment. In fact, as we have noted, infections, malaria and diarrheal diseases are common pathologies among paediatric referrals to both primary and higher tertiary care in low-income countries[13-14]. However, in primary care settings such as county hospitals, children are often looked after by nurses and general practitioners who are unfamiliar with the risk factors and early symptoms of AKI that lead to a diagnosis of AKI[15-16]. Several factors can delay admission to hospitals for care in low-income countries; Lack of funds, cultural prejudices and geographic access to healthcare facilities are widely reported. Contrary to the poor short-term results noted in previous low-income studies, we observed low mortality and good kidney regeneration in this study[17-18]. Systematic screening of patients at risk of ARF allows for rapid correction of risk factors, monitoring of renal function and appropriate management of people with ARF. A high rate of prerenal azotaemia suitable for fluid resuscitation may also explain these findings. This highlights the need to implement a 5R strategy for causes that can be corrected and thus prevent AKI in the event of early detection, particularly in those primary care settings where community-acquired pre-renal azotaemia predominates[19-20]. Despite substantial subsidies from the government for dialysis, previous studies have shown a lack of funding and limited opportunities to limit children's access. The only dialysis patient died from lack of timely availability of resources. In addition, patients have to pay out-of-pocket hospital bills in a primary care facility before transferring them to dialysis in a tertiary hospital and also have to pay a deposit as a risk if they cannot pay for the services at the end of that hospital[21-22].

CONCLUSION

AKI risk factors are very common when children are admitted to the Pediatric Unit, with at least one in 10 children being admitted with risk factors for developing AKI. Risk factors are mainly due to common and preventable childhood diseases such as bacterial infections, malaria and diarrheal diseases. Routine screening for risk factors, monitoring of renal function in at-risk individuals, and appropriate response to risk factors and AKI can reduce the incidence of AKI and improve outcomes. Urgent efforts are needed to train the primary care provider about AKI in general and 5R strategy in particular.

REFERENCES

1. Chanchlani R, Nash DM, McArthur E, Zappitelli M, Archer V, Kuwornu JP, Garg AX, Greenberg JH, Goldstein SL, Thabane L, Wald R. Secular trends in incidence, modality and mortality with dialysis receiving AKI in children in Ontario: A population-based cohort study. Clinical Journal of the American Society of Nephrology. 2019 Sep 6;14(9):1288-96.
2. Rustagi RS, Arora K, Das RR, Pooni PA, Singh D. Incidence, risk factors and outcome of acute kidney injury in critically ill children–a developing country perspective. Paediatrics and international child health. 2017 Jan 2;37(1):35-41.
3. Xu X, Nie S, Zhang A, Mao J, Liu HP, Xia H, Xu H, Liu Z, Feng S, Zhou W, Liu X. Acute kidney injury among hospitalized children in China. Clinical Journal of the American Society of Nephrology. 2018 Dec 7;13(12):1791-800.
4. Bhojani S, Stojanovic J, Melhem N, Maxwell H, Houtman P, Hall A, Singh C, Hayes W, Lennon R, Sinha MD, Milford DV. The incidence of paediatric acute kidney injury identified using an AKI E-Alert algorithm in six English hospitals. Frontiers in pediatrics. 2020 Feb 11;8:29.
5. Sharma M, Mahanta A, Barman AK, Mahanta PJ. Acute kidney injury in children with nephrotic syndrome: a single-center study. Clinical kidney journal. 2018 Oct;11(5):655-8.
6. Xiong M, Wang L, Su L, Luo W, Li Y, Li L, Nie S, Hou FF. Acute kidney injury among hospitalized children with cancer. Pediatric Nephrology. 2021 Jan;36(1):171-9.
7. Lameire N, Van Biesen W, Vanholder R. Epidemiology of acute kidney injury in children worldwide, including developing countries. Pediatric Nephrology. 2017 Aug;32(8):1301-14.
8. Baalaaji M, Jayashree M, Nallasamy K, Singhi S, Bansal A. Predictors and outcome of acute kidney injury in children with diabetic ketoacidosis. Indian pediatrics. 2018 Apr 1;55(4).
9. Lee JH, Jung JY, Park SW, Song IK, Kim EH, Kim HS, Kim JT. Risk factors of acute kidney injury in children after cardiac surgery. Acta Anaesthesiologica Scandinavica. 2018 Nov;62(10):1374-82.
10. Greenberg JH, Parikh CR. Biomarkers for diagnosis and prognosis of AKI in children: one size does not fit all. Clinical Journal of the American Society of Nephrology. 2017 Sep 7;12(9):1551-7.
11. Jetton JG, Boohaker LJ, Sethi SK, Wazir S, Rohatgi S, Soranno DE, Chishti AS, Woroniecki R, Mammen C, Swanson JR, Sridhar S. Incidence and outcomes of neonatal acute kidney injury (AWAKEN): a multicentre, multinational, observational cohort study. The lancet child & adolescent health. 2017 Nov 1;1(3):184-94.
12. Canete P, Fernandez A, Solis A, Del Castillo J, Fernandez S, Lopez-Herce J, Pediátrica GE. Incidence and prognosis of acute kidney injury after cardiac arrest in children. Nephron. 2019;141(1):18-23.
13. Xu X, Nie S, Zhang A, Jianhua M, Liu HP, Xia H, Xu H, Liu Z, Feng S, Zhou W, Liu X. A new criterion for pediatric AKI based on the reference change value of serum creatinine. Journal of the American Society of Nephrology. 2018 Sep 1;29(9):2432-42.
14. Charlton JR, Boohaker L, Askenazi D, Brophy PD, D'Angio C, Fuloria M, Gien J, Griffin R, Hingorani S, Ingraham S, Mian A. Incidence and risk factors of early onset neonatal AKI. Clinical Journal of the American Society of Nephrology. 2019 Feb 7;14(2):184-95.
15. Downes KJ, Cowden C, Laskin BL, Huang YS, Gong W, Bryan M, Fisher BT, Goldstein SL, Zaoutis TE. Association of acute kidney injury with concomitant vancomycin and piperacillin/tazobactam treatment among hospitalized children. JAMA pediatrics. 2017 Dec 1;171(12):e173219-.
16. Prasad BS, Kumar M, Dabas A, Mishra K. Profile of Acute Kidney Injury in Hospitalized Children with Idiopathic Nephrotic Syndrome. Indian pediatrics. 2019 Feb 1;56(2).
17. Hsu CN, Chen HL, Tain YL. Epidemiology and outcomes of community-acquired and hospital-acquired acute kidney injury in children and adolescents. Pediatric research. 2018 Mar;83(3):622-9.
18. Mammen C, Bissonnette ML, Matsell DG. Acute kidney injury in children with sickle cell disease—compounding a chronic problem. Pediatric Nephrology. 2017 Aug;32(8):1287-91.
19. Parikh RV, Tan TC, Salyer AS, Auron A, Kim PS, Ku E, Go AS. Community-based epidemiology of hospitalized acute kidney injury. Pediatrics. 2020 Sep 1;146(3).
20. Bjornstad EC, Muronya W, Smith ZH, Gibson K, Mottl AK, Charles A, Marshall SW, Golightly YM, Munthali CK, Gower EW. Incidence and epidemiology of acute kidney injury in a pediatric Malawian trauma cohort: a prospective observational study. BMC nephrology. 2020 Dec;21(1):1-2.
21. Du Plessis L, Rassekh SR, Mammen C. High incidence of acute kidney injury during chemotherapy for childhood acute myeloid leukemia. Pediatric blood & cancer. 2018 Apr;65(4):e26915.
22. Bernardo EO, Cruz AT, Buffone GJ, Devaraj S, Loftis LL, Arikan AA. Community-acquired Acute Kidney Injury Among Children Seen in the Pediatric Emergency Department. Academic Emergency Medicine. 2018 Jul;25(7):758-68.