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Research Article

Acute Kidney Injury in ICU: Prevalence and Outcome at Muhimbili National Hospital, Dar es Salaam, Tanzania

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Abstract

Background: Acute Kidney Injury (AKI) is common among hospitalized patients worldwide and has a poor prognosis among Intensive Care Unit (ICU) patients with mortality rates ranging from 10-90%. There is a paucity of data on the burden and spectrum of AKI in lower income countries especially those in sub-Saharan Africa region. This study was conducted at Muhimbili National Hospital (MNH) to determine the prevalence and outcome of AKI among patients admitted in ICU.

Methodology: This was a retrospective descriptive study of all patients admitted to the MNH-ICU from January 2009 through December 2012. Medical records of the patients admitted to the ICU during the study period were reviewed and those with AKI were identified. Standardized pre-tested data instrument tools were used to collect socio-demographic data, clinical and laboratory parameters which included; date of admission to the ICU, type of patient (surgical or medical patient), duration of ICU stay, modality of ICU treatment for AKI, need for mechanical ventilation, or inotropic support and outcome.

Results: A total of seven hundred and sixty-eight (768) patients were admitted to the MNH-ICU during the study period 2009-2012. Two hundred and thirty-three (233) case notes of patients met inclusion criteria for recruitment, were reviewed and included in the final analysis. Out of 233 participants, males were 60.9% and mean age of participants was 45.7 ± 17.8 years. The prevalence of AKI in this study was 57.9% (135/233) with the different AKIN stages contributing: I-(19.2%), II-(28.1%) and III-(52.6%). %). The length of stay in the ICU for those with AKI was 2 days (IQR 2-6) while that for those with no AKI was 3 days (IQR 2-8), P=0.094. Mortality among patients with AKI was higher than in those without AKI, 94.1% (127/135) compared to 91.8% (90/98), p=0.0037. For patients with AKI, 67.4% were recorded as having sepsis while 15.5% had septic shock. Factors associated with mortality included underlying CKD (p=0.011), the need for mechanical ventilation (p=0.046), and the need for vasopressor in ICU (p=0.018).

Conclusion: The prevalence of AKI was high (57.9%) with high mortality of 94.1% Mortality. Factors associated with mortality included underlying CKD, the need for mechanical ventilation and vasopressors.

Background

Acute kidney injury results in devastating outcomes to affected patients and is reported to contribute to high morbidity and mortality rates disproportionately in lower- and middle-income countries (LMIC). [1, 2] The global burden of AKI is high and at one time it was estimated to be 13.3 million cases per year, with 85% of these being in LIMIC. [3] The aetiology of AKI in LMIC was predominantly community acquired in contrast to developed world, however with improved critical care facilities there is trend towards hospital acquired AKI in developing countries. [4, 5, 6] In 2015 International Society of Nephrology (ISN) declared AKI to be a human right problem and called for reduction of deaths attributable to AKI by 2025 through an initiative dubbed 0 by 25 initiative [7]. Despite the scarcity of information on the burden of AKI in sub-Saharan Africa which hamper efforts in reducing its impact on morbidity and mortality, it is reported to be common with devastating outcome. In Malawi, Evans et al reported AKI incidence of 17.2% among admitted medical patients with mortality of 44.4% [8]. Similar findings were reported by Halle et al in a study conducted in Cameroun with AKI incidence of 22.3% among patients admitted in internal medicine ward and ICU at Douala General Hospital [6]. Outcome of AKI in sub-Saharan African is reported to be poor with mortality of up to 86% when renal replacement therapy is required and not offered [9]. This study was carried out in Tanzania aiming at determining the burden of AKI among patients admitted in the ICU at Muhimbili National Hospital, which is the largest referral hospital. Tanzania like many other countries in the region is faced with difficulties of providing nephrology services despite some remarkable improvement in nephrology services [10,11].

Methods

Study design and study area

This was a retrospective chart review of patients admitted to the Intensive Care Unit at Muhimbili National Hospital (MNH) from 2009 to 2012. MNH is the largest tertiary hospital in Tanzania and is also teaching hospital for Muhimbili University of Health and Allied Sciences (MUHAS). MNH is in Dar es Salaam city which has a population of approximately 8 million people. MNH has more than 1500 beds and at the time of this study, the ICU had 8 beds with no renal replacement therapy in form of hemodialysis. The staffing in ICU included 34 registered nurses who run 2-3 shifts a day with 4 in-house doctors, all of whom are qualified anesthesiologists. About 2-25 patients were admitted to the ICU monthly, these included medical, surgical, obstetrics/gynaecological and paediatric patients.

Study Population

All adult patients (aged 18 years and above) admitted in ICU between 1st January 2009 and 31st December 2012 were eligible for this study. All charts of patients admitted in ICU were reviewed and those with filled clinical and laboratory data were included in this study.

Data Collection

Data collection was carried out by one of the investigators and a trained research assistant; these were obtained from patients' charts retrieved from medical records and recorded into a pre-tested research tool. Recorded information included; demographic data like age, sex, and address. Others included duration of illness, ICU admission and discharge dates, admission and final diagnoses, ICU outcome (death/survival at discharge), any co-morbidities, mode of treatment including mechanical ventilation and Renal replacement therapy like hemodialysis. Vital signs (blood pressure, respiratory rate, temperature, oxygen saturation, urine output) and laboratory tests including serum creatinine, urea, and electrolytes, complete blood counts and liver function tests were also recorded. AKI was defined based on AKIN criteria with two serum creatinine values separated by a time duration of at least 48 hours with an increase in serum creatinine of ≥0.3mg/dl (26.4µmol/l) and/ or a urine output of <0.5mls/kg/hr.

Data Analysis

Data were coded and entered data into epi data version 3.1 and was exported to STATA version 12 (Stata Corp. STATA 12.0, College Station, Texas 77845 USA) for analysis. Descriptive statistics were used to summarize the characteristics of the patients. Continuous variables were summarized into means, medians and ranges. Categorical data were summarized as frequencies and percentages. Comparisons of AKI patients according to AKIN classification were based on chi-square test or Fisher's exact test for categorical data. A p-value of <0.05 was considered statistically significant.

Ethical Consideration

This study was approved by MUHAS ethical committee with ethical approval number MU/PGS/SAEC/Vol. IV. Permission to conduct this study at MNH was granted by the Hospital administration. None of the patients' identifying information including registration number and names was recorded and access to data was only provided to research team.

Results

Seven hundred and sixty-eight patients were admitted in ICU between January 2009 and December 2012, of these 233 (30%) met the inclusion criteria and were included in the final analysis. Five hundred and thirty-five (535) patients were excluded because of age <18 years (136), missing files from the medical records department (207), and incompletely filled files (192) Figure 1.

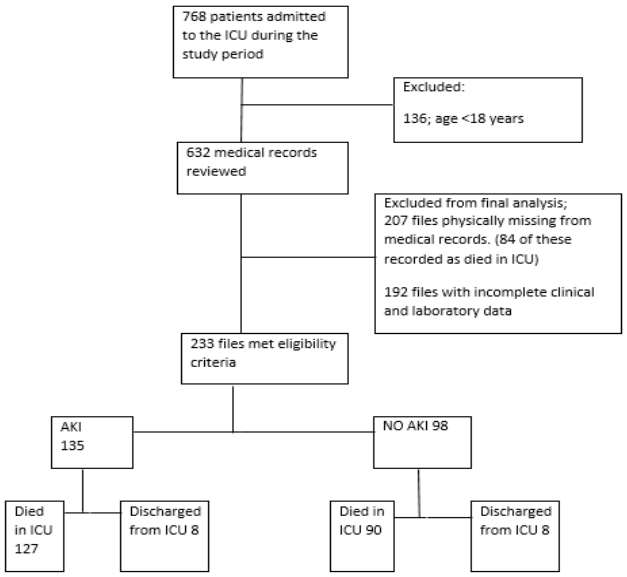

Figure 1: Participants flow chart.

Baseline Characteristics of Study Patients

Table 1 describes participants' demographic characteristics at admission. Among 233 participants 60.9% (142/233) were males. Mean age of study participants was 45.7 (SD 17.8). There were no statistically significant differences between patients with AKI and no AKI in terms of sex (p=0.996), education level (p=0.924), and nature of patient, medical or surgical (p=0.076). Length of stay in ICU was noted to be shorter for participants with AKI [2 days (IQR 2-6)] as compared to those without AKI [3 days (IQR 2-8)], p =0.094. Medical diagnosis was noted in 54.5% of participants while surgical diagnosis was noted in 45.5%, 18 (18.4%) participants with AKI had chronic kidney disease while 10 (7.4%) of those without AKI had CKD, p =0.011. Vasopressors were prescribed to fewer participants among those without AKI 13 (13.3%) as compared to those with AKI 35 (25.9%) p=0.018.

	AKI (n=135)	**No AKI n=98)**	**Total (n=233)**	**P-value**
Age (yrs): mean(SD)	46.4(18.2)	44.8(17.3)	45.7(17.8)	0.495
Sex: n (%)				
Male	82(60.7)	60(61.2)	142(60.9)	0.996
Female	53(39.3)	38(38.8)	91(39.1)	
Education level: n (%)				
None	62(45.9)	46(46.9)	108(46.4)	
Primary	60(44.4)	44(44.9)	104(44.6)	
Secondary	9(6.7)	4(4.1)	13(5.6)	0.924
University	3(2.2)	3(3.1)	6(2.6)	
Unknown	1(0.7)	1(1.0)	2(0.9)	
Nature of patient: n (%)				
Medical	67(49.6)	60(61.2)	127(54.5)	0.079
Surgical ±	68(50.4)	38(38.8)	106(45.5)	
Co morbidities: n (%)				
Hypertension	44(32.6)	33(33.7)	77(33.0)	0.863
Diabetes	23(17.0)	13(13.3)	36(15.5)	0.432
Chronic kidney disease	18(18.4)	10(7.4)	28(12.0)	**0.011***
HIV	14(10.4)	7(7.1)	21(9.0)	0.396

Mode of referral: n (%)				
Self-referral	3(2.2)	5(5.1)	8(3.43)	
Hospital referral	71(52.6)	46(46.9)	117(50.2)	0.401
Undocumented	61(45.2)	47(47.9)	108(46.4)	
Duration of stay in ICU(days) median(IQR)	2(2-6)	3(2-8)	2(2-7)	0.094
Mode of treatment in ICU:				
- Mechanical ventilation±				
- Vasopressor support	90(66.7)	59(60.2)	149(63.9)	0.31
	35(25.9)	13(13.3)	48(20.6)	**0.018***

Table 1: Characteristics of study participants.

Prevalence of Acute Kidney Injury

The prevalence of AKI was 57.9% (135/233) with AKIN stages I, II, and III constituting 19.2%, 28.1% and 52.6% respectively. The characteristics of AKI patients by AKIN stage are shown in Table 2. Compared to patients with stage I AKI, duration of stay showed a decreasing trend as the AKI stage increased although this did not reach statistical significance, p=0.071. We noted that the proportion of patients with hypertension increased with increasing stage while that of hypotension decreased with increasing AKI stage, p=0.036. The mean hemoglobin level also decreased with increasing AKI stage, p=0.011. For patients with AKI, 67.4% were recorded as having sepsis while 15.5% had septic shock. Other clinical diagnoses recorded by the clinicians were obstructive uropathy, hypovolemia, glomerulonephritis and others contributing 2.2%, 2.2%, 0.74% and 12% respectively.

Characteristics of AKI patients					
	All	**Stage1 (n=26)**	**Stage 2 (n=38)**	**Stage 3 (n=71)**	**P-value**
Age: mean (SD)	46(17.8)	46(16.7)	43(15.5)	50(18.9)	0.642
Sex: n (%)					
Male	86(63.7)	18(69.2)	21(55.2)	47(66.2)	0.426
Female	49(36.3)	8(30.8)	17(44.7)	24(33.8)	
Duration of stay in ICU in days: mean (SD)	4.9(6.0)	5.4(8.2)	4.8(7.0)	4.8(6.0)	0.071
Nature of patient; n (%)					
Medical	80(59.3)	16(61.5)	24(63.2)	39(54.9)	0.674
Surgical	55(40.7)	10(38.5)	14(36.8)	32(45.1)	
Mode of referral: n (%)					
Self	4(2.9)	1(3.8)	1(2.6)	2(2.8)	
Hospital	68(50.4)	12(46.2)	21(55.3)	35(49.3)	0.939
Unknown	63(46.7)	13(50.0)	16(42.1)	34(47.9)	
Co morbidities: n (%)					
Hypertension	51(37.5)	8(30.8)	16(42.1)	27(38.0)	0.587

Diabetes	20(14.7)	5(19.2)	3(7.9)	12(16.9)	0.37
CKD	14(10.3)	1(3.8)	6(15.8)	7(9.9)	0.283
HIV	14(10.3	6(23.1)	2(5.3)	6(8.5)	0.065
Mode of ICU treatment: n (%)					
Mechanical ventilation					
Vasopressor support	87(63.1)	13(48.2)	25(65.8)	49(69.0)	0.152
	30(22.1)	6(22.2)	5(13.2)	19(26.8)	0.264
Blood pressure status: n (%)					
Normal					
Hypertension	39(28.9)	8(30.8)	6(15.8)	25(35.2)	**0.036***
Hypotension	45(33.3)	4(15.4)	14(36.8)	27(38.0)	
	51(37.8)	14(53.8)	18(47.4)	19(26.8)	
Respiratory rate; mean (SD)	27(10.6)	27.3(10.6)	27.3(10.3)	27.1(10.2)	0.992
Pulse rate: mean (SD)	108(23.8)	105(27.7)	106(21.8)	110(23.5)	0.684
Baseline serum creatinine: mean (SD)	237(324)	242(260)	315(478)	194(231)	0.168
Baseline urea: mean (SD)	16.5(18.7)	13.8(12)	24.1(27.8)	13.6(13.5)	0.127
Baseline WCC: mean (SD)	2.16(0.94)	2.04(0.99)	2.26(0.92)	2.15(0.95)	0.752
Baseline Hb: mean (SD)	10.9(3.2)	12.4(3.4)	10.0(3.6)	10.9(2.9)	**0.011***

Table 2: Characteristics of patients by AKI staging (n=135).

Outcome of Study Participants

The overall all-cause mortality among the study patients during the study period was 93.1% (217/233), this was noted to be higher among patients with AKI (94.1%; 127/135) as compared to 91.8% (90/98) for those without AKI, p=0.0037 (Figure 2). We observed that mortality occurred earlier during admission to ICU with approximately 90% dying within 10 days (Figure 2). Bivariate analysis of the factors associated with mortality in ICU by AKI status is shown in Table 3. Needing mechanical ventilation was the only factor found to be significantly associated with mortality among AKI patients (p=0.046 CI 1.049-2.262), Table 3. As shown in Figure 2, AKI patients had a worse survival compared to those with no AKI during the first 2 weeks; however, mortality among the non-AKI group approximates that of the AKI group by the fifth week (p=0.0037).

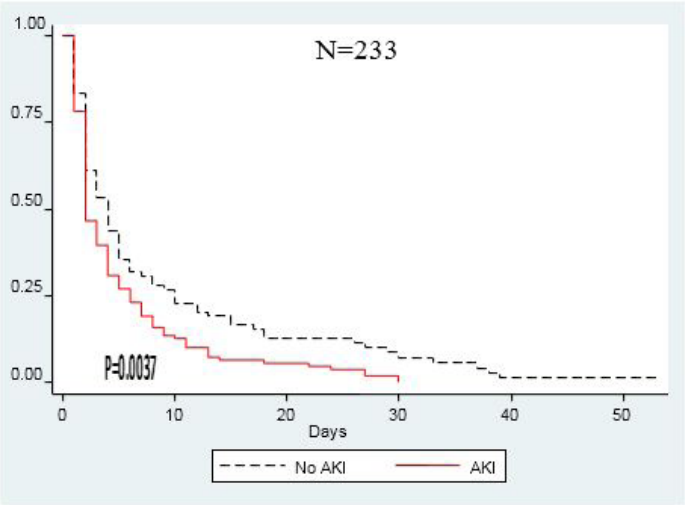

Figure 2: Mortality curve of study patients by AKI status.

Variable	Discharged from ICU (%)	Died in ICU (%)	HR (95% CI)	P-value
Age: mean (SD)	66.6(6.4)	45.3(18.1)	0.998 (0.988-1.008)	0.747
Sex: n (%)				
Male	4(50)	75(59.1)	0.942 (0.655-1.353)	0.718
Female	4(50)	52(40.9)		
Nature of patient: n (%)				
Medical				
Surgical	3(37.5)	60(47.2)	0.958 (0.670-1.369)	0.723
	5(62.5)	67(52.8)		
Co morbidities:				
Hypertension	1(12.5)	38(29.9)	1.307 (0.891-1.918)	0.551
Diabetes	2(25.0)	22(17.3)	1.100 (0.692-1.749)	0.514
CKD	2(25.0)	10(7.8)	1.217 (0.629-2.351)	0.677
HIV	0(0)	14(11.0)	1.276 (0.725-2.245)	0.616
Resp. rate: mean (SD)	22(10.2)	29(10.3)	1.013 (0.996-1.030)	0.14
Pulse rate: (SD)	95(7.1)	112(24.7)	1.003 (0.996-1.010)	0.419
Baseline Cr: (SD)	369.1(183.9)	302(364.3)	1.000 (0.999-1.000)	0.639
Baseline Urea: (SD)	21.3(1.1)	19.2(18.1)	1.002 (0.991-1.013)	0.75
Baseline Hb: (SD)	11.5(3.1)	10.6(3.2)	1.048 (0.990-1.109)	0.105
WCC: (SD)	2.41(0.9)	2.42(0.87)	0.979 (0.797-1.202)	0.84
Mode of treatment: n (%)				

Mechanical ventilation.				
Vasopressor support				
	0(0)	84(67.2)	1.540 (1.049-2.262)	**0.046***
	0(0)	34(27.2)	1.108 (0.745-1.646)	0.389

Table 3: Bivariate analysis of predictors of mortality among AKI patients (n=135).

Discussion

This was a retrospective cross-sectional study which was carried out among patients admitted in ICU at Muhimbili National Hospital between January 2009 and December 2012, to determine occurrence and outcome of AKI. AKI occurrence among critically ill patients was noted to be common and 135/ 233 (57.9) had AKI, among these 52% had severe AKI defined as AKIN stage 3. This finding is quite high and is in line with other studies which have reported high burden of AKI in ICU. Ya-Wen et al reported a similar prevalence of AKI (59%) from a study conducted among medical ICU patients in Taiwan [12]. Burden of AKI in ICU reported from developed countries varies (19.2% -74.5%), depending on defining criteria of AKI [13]. At the time of this study no renal replacement therapy was offered in ICU at MNH which may account for the finding of more than 50% of patients with AKI having AKIN stage 3 and the extremely high mortality outcome.

Sepsis is a predominant risk factor and cause of AKI for patients admitted in ICU, in our study 67.4% of patients with AKI were recorded as having sepsis, out of which 15.5% had septic shock. In a multicentre retrospective study conducted by Bagshaw et al among patients admitted in 57 ICUs across Australia, sepsis accounted for 32.4% of all patients with AKI [14]. Sepsis among patients in ICU is reported to result in severe form of septic AKI which result in adverse outcome including failure of recovery of AKI and mortality [14-17]. Glomerulonephritis which is an important cause of AKI was reported with small contribution of only 2%, this shows native kidney diseases may also contribute to AKI and should not be underestimated. Yousif et al reported glomerulonephritis as the predominant cause among patients who received haemodialysis for AKI in Sudan [18].

Overall mortality in this study was 93.1%, this mortality was noted to be significantly higher among patients who had AKI as compared to those without, showing the significant contribution of AKI to mortality. This high mortality reflects the absence of renal replacement therapy in the ICU at MNH when study participants were admitted. This finding is in line with what was reported by Olowu et al in systematic review of studies on outcome of AKI in sub-Saharan Africa reporting mortality as high as 86% when dialysis was needed but was not offered. [9]. From the mortality curve comparing the two groups (Figure 2), it was observed that though mortality was significantly high in both groups, AKI patients died faster within the first 2-3 weeks as compared to those without AKI. This could probably be explained by the fatal acute complications of AKI like fluid overload, electrolyte abnormalities like hyperkalaemia, metabolic acidosis that require prompt diagnosis and quick management including renal replacement therapy which was not available in the ICU. Need for mechanical ventilation was noted to be associated with mortality in our study which is in agreement with many other similar studies conducted in ICU settings both in high income and low-income countries [16,19-22].

This is one of few studies indicating the burden of AKI in intensive care unit in Tanzania, being a retrospective study and hospital based, there are several limitations which are attributed to missing information and generalizability of the findings of this study. Nevertheless, the findings highlight the high burden of morbidity and mortality faced by health facilities in limited resourced settings. Additionally, this study highlights the need for timely accessibility of renal replacement therapy in low-income countries like Tanzania especially in the intensive care units that manage critically ill patients.

Conclusions

High prevalence of AKI of 57.9% (135/233) was noted for ICU patients at MNH. Mortality among those with AKI was 94.1% (127/135) while the overall cause mortality of the study patients during the four-year 93.1%. Need for mechanical ventilation was found to be significantly associated with increased risk of mortality among our study patients. Among patients with AKI, sepsis and septic shock, 67.4% and 15.5% respectively, were the most common underlying diagnoses for ICU patients.

Disclaimer

The findings from this study have since changed due to major improvements at the Muhimbili National Hospital including renal transplant currently being done. The findings from our study highlighted challenges then when renal replacement therapy was unavailable in the ICU, this has however since changed

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