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Prevalence, outcome and associated factors of acute kidney injury among trauma patients admitted to adult intensive care unit at trauma centers of Addis Ababa Ethiopia, 2020

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Abstract

Background: Trauma is a global public health problem, which accounts for one in ten deaths worldwide. Organ failure, including acute kidney injury, was the third leading cause of death. Acute kidney injury was a common cause of organ failure associated with poor outcomes and higher mortality rates.

Objectives: To assess the prevalence, outcomes, and associated factors of acute kidney injury among trauma patients admitted to the Adult Intensive Care Unit at the trauma centers of Addis Ababa, Ethiopia.

Methods: Institutional-based retrospective cross-sectional study was used. All trauma patients older than 18 years admitted to the adult intensive critical care unit at two trauma centers were included in the study. Simple random sampling using the lottery method was used to select the study area and proportion to size allocation was used to select the study participant from two trauma centers.

Results: Out of the 383 trauma patients enrolled in the study, with a 3% rate of missed card, a total of 82 individuals (21.4%) developed acute kidney injury. Among these cases, 24 (29.3%) were classified as Stage I, 18 (21.9%) as Stage II, and 40 (48.8%) as Stage III. The overall mortality of acute kidney injury among trauma patients admitted to the adult intensive care unit was 111(29.0%). Out of all the patients who were reported to have acute kidney injury, over half of them 46 (56.1%) died and 14 patients (17.1%) received renal replacement therapy. On multivariable logistic regression, Intra-abdominal injury (AOR=1.71, 1.011-2.89), direct renal injury (AOR=4.22, 1.72-10.344), burn (AOR=6.61, 1.497-29.211) and hypovolemic shock (AOR=2.19, 1.097-4.382) were found to have significant association with the occurrence of acute kidney injury.

Conclusion: Post-traumatic acute kidney injury was common in the study area. The development of post-traumatic acute kidney injury was closely associated with increased mortality. Every trauma center should focus on developing resuscitation strategies that aim to preserve the kidney function of trauma patients.

Keywords: Acute kidney injury, Adult Intensive care unit, Trauma patients

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Background

Trauma is a global public health problem, which accounts for one in ten deaths. World Health Organization (WHO) estimates the effect of trauma is about 5.1 million deaths per year worldwide, and over 80 million lost disability- adjusted life years. The majority of trauma deaths are due to central nervous system injury and organ failure(1).

Road traffic accident (RTA) is the ninth leading cause of death but rise to the seventh by 2030. Globally, young people aged between 15-44 years account for almost 50% of the world's injury-related deaths, and have a greater economic impact(2). Organ dysfunction is the third leading cause of death in trauma patients, after hemorrhage and traumatic brain injury (TBI). Acute kidney injury (AKI) is an abrupt deterioration in kidney function that disrupts metabolic, electrolyte, acid-base balance, derangement of extracellular fluid volume, retention of nitrogenous waste products, and decreased urine output over hours to days(3–5).

Globally, AKI affects more than 13 million people and results in 1.7 million deaths per year. 20% of hospitalized patients and 30-60% of critically ill patients are diagnosed with AKI. The most common cause of organ dysfunction in ICU and death in mild AKI is 50%(6). Among trauma-related organ failure, AKI is common, with an incidence reaching up to 50%, and has been independently linked to prolonged hospital length of stay (4).

In developing countries, four out of five trauma patients have AKI. Due to, geographic, etiologic, cultural, and economic reasons, they have a potential risk of AKI, and the outcome of AKI varies with the availability of transportation services and health care resources, including medications, equipment, trained personnel, and dialysis facilities(6).

In 2012, Acute Kidney Injury was defined as stage I to stage III based on the Kidney Disease Improving Global Outcomes (KDIGO) on clinical practice guidelines defined AKI as a SCr increase of 1.5 times or 0.3 mg/dL within 48 hours as stage I, a 50% increase in SCr within 7 or increase SCr 2 times from baseline as stage II and increase SCr 3 times or increase SCr to $\geq$ 4.0 mg/Dl as stage III(7,8).

Trauma patients are at risk of AKI due to renal hypo perfusion, direct renal injury, hemorrhage, shock, sepsis, abdominal compartment syndrome, nephrotoxic effects of therapies (antibiotics and intravenous contrast), systemic inflammation, massive transfusion, rhabdomyolysis, major surgery, subdural hematoma, intracerebral hematoma, intra-abdominal injury, and hepatic injury. older age, co-morbidities including diabetes millets (DM) and chronic kidney disease (CKD), more severe shock or injury, and blood transfusion, increase the risk of AKI. The outcome was in-hospital mortality (IHM) and requirement of renal replacement therapy (RRT)(9–12).

European guidelines recommend that the use of early imaging and free fluid resuscitation in patients with suspected torso trauma, intra-thoracic, intra-abdominal, or retroperitoneal bleeding, and hemodynamic instability need urgent intervention. However, numerous studies that have established the relationship between small increments in serum creatinine (SCr) and AKI suggested that accurate early identification of individuals at risk and early recognition of AKI could offer opportunities for diagnostic, preventive, or even therapeutic interventions(13,14).

Acute kidney injury is associated with mortality and increased hospital length of stay, loss of the self-regulation capacity of the patients' organs, which is a challenge to the implementation of therapeutic resources and results in a rise in health care expenditure and, progress to end-stage renal disease, chronic kidney disease (CKD), and increased cardiovascular risk(15–17).

Different studies were done on the prevalence, outcome, and associated factors of AKI in different countries of the world. This study is important for early identification of AKI patients by knowing the risk factors for diagnosis, and management for good treatment outcomes. In Ethiopia, studies evaluating the prevalence, outcomes, and associated factors of AKI are very limited. Hence, this study will contribute to bridging the information gap on AKI among trauma patients.

To the best of the investigators knowledge, there is a limited study done on the prevalence, outcome, and associated factors of AKI among trauma patients. The finding of this study will be important for policy maker to identify the prevalence, associated factors, and outcome of AKI among trauma patients. Policymakers can use this study to identify the occurrence of acute kidney injury, to give priority

to possible intervention, and also to select priority groups to allocate resources for better treatment success.

Clinicians can use this study to give emphasis on the prevalence of acute kidney injury, identify risk groups of the population, and focus to prevent the possible occurrence of AKI among trauma patients. Knowing the prevalence and risk factors associated with AKI may be important to set referral system, early resuscitation practice, and prioritize tasks and interventions in the prevention and overall treatment of AKI.

Researchers can also use the results of this study as baseline information to conduct further studies by using different study designs and possible comparison groups to perform different analyses of AKI in trauma patients in other settings.

Methods

Study setting period and design

The study was conducted in Addis Ababa, which is the capital city of Ethiopia with an estimated population of 3.6 million in the city, and a metro population of more than 4.6 million. It has an estimated area of 530 Km2, with altitudes ranging from 2200 to 3000 meters above sea level, average temperature of 22.8°C, and average rainfall of 1,180.4 millimeters. Addis Ababa has 41 hospitals (13 public hospitals, 28 NGOs, and private hospitals), 29 health centers, 122 health stations, 37 health stations, and 382 modern private clinics (18).

Addis Ababa, Burn and Emergency Trauma (AaBET) Hospitals and All African Leprosy Rehabilitation and Training Center (ALERT) Hospital, allocated as trauma centers by the FMOH, provide trauma services not only for the city but also for the country

AaBET s an affiliate Hospital of SPHMMC and it was opened by the FMOH on August 2015. AaBET Hospital has 14 departments, 250 beds (12 ICU beds), 369 health professionals (including 282 nurses), and 624 administrative staff. Annually, it serves 5,000 to 7,000 patients. ALERT Hospital has a total of 320 beds (6 ICU beds) and serves as a trauma center since April 2015. ALERT Hospital has 18 departments, 900 health professionals (including 420 nurses), and 780 administrative staff.

The research was conducted from September to October 2020 at two hospitals, namely ALERT and AaBET, located in Addis Ababa, Ethiopia. These hospitals are recognized as trauma centers and play a crucial role in providing higher education in various healthcare fields, including specialty and sub-specialty training, to numerous professionals across the country.

Institutional-based retrospective cross-sectional study (chart review study) was conducted, and two years of data were taken from patient's cards from February 1, 2018, to January 30, 2020, at two trauma centers in Addis Ababa, Ethiopia.

Source Population

All trauma patients admitted to Adult ICU at trauma center (AaBET and ALERT) of Addis Ababa, Ethiopia.

Study Population

All trauma patients who develop post-traumatic AKI were admitted to Adult ICU of AaBET and ALERT Hospitals of Addis Ababa, Ethiopia from February 2018 to January 2020 that fulfill the inclusion criteria.

Inclusion criteria

Trauma patients with AKI admitted to Adult ICU (age ≥18 years) from February 2018 to January 2020 by using the patient card number on HMIS with complete information

- Trauma patient with known CKD
- Trauma patients whose medical cards were found to be missed, or misplaced from the HMIS record room were not included in the study.
- Prevalence of Acute kidney injury
- Outcome (Died, Recovered, Initiation of RRT)
- Socio-demographic (Age, Sex, Residence, Region)
- Length of stay
- Stage of AKI (Stage I, Stage II, and Stage III)
- Characteristics of the trauma
  - ✓ Mechanism of injury (Blunt injury, Penetrating injury)
  - ✓ Types of trauma(single trauma, multiple trauma)
  - ✓ Site of injury (TBI, Head injury, chest injury, Intra-abdominal injury, Renal injury, Pelvic injury)
- Shock
- Burn
- Co-morbidities (DM, Hypertension, CHF, CAD, and others)
- Nephrotoxic drug

Sample size and sampling techniques

The actual sample size was determined by single population proportion formula $n = (z_{a/2})^2 p (1-p)/d^2$ Where; n=Desired sample size, Z= Standard error of the mean which corresponds to 95% confidence level (1.96). P- Value was taken from SPHMMC that was done on the outcome of patients with AKI requiring dialysis and 53% of the patients improved(19). Sample size among co-morbidities of hypovolemia (22.5%), $n= (1.96)^2 0.23(0.67)/ (0.05)^2 = 237$ by taking p-value 23%. Sample size of acute glomerular nephritis (P- value 21.9 %), $n= (1.96)^2 0.22(0.68)/ (0.05)^2 = 230$ The outcome of AKI patients with recovered was 53% and the sample size was calculated, $n= (1.96)^2 0.53(0.47)/ (0.05)^2 = 383$ by taking p- value of 53%. The outcomes of AKI patients with a death rate of 29.1% and the sample size was $n= (1.96)^2 0.29(0.71)/ (0.05)^2 = 316$ by taking p- value of 29%.

The final sample was taken from the aforementioned calculations of sample sizes, and the one that exhibited a higher value in comparison to the rest was chosen. With a contingency of 3 % for missed cards, the final required sample size was 395. AaBET and ALERT hospitals were selected by simple random sampling technique by using the lottery method from three trauma centers AaBET, ALERT, and Tikur Anbessa Specialized Hospitals (TASH) of Addis Ababa, Ethiopia.

Samples for the study population were recruited using a systematic random sampling method from two trauma centers. Every 2nd data point was taken from the patient's HMIS, and actual data was extracted from the patient's card. The initial data point was selected using a lottery method, and the final sample was chosen from the two trauma centers using a proportional-to-size allocation formula.

Data collection

Data was collected using structured checklists, which were developed after different literature was reviewed based on research objectives. Two years of data were obtained from the HMIS record of AaBET and ALERT centers from February 1, 2018 to January 30, 2020. First, the sample card number was taken from the HMIS record, sorting the card number and then using a systematic random sampling technique the actual data were taken. Finally, a structured checklist was used to take the actual data from the patient card. Four data collectors and two supervisors were included in the data collection.

To ensure the quality of data, well-designed checklist was prepared. The principal investigator provided with one-day training for data collectors and supervisors. The data was supervised by principal investigators on each data collection day. Proper categorization and coding of the data were done. The checklist was prepared in English. Pretest was done on 5% (20) of the study participants in TASH before the start of the actual study. The principal investigator and supervisor checked the data closely. During the data collection process, each structured checklist was checked for its completeness, consistency, and accuracy.

The collected data were checked and edited manually if any error was present. Once the collected data were checked manually, the data was entered into Epi-Info version 7.1, and then the data was exported to SPSS version 25 for cleaning and analysis. Descriptive statistics such as frequencies, central tendency, and lists of variables were analyzed by SPSS software by using bivariate logistic regression. Bivariate logistic regression was used to identify candidate variables for further analysis of multivariate logistic regression with a significant level of p-value < 0.05 and a 95% confidence interval. Multivariate logistic regression was used to analyze and identify the association between the independent variable and dependent variables with a significant level of AOR, p-value <0.05, and 95% confidence interval.

Results

Socio-demographic characteristics of participants

A total of 383 records (missed card = 3%) of trauma patients at Adult ICU of Trauma Centers in Addis Ababa were included in the study. Three hundred seventeen (82.8%) were males and 66(17.2%) were females. The majority of the trauma patients were in the age group 21-30 years, which accounted for 139 (36.3%), the minimum age was 18, the maximum was age 84 and the mean age of the study population was 36.93 (S.D. =16.02) years. Two hundred sixty-seven (69.7%) of the patients were urban dwellers. As for the region of occurrence of the trauma, most were reported from Addis Ababa 169(44.1%) followed by the Oromia region 148(38.6%) (See Table 1).

Table 1: Socio-demographic characteristics of trauma patients with Acute Kidney Injury admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Frequency	Percent (%)	AKI (n, %)
Sex	Male	317	82.8%	70 (85.4%)
	Female	66	17.2%	12 (14.6%)
Age	18-20	45	11.7%	10(12.2%)
	21-30	139	36.3%	27(32.9%)
	31-40	84	21.9%	19(23.2%)
	41-50	45	11.7%	10(12.2%)
	51-60	31	8.2%	6(7.3%)

	>=60	39	10.2%	10(12.2%)
Residence	Urban	267	69.7%	50(61%)
	Rural	116	30.3%	32(39%)
Region	Addis Ababa	169	44.1%	35(42.7%)
	Dire Dawa	1	0.3%	0
	Tigray	2	0.5%	2(2.5%)
	Amhara	25	6.5%	6(7.3%)
	Oromia	148	38.6%	28(34.1%)
	SNNRP	35	9.1%	11(13.4%)
	Others	3	0.8%	0

Characteristics of the trauma

The most common mechanism of injury was blunt injury 280(73.1%) followed by penetrating injury of 103(28.9%). In the case of types of trauma, 209(54.6%) were having a single-site, and the remaining 174(45.4%) had multiple-site traumas. As for the site of injury, traumatic brain injury was the most frequent one 327(85.4%) followed by Intra-abdominal injury 134(35.0%) and chest injury 87(22.7%). Of the total trauma patients, 57(14.9%) had developed shock and the majority were hypovolemic shock 46(80.7%) (See Table 2).

Table 2: Characteristics of trauma patients admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Frequency	Percent (%)	AKI (n, %)
Mechanism of injury	Blunt injury	280	73.1%	65(79.3%)
	Penetrating injury	103	28.9%	17(20.7%)
Types of trauma	Single trauma	209	54.6%	35(42.7%)
	Multiple trauma	174	45.4%	47(57.3%)
Site of injury	Traumatic brain injury	327	85.4%	67(81.7%)
	Intra-abdominal injury	134	35.0%	39(47.6%)
	Chest injury	87	22.7%	19(23.2%)
	Direct renal injury	22	5.7%	11(13.4%)
	Pelvic injury	40	10.4%	12(14.6%)
Burn	Yes	8	2.1%	5(62.5%)
Shock	Yes	57	14.9%	22(38.6%)
Types of Shock	Hypovolemic Shock	46	80.7%	17(37%)
	Septic Shock	10	17.5%	5(50%)
	Cardiogenic Shock	1	1.8%	0

Co-morbidity and admission clinical condition

Overall, trauma patients admitted to adult Intensive Care Units at trauma centers had comorbidities 71(18.5%), diabetes Miletus 23(32.4%) and 52(73.2%) had hypertension. The prevalence of AKI from overall trauma patients was 82(21.4%) including 24(29.3%) Stage I, 18(21.9%) Stage II and 40(48.8%) Stage III (See Table 3). The overall average LOS of trauma patients was 15.15 days. The average LOS of AKI patients was 13.7 days (See Table 3).

Table 3: Co-morbidities in trauma patients admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Fx	Percent (%)	AKI (n, %)
Comorbidities	Yes	71	18.5%	21(25.6%)
	DM	23	6.0%	6(7.3%)
	Hypertension	52	13.6%	16(19.5%)
	CHF	9	2.3%	2(2.4%)
	Others	6	1.6%	2(2.4%)
Baseline HGB	<=7 md/dl	6	1.6%	2(2.4%)
	2-7-11 mg/dl	99	25.8%	25(30.5%)
	>=11 mg/dl	278	72.6%	55(67.1%)
Discharge HGB Level	<=7 mg/dl	17	4.5%	12(14.6%)
	7-11 mg/dl	184	48%	42(51.2%)
	>=11 md/dl	182	47.5%	28(34.2%)
Diagnosis as AKI	Yes	82	21.4% (17.2%-25.8%)	82(21.4%)
Stage of AKI	Stage I	24	29.3%	24(29.3%)
	Stage II	18	21.9%	18(21.9%)
	Stage III	40	48.8%	40(48.8%)

Outcomes of Acute Kidney Injury

The overall mortality among trauma patients admitted to Adult ICU was 111(29.0%). A relatively higher number of admitted trauma patients with AKI 46(56.1%) had died compared to those who did not develop AKI 36(43.9%). The absolute mortality rate was 7(15.2%), 10(21.7%) and 29(63.0%) in stage 1, 2 and 3 AKI respectively from a total of patients who died due to AKI. As for the degree of renal recovery, in 9(11.0%) of the cases their renal status had recovered, whereas 10(12.2%) had partial recovery, 40(48.8%) no recovery at all and 23(28.0%) the status of renal recovery was reported as unknown. Whereas, 14(17.1%) of AKI patients required, and received renal replacement therapy (See Table 4).

Table 4: Outcomes of Acute Kidney Injury among trauma patients admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Fx	Percent (%, CI)	AKI (n, %)
Died	Yes	111	29% (24.3%-33.7%)	46(56.1%)
Degree of Renal Recovery	Fully Renal Recovered	274	71.5% (67.4%-75.5%)	9(11.0%)
	Partially Recovery	10	2.6% (1.3%-4.4%)	10(12.2%)
	No Renal Recovery	40	10.4% (7.6%-13.6%)	40(48.8%)
	Unknown Recovery	59	15.4% (11.7%-19.1%)	23(28.0%)
Initiation of RRT	Yes	14	3.7% (1.8%-5.5%)	14(17.1%)

Associated Factors of AKI

By entering each variable into bivariable logistic regression, multiple traumas, intra-abdominal injury, direct renal injury, Burn, shock, hypovolemic shock, septic shock, and at discharge hemoglobin level with <= 7mg/dl were found to be significant with p-value of <0.05. These variables altogether were entered into multivariable logistic regression in order to control the confounders (See Table 5). Accordingly, intra-abdominal injury (AOR=1.71, 1.01-2.89), direct renal injury (AOR=4.22, 1.72-10.34), burn (AOR=6.61, 1.50-29.21) and hypovolemic shock (AOR=2.19, 1.10-4.38) were found to have significantly associated with the occurrence of acute kidney injury (See

Table 6).

Table 5: Bivariate Logistic Regression of Acute Kidney Injury among trauma patients admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Coef	p-value	COR(CI)
Sex	Male	.24	.48	1.28 (.65-2.52)
Age		.04	.61	1.04 (.89-1.23)
Residence	Urban	-.50	.05	.61 (.36-1.007)
Mechanism of injury	Blunt	.43	.16	1.53 (.85-2.76)
Types of trauma	Multiple	.61	.016	**1.84 (1.12-3.02) ***
Site of Injury	Traumatic brain injury	.35	.29	1.42 (.74-2.72)
	Intra-abdominal injury	.68	.008	1.97 (1.20-3.23) *
	Chest injury	-.03	.91	.97 (.54-1.73)
	Direct renal injury	1.41	.002	**4.09 (1.70-9.80) ***
	Pelvic injury	-.51	.17	.60 (.29-1.24)
Burn	Yes	1.86	.012	**6.45 (1.51-27.58) ***
Shock	Yes	1.03	.001	**2.79 (1.53-5.09) ***
	Hypovolemic	.90	.007	**2.45 (1.27-4.73) ***
	Septic Shock	1.35	.04	**3.84 (1.09-13.62) ***
Comorbidities	Yes	-.55	.07	.58 (.32-1.04)
	DM	-.28	.57	.76 (.29-1.99)
	HTN	-.58	.08	.56 (.29-1.07)
	CHF	-.05	.95	.95 (.19-4.67)
Baseline HGB Level	<= 7mg/dl	.707	.421	2.027 (.36-11.35)
	7-11mg/dl	.315	.254	1.370 (.80-2.35)
	>=11mg/dl			1
Discharge HGB Level	<= 7mg/dl	2.580	.000	**13.20 (4.31-40.39) ***
	7-11mg/dl	.487	.072	1.627 (.96-2.76)
	>=11mg/dl		000	1

N.B. * = Significant level with p-value <0.05, CI=95%

CI= Confident Interval, COR= Crude Odd Ratio

Table 6: Multiple Logistic Regression of Acute Kidney Injury among trauma patients admitted to Adult ICU at the trauma centers of Addis Ababa, Ethiopia 2018 to 2020 (n =383)

Variable	Category	Coef	p-value	AOR (CI)
Types of trauma	Multiple	.098	.76	1.10(.58-2.09)
Intra-abdominal injury	Yes	.54	.045	**1.71(1.01-2.89) ** **
Direct renal injury	Yes	1.44	.002	**4.22(1.72-10.34) ** **
Burn	Yes	1.89	.013	**6.61(1.50-29.21) ** **
Shock	Yes	.60	.41	1.81(.44-7.52)
	Hypovolemic shock	.79	.026	**2.19(1.10-4.38) ** **
	Septic shock	.97	.19	2.64(.62-11.25)
Discharge HGB Level	<= 7mg/dl	1.06	.24	2.90(.50-16.86)
	7-11mg/dl	.23	.44	1.26(.70-2.25)
	>=11mg/dl		000	1

N.B. ** = Significant level with p-value <0.05, CI=95%

CI= Confident Interval, AOR= Adjusted Odd Ratio

Discussion

This study assessed the prevalence, outcome, and associated factors of Acute Kidney Injury among trauma patients. Accordingly, one in five patients developed AKI following injury 82(21.4%) and 3.7% required renal replacement therapy from the total trauma patients. In addition to this, the finding of this study revealed that associated factors for trauma-induced AKI were intra-abdominal injury, direct renal injury, burn and hypovolemic shock.

In the present study, AKI occurred in 21.4% (CI 17.2%-25.8%) of trauma patients. The result of this study was comparable to the study done in Royal London (19.6%), Japan (19.8%), and Rajaee Trauma Hospital in Iran (21%) (20–22).

However, the prevalence of this study was higher compared to the studies done in UK major Trauma Centre (12.6%), at three regional level 1 trauma centers in France (13%) and South Africa (5.6%) (1,4,9). This might be because of poor resuscitation practice, poor first aid service, increased length of stay and inadequate infrastructure. Another reason for the variability in the reported prevalence was the time at which AKI was diagnosed.

On the other hand, the prevalence of this result was found to be lower as compared to a retrospective cross-sectional study done in Brazil (44.7%) and in Bangkok, Thailand (49.8%) (16,23). This might be because of the difference in the sample size. The prevalence of AKI was significant among trauma patients and highlights the need for calls of attention to minimizing the decline in patients' kidney function after trauma.

Acute kidney injury prevalence increased up to 47.6% in patients presenting with intra-abdominal injury. There was wide variability in the published prevalence rates of AKI following trauma. Incidence rates as low as 5.6% and as high as 58.5% have been reported(9,12). Some of this variability may be explained by the differences in studied trauma populations and types of trauma occurrence which contribute to the variability of AKI prevalence.

In this study, multiple traumas were one of the variables that determine the development of AKI in trauma patients. In accordance with the previous studies, patients having multiple traumas were two times more likely to develop AKI than single trauma in our study.

This study revealed that patients who have intra-abdominal injury were 1.71 times more likely (AOR= 1.71, 1.01-2.89) to develop AKI than others. This study was consistent with numerous studies including studies done in Royal London and Germany which revealed and confirmed that intra-abdominal injury was significantly associated with

AKI(20,24). This may be due to the fact that intra-abdominal injuries need specialized care that cannot be provided in the first health care, poor pre-transfer resuscitation, and under-triaging. Early admission to the referral trauma centers likely allows earlier hemorrhage control, and injury care, and prevents renal derangement.

Patients with a direct renal injury were 4.22 times more likely (AOR= 4.22, 1.72-10.34) to develop AKI among trauma patients. No previous study has addressed the link between AKI and renal injury in trauma patients. A study done at three regional level 1 trauma centers in France did not see a statistically significant association between AKI and renal injury(4). This might be because of under-resuscitation before the transfer which results in hypo-perfusion to the kidney, and the severity of renal injury as severe renal injuries can decrease the functional nephron mass and glomerular filtration rate which finally results in AKI.

Moreover, burn was 6.61 times more likely (AOR= 6.61, 1.50-29.21) significantly associated with the development of AKI. This might be due to severe electrolyte abnormality, fluid loss, and poor fluid resuscitation practice to preserve cardiac output in the face of fluid losses which may have adverse effects on multiple organ systems, including the kidney that results in AKI(2).

In this study, developing hypovolemic shock was 2.19 times more likely (AOR=2.19, 1.10-4.38) significantly associated with AKI in trauma patients. This study is comparable with the multicenter cohort study done a in three hospitals in France (OR=2.774, 1.572–4.895) and a systematic review and meta-analysis done in Germany (OR=2.3, 1.6-3.2)(4,24). This might be because of severe bleeding, low prehospital resuscitation practice, and the need for a specialized care that causes tissue hypo-perfusion. Early identification of patients requiring resuscitation in hospital and pre-hospital and shortening transport time from the injury scene might contribute to minimizing development of AKI. Pre-transfer resuscitation should not be neglected if there are prolonged waiting times before patient transport to referral hospitals.

AKI demonstrated a consistent association with the risk of death 111 (29.0%) (CI 24.3%-33.7%) among trauma patients and 46(56%) patients with AKI died. This indicates that patients with AKI have high mortality compared with the non- AKI patients. This study was comparable with a retrospective cross-sectional study performed in SPHMMC (29.1%), a prospective observational study done in the UK (26.4%), Italy (27.7%), and a study done in Sweden (26.2%)(10,19,25,26).

However, the mortality result of this study was higher compared to the retrospective observational cohort study done in Royal London (18.8%), the study done in France (10.8%) and the observational prospective study done in South Africa (4.0%) (4,12,20). This may be due to inadequate ambulance service, low quality of care, poverty, maladministration of resources, and lack of adequate funding. The mortality rate increased when the stage of AKI increases 7(15.2%), 10(21.7%) and 29(63.0%) in stage 1, 2 and 3 AKI respectively. This may be due to the severity of the injury and multi-organ failure.

In this study, 17.1% of patients who developed AKI required RRT. This finding is comparable with the prospective observational study done in the UK. The advantages of RRT were electrolyte and pH correction, fluid balance control, and potential avoidance of complications associated with AKI, including issues with vascular access, infection, anticoagulation, and hemodynamic complications. However, it may be possible to identify a subset of trauma patients at high risk of deteriorating AKI who may benefit from early RRT initiation(10).

To the best of the investigator's knowledge, this study was the first study in the area and gives direction for further studies. The fact that data was collected retrospectively, it was difficult to find complete information in patient medical charts. There was a limited data on any prehospital fluid administration. Therefore, several variables may not have been entered correctly or may have been missed. Regular review of the data with cleaning and correction was undertaken to curb this limitation. Incomplete trauma registration book was another challenge. Moreover, the retrospective cross-sectional nature of the study did not allow a follow-up study.

Conclusion

This study shows that AKI was a frequent complication among trauma patients admitted to the ICU, and associated with increased risk of mortality. The prevalence of AKI among trauma patients was 21.4% and the mortality related to AKI was 29.0%. intra-abdominal injury, direct renal injury, burns, and hypovolemic shock were statistically associated with AKI in trauma patients. Development of post-traumatic AKI was closely associated with increased mortality. Most AKI patient had unknown renal recovery. The number of patients who received

RRT was low, clinically important for patient outcomes and warrants inclusion in future studies.

Abbreviations

AICU: Adult Intensive Care Unit

AKI: Acute Kidney Injury

CKD: Chronic Kidney Disease

CRRT: Continuous Renal Replacement Therapy

IHM: In Hospital Mortality

ISS: Injury Severity Score

KDIGO: Kidney Disease Improving Global Outcomes

LOS: Length of Stay

RRT: Renal Replacement Therapy

SCR: Serum Creatinine

Declarations

Consent for publication

Not applicable.

Ethical Consideration

Ethical clearance was obtained from the SPHMMC Ethical Review Board (ERB). After fully explaining the nature and design of the study and confidentiality, permission letters were obtained from AaBET and ALERT Hospital. Then, the data collector was showing the ethical clearance to the respective trauma centers during the data collection day. The collected information does not contain a patient name, or card number and was kept confidential in all possible circumstances. The collected data was handled and secured with the principal investigator on every data collection day and the data was used only for the purpose of this research.

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Authors' contributions

MT, EN: conceptualized the research problem, designed the study, conducted fieldwork, collected and data analyzed, and drafted the manuscript. MK, YW & AM: was involved in conceptualization, preparing the research proposal, and revising the final manuscript. All authors of the manuscript have read and agreed to its content.

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Competing interest

All authors read and approved the final manuscript. The authors declare that they have no competing interests.

Availability of data and materials

The datasets used in the current study or data collection tool are available from the corresponding author with a reasonable request.

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