COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE

SPECIALTY PROGRAM RESEARCH PROPOSAL

PREVALENCE AND ASSOCIATED FACTORS OF ACUTE KIDNEY INJURY AMONG POSTOPERATIVE PATIENTS ADMITTED TO INTENSIVE CARE UNIT AT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA, 2021

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DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE RESEARCH THESIS

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APPROVED BY THE BOARD OF EXAMINATION

The thesis here, entitled "Prevalence and associated factors of Acute Kidney Injury Among Postoperative Patients Admitted to Intensive Care Unit at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, 2021" is accepted in its present form by the board of examiners as partial fulfillment of the requirement for specialty certificate in Anesthesiology, Critical Care And Pain Medicine. Examiners:

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Abbreviations and Acronyms

AKI	Acute Kidney injury
ATN	Acute Tubular Necrosis
GFR	Glomerular Filtration Rate
ADQI	Acute Dialysis Quality Initiative
RIFLE	Risk, Injury, Failure, Loss and End stage kidney disease classification
AKIN	Acute Kidney Injury Network
CRRT	Continuous Renal Replacement Therapy
ESRD	End Stage Renal Disease
ICU	Intensive Care Unit
SCr	Serum Creatinine
DBP	Diastolic blood pressure
SBP	Systolic blood pressure
ABL	Allowable blood loss
EBL	Estimated blood loss
UOP	Urine output

Abstract

Background: Postoperative AKI in critically ill patients carries significant morbidity and mortality yet it is understudied in Sub-Saharan countries. This study aims to assess the prevalence, associated factors and outcomes of AKI in postoperative patients requiring ICU care.

Methods: Single center study of 152 patients in a 1 year retrospective analytic study in patients ≥ 14years old with no underlying CKD. It is conducted in ICU of the largest teaching specialized hospital in Ethiopia which has 6 beds dedicated to non-cardiac surgical patients.

Results: Overall prevalence of AKI was 23.7% (36) be KDIGO criteria of which 17(47.2%) were stage 1, 11(30.6%) were stage 2 and 8(22.2%). Independent predictors of AKI were surgeries outside gastrointestinal and cardiothoracic surgery (0.024(0.03-0.385)0.08), emergency surgery (OR: 11.5(1.343-98.69)), Estimated blood loss >1500ml (OR: 10.418(2.016-78.183)0.023),

Conclusion: AKI is highly prevalent among patients admitted to ICU postoperatively. It is associated with increased length of ICU stay. Its predictors are cardiothoracic and gastrointestinal surgery, higher estimated blood loss and emergency surgery.

1. Introduction

1.1. Background

Acute Kidney Injury (AKI) is a syndrome which can result from a wide array of clinical conditions which share common clinical characteristics(1). It encompasses a broad spectrum of decline in renal function from small decreases in glomerular filtration rate (GFR) to complete loss of renal function requiring renal replacement therapy(2)(3).

Until 2004, there were no standard criteria of diagnosis of AKI(4). That year, the Acute Dialysis Quality Initiative (ADQI) group developed the Risk, Injury, Failure, Loss and End stage (RIFLE) system through a broad consensus of experts from around the world with the aim of standardizing the definition of AKI for clinical and research purpose(4). In light of subsequent researches that showed even slight increments are associated with mortality, the RIFLE criteria was further modified to AKIN and lately the KDIGO definition has been endorsed(5).

Postoperative AKI is shown to be an independent risk factor for hospital mortality in critically ill postoperative patients(6). Its incidence and prevalence varies widely depending on the setup and definition(7).

Prevention of postoperative AKI should commence even before the start of the surgery. Patients at risk should be determined and measures to reduce or avoid modifiable risk factors should be taken(7).

The aim of this research is to explore for predictors of postoperative AKI and lay foundation for subsequent risk reduction models and preventive strategies. It also aims to show the overall mortality rate associated with AKI.

1.2. Statement of the problem

AKI is a common and morbid complication in the surgical ICU and it significantly increases patient mortality, chronic kidney disease (CKD) and hemodialysis after discharge. Furthermore, it is associated with increment in health care cost and resource utilization (8).

In contrast to technological advances and extensive researches, AKI remains a big concern in causing increased morbidity and mortality. Researches on postoperative AKI in western setup show incidence of AKI to range from 0.8-17% (7). Another research from China, in 30 ICUs showed postoperative AKI incidence of 44.8% (9).

In Africa, particularly sub-Saharan Africa, AKI is presumed to exist more commonly as four out of five AKI cases occur in developing countries (10). A study made in Zimbabwe showed incidence of AKI to be 52.9% (11). A study targeting both medical and surgical patients in TASH ICU found out it has 45% mortality rate and showed sepsis to be the leading factor associated with AKI.

The International Society of Nephrology has proposed the five R's to mitigate the ever increasing burden of AKI- Risk assessment, Recognition, Response, Renal support and Rehabilitation and called the nephrology and the broader health care community to work collaboratively to develop effective programs to stem the tide of preventable deaths due to untreated AKI in developing countries(12).

This study explores potential predictors of AKI among postoperative SICU patients which will help fill the information gap to take appropriate and cost effective measures for prevention and early detection of postoperative AKI by identifying at risk populations.

3. Significance of the study

Critically ill patients are at the highest risk of acquiring AKI of which surgical patients are a part. Majority of previous studies focused on both medical and surgical patients while few specifically studied postoperative patients. Global analysis of researches shows very low studies from Africa particularly the Sub-Saharan Africa(12).

The risk for postoperative complications, including AKI, arises from the interactions be- tween patients' preoperative health that determines the physiologic capacity to with- stand surgery-related stress, modulated by the type and quality of surgery and anesthesia that patients experience(8).

This study is a major step forward in establishing the prevalence of AKI in the hospital and also contributes to the pool of data on country and the region. It also explores the risk factors in the present resource limited setup which are generally preventable. Lastly it evaluates the burden of postoperative AKI in increasing morbidity and mortality.

Identification of these factors lays the foundation for future research and helps to channel resources devise a cost effective and efficient plan to mitigate the risks.

4. Literature Review

Defining AKI

The definition of AKI has been continuously evolving and being multidimensional. In fact, it has advanced significantly from clinical to biochemical and further to molecular level(1). Acute kidney injury (AKI) in intensive care unit has been a common occurrence and often devastating syndrome which is difficult to treat; with high financial burden to patients and healthcare systems(13). Perioperative AKI is also common entity with associated increment in morbidity and mortality.

RIFLE Vs AKIN Vs KDIGO

With intention of creating a standardized approach for definition and classification of AKI, the RIFLE, AKIN and later on KDIGO classification systems were proposed. The RIFLE criteria have been extensively researched for monitoring in critically ill patients which resulted in ample evidence of its great relevance for classifying and evaluating the progression of renal disease and for predicting death.

The AKIN criteria emerged in 2012 with joint work of nephrologists and intensivists. Its major advancements are that it curbs the need for baseline creatinine and is sensitive for small increments in creatinine which are prognostically important. It is also inclusive of patients who require RRT.

Recently, the KDIGO proposed changes to the staging for AKI. KDIGO covers both the AKIN and RIFLE criteria, taking into account changes in creatinine within 48 hours or a decline in the glomerular filtration rate (GFR) over 7 days.

A prospective cohort study that included cases consecutively admitted to the ICU showed all were good predictors of mortality in critically ill patients, and there were no differences among them in terms of predicting death. These scores are good predictors of death(14).

Table 1 Comparison of definitions of AKI (15)

RIFLE 7 days	AKIN 48hrs	KDIGO
Risk Increased sCr × 1.5 or GFR decrease >25% or urine output for 6 h	Stage 1 Increased sCr × 1.5–2 or sCr increase ≥0.3 mg dl−1 or urine output <0.5 ml kg−1 h−1 for >6 h	Stage 1 Increased sCr × 1.5–1.9 that is known or presumed to have occurred within the preceding 7 days or sCr increase ≥0.3 mg dl−1 within 48 h or urine output <0.5 ml kg−1 h−1 for 6–12 h
Injury Increased sCr × 2 or GFR decease >50% or urine output <0.5 ml kg−1 h−1 for 12 h	Stage 2 Increased sCr × 2–3 or urine output <0.5 ml kg−1 h−1 for >12 h	Stage 2 Increased sCr × 2–2.9 or urine output <0.5 ml kg−1 h−1 for ≥12 h
Failure Increased sCr × 3 or GFR decrease 75% or sCr ≥4 mg dl−1 when sCr is in acute increase (≥0.5 mg dl−1) or urine output <0.3 ml kg−1 h−1 for 24 h or anuria for 12 h	Stage 3 Increased sCr × 3 or more or sCr ≥4 mg dl−1 when sCr is in acute increase (≥0.5 mg dl−1) or urine output <0.3 ml kg−1 h−1 for >24 h or anuria for 12 h	Stage 3 Increased sCr × 3 or sCr ≥4 mg dl−1 or initiation of RRT or GFR decrease to <35 ml min−1 (1.73 m)−2 in patients <18 year old or urine output <0.3 ml kg−1 h−1 for ≥24 h or anuria for ≥12 h

Occurrence of AKI

Myriads of researches had been conducted regarding the occurrence and risk factors for AKI in ICU patients to which postoperative AKI among critically ill patients are a subset. A ten year study extending from 1989-1999 from UK-Germany ICUs showed AKI incidence of 35.8% with RIFLE criteria(16).A more recent worldwide multicenter study from 2009-2010 showed incidences of 52% for elective and 56% after emergency surgery in the first week of ICU admission; in contrast to an incidence of 57% among non-surgical patients according to the KDIGO classification. This study included all the 6 continents and 2 out of the 33 papers were from Africa(17). In 2005, a 5 year meta-analysis of prospective studies involving more than of 120,000 patients showed incidence of AKI among critically ill to be 36 and 37.1% using AKIN and RIFLE diagnostic criteria respectively(18). Another meta-analysis of AKI among postoperative trauma patients using any one of the three criteria showed incidence rate of 24%(19).

Single center study from Turkey showed postoperative AKI incidence of 6.7% using the RIFLE criteria in a single center prospective analytic study extending 2010-2012(20). Another retrospective cohort study from Portugal showed prevalence of 7.5% using AKIN criteria(6).

A study from Hungary, involving multiple centers in a prospective study in 2009, showed AKI incidence to be 18.1% using the AKIN criteria(21). In Beijing, china, multicenter study of postoperative AKI among critically ill neurosurgical patients showed AKI incidence of 13.5%(22). In Egypt a multicenter study of critically ill patients showed incidence of 37.4% whereas in Zimbabwe, a study of in AKI ICU setting showed incidence rate of 52.9% both using the KDIGO criteria(10)(11).

Predictors of postoperative AKI

The comparison of demographic data of patients with or without AKI showed that patients with AKI were older and had higher rate of emergency surgery when compared to non-AKI patients. The incidence of concomitant diseases (NYHA IV, hypertension, CKD) and organ failure (respiratory failure and cardiogenic shock) was also significantly higher in the AKI group than that in the non-AKI group. Patients with AKI were observed to be more severely ill as determined by the APACHE II score and the SOFA score(23).

ASA physical status, although not initially developed as perioperative risk score, large-scale studies have showed that it is highly associated with postoperative morbidity. A study from Portugal showed ASA physical status to be one of independent risk factors for the development of postoperative AKI(6).

In a literature reviewing effect of intraoperative urine output, patients with lower intraoperative urine output had increased serum creatinine based KDIGO-AKI stage. Another single center study involving more than 3000 patients showed that patients with intraoperative urine output <0.3 ml/kg had increased risk of AKI whereas those with UOP between 0.3 and 0.5 had no increased risk(24).

In addition, the percentage of patients who received nephrotoxic drugs and mechanical ventilation was significantly higher in AKI patients than in non AKI patients. There was more unstable hemodynamics (MAP < 65 mmHg) in AKI patients; thus, a higher proportion of vasoactive drugs was used. Similarly, AKI was usually accompanied by oliguria, and diuretics are effective interventions; therefore, a higher proportion of diuretics was used. More patients experienced sepsis, which made the duration of positive fluid balance longer in the AKI group than that of the non-AKI group. For different types of surgery, only the proportion of cardiovascular surgery in the AKI group was higher than that in the non-AKI group. For neurosurgery and other surgeries (including ENT and head and neck surgery), there were differences between both groups, but the AKI group showed a lower incidence than that of the non-AKI group.

Six risk factors were found to be related to postoperative AKI in ICU independently: emergency surgery, nephrotoxic drugs, cardiovascular surgery, positive fluid balance, use of diuretics and sepsis(23).

Outcomes

Relatively few studies have examined the incidence and fewer have examined the consequences of hospital-acquired AKI among postoperative surgical intensive care patients.

Several other groups have shown an association between very small changes in serum creatinine and outcomes. A study explored this issue in elderly individuals who were hospitalized with congestive heart failure, for whom small changes in serum creatinine concentration have been associated with increased mortality and extended length of hospital stay. Recently, showed a two-fold increase in the risk for death for patients who experienced no change or a small increase (0.5 mg/dl) in serum creatinine 48 h after cardiothoracic surgery compared with patients who experienced a small decline in serum creatinine during the same time frame. In a similar population, it was showed that an association between a 25% increase in serum creatinine during the first postoperative week and short- and long-term (8 year) mortality(23).

4. Objectives

4.1. General Objective

To assess prevalence of AKI among postoperative SICU patients at TASH ICU, Addis Ababa, Ethiopia, 2021

4.2. Specific objectives

To assess the associated factors of AKI among postoperative SICU patients at TASH, Addis Ababa, Ethiopia, 2021

To assess clinical outcomes of AKI among postoperative SICU patients at TASH Addis Ababa, Ethiopia, 2021

5. Method

5.1. Study design

Institution based single center retrospective, analytic, observational study.

5.2. Study area

The study was conducted at Tikur Anbessa Specialized Teaching Hospital which is found in Addis Ababa, Arada sub city. Tikur Anbessa Specialized Teaching Hospital is the largest health care facility and medical academic institution found in the country. The ICU consists of six beds dedicated to surgical patients with age ≥14 years. It has 6 mechanical ventilators and intermittent dialysis is available on another floor 24 hours and 7 days but there is no CRRT (Continuous Renal Replacement Therapy). It is run by 15 Anesthesiology, Critical Care and Pain Medicine consultants. Nephrology and other specialties are accessible on consultation basis.

5.3. Population

5.3.1. Source population

All patients admitted to TASH SICU

5.3.2 Study population

All postoperative patients admitted to TASH SICU from May, 2020- July, 2021

5.4. Inclusion and exclusion criteria

5.4.1 Inclusion criteria

Postoperative patients admitted to the surgical ICU and stayed more than 24 hours

5.4.2 Exclusion criteria

Patients aged less than 14 years

Patients with unavailable preoperative or postoperative creatinine measurement

Patients with underlying CKD as documented on the chart or last preoperative serum creatinine value above equal to 1.6.

5.5. Study variables

- **Independent variables**
  - Sociodemographic variables
    - Age
  - Preoperative characteristics
    - Comorbidity
    - ASA physical status
    - Urgency of surgery (emergency Vs elective)
    - Surgical intervention
  - Intraoperative characteristics
    - Mannitol
    - Vasopressors
    - Diastolic or Systolic hypotension
    - Estimated blood loss
    - Allowable blood loss
    - Intraoperative urine output
  - Postoperative characteristics
    - Systolic or Diastolic hypotension
    - Maximum positive or negative fluid balance
- **Dependent Variables**
  - AKI according to KDIGO criteria

5.5.1. Measurement of variables

Preoperative investigations were taken as the latest investigations done within 30 days before the operation, diastolic blood pressure, intraoperative medications, intraoperative urine output, allowable blood loss and estimated blood loss were recorded from anesthesia monitoring sheet. Postoperative blood pressure and fluid balance were taken from the chart as documented every1-6 hours for vital signs and 6, 12 or 24 hours for fluid balances.

5.6. Sample size

Sampling size was determined by single population correction formula with incidence rate of 52.9%. Calculated with

N= sample size

P= Prevalence rate- .529

Z = Z value corresponding to a 95% level of significance = 1.96

D= margin of error- 0.05

Substituting the numbers yields a total result of 381.8 ~ 382

Using finite population correction formula

Using yearly ICU admission of 254 per year and a 10% addition for non-responders yields a total number of 168.

5.7. Sampling procedure

The sampling technique was simple random from list of medical record numbers. The charts were assigned unique numbers and sample patients were selected with lottery method. When the chosen card number is not eligible or not available, the next case was taken.

5.8. Data collection method

Data collection format was made from data from previous researches and individually established parameters. The questionnaire variables were made from previous studies and observations. Expert comment was obtained from consultants on the field.

5.9. Data collection procedure

Using the format, investigation values were taken as documented on the chart and checked on electronic fields when not available. Intraoperative BP measurements are documented every 10 minutes and were taken as maximum and minimum values. Postoperative vital signs were collected variably every 1-6hrs whereas urine output and fluid balance measurements were taken every 6, 12 or 24 hours variably and entered to the data as is documented.

5.10. Data analysis procedure

Data was checked for completeness and was entered using Epi-info 7 software and cleaned. Then the data was imported to and analyzed using SPSS 25.0(IBE, Armonk, NY, USA) software package. Statistical significance was indicated by $p<0.05$. Univariate analysis was used to assess frequencies and ratios for categorical variables. Continuous variables were presented as ratios and percentages as well as median with interquartile range (IQR) (for non-normally distributed continuous variables) as appropriate. The association of socio-demographic, preoperative, intraoperative and postoperative factors with AKI was assessed with bivariate analysis. Multivariate analysis was utilized to filter out independent predictors. Treating the presence or absence of AKI as an independent variable, outcomes of AKI were assessed using Chi square analysis.

5.11. Data quality assurance

The data collectors were trained before data collection. Data was cleaned on daily basis.

5.12. Ethical issue

Ethical clearance and support letter was obtained from Addis Ababa University College of Health Sciences, Department of Anesthesiology, Critical Care and Pain Medicine.

As this is a retrospective data, the need for verbal consent is waived.

Study participants confidentiality was assured by removing personal identifications instead using codes and not sharing their information to anyone other than the study team.

5.13. Result dissemination plan

The study result will be submitted to Addis Ababa University School of medicine and presented to the health science community. It will be disseminated to the concerned bodies and the result will be published on peer reviewed scientific journal/s.

This study will help policy makers, programmers and researchers to give appropriate attention on issues of interest.

6. Operational definition

Postoperative AKI in the ICU- renal dysfunction occurring in the first 7 postoperative days of ICU stay as defined by KDIGO with urine output of <0.5ml/kg/hr for 6 or more hours or SCr increment of ≥0.3mg/dl that occurred or presumed to have occurred in the past 7 days.

Stage 1 AKI- Increased sCr × 1.5–1.9 that is known or presumed to have occurred within the preceding 7 days or sCr increase ≥0.3 mg/dl−1 within 48 h or urine output <0.5 ml kg−1 h−1 for 6–12 h

Stage 2AKI- Increased sCr × 2–2.9 or urine output <0.5 ml kg−1 h−1 for ≥12 h

Stage 3 AKI- Increased sCr × 3 or sCr ≥4 mg dl−1 or initiation of RRT or GFR decrease to <35 ml min−1 (1.73 m)−2 in patients <18 year old or urine output <0.3 ml kg−1 h−1 for ≥24 h or anuria for ≥12 h

CKD- patients who are known to be CKD as documented on their chart

Preoperative BUN- the latest preoperative serum BUN level within 1 month

Preoperative SCr- the latest preoperative serum creatinine level within 1 month

Maximum positive fluid balance- maximum documented fluid balance in the first seven postoperative periods

Maximum postoperative negative fluid balance- maximum documented fluid balance in the first seven postoperative periods

Minimum postoperative hemoglobin- minimum documented postoperative hemoglobin in the first seven postoperative periods

Comorbidity- any preexisting acute or chronic systemic illness

7. Results

This study assessed prevalence as well as predictors of perioperative AKI among postoperative patients who were admitted to SICU. Sociodemographic data, Baseline health status, Intraoperative as well as postoperative factors and outcomes were assessed. The results of univariate and bivariate analyses are presented as follows.

Univariate analysis

Sociodemographic data

Of the 173 charts reviewed, 152 cases were obtained fulfilling the inclusion criteria. The rest of the cases were differed due to incomplete chart documentation or shorter duration of ICU stay. The remaining cases constitute 90.5% from the calculated total sample size. From the total of 152 patients 78(53.1%) of the patients were male and 61(46.7) were female. The median age distribution of the patients was 40 with interquartile range of 22 years. Residency of participants was in Addis Ababa in 63(42.9) of the cases whereas 84(57.1%) lived outside the capital.

Table 2 Sociodemographic characteristics of study participants at TASH, Addis Ababa, Ethiopia, 2021 (n=152)

Variable	Frequency (%)
Age	
≤40	79(53.7)
>40	68(46.3)
Sex	
Male	78(53.1)
Female	69(46.9)

Preoperative conditions

Regarding preoperative clinical conditions, more than two third of the patients had coexisting medical conditions while 41(27%) of them had no coexisting medical conditions. Seventy three had malignancy or tumor, 22 of had Hypertension, 30 had infection, 10 had cardiac illnesses, 9 had diabetes mellitus, 2 had asthma and 2 had previous stroke. Majority of the cases were ASA II and ASA III patients which constitute 69.7% and 23.0% each respectively and 92.7% together. Elective surgeries constitute 114(75%) of the cases.

Majority the surgical interventions were neurosurgery, cardiothoracic surgery, vascular surgery and gastrointestinal surgeries which together constitute 90.2% of the cases. Only 15(9.8%) of the cases had hemoglobin level below 12g/dl.

Table 3 Preoperative characteristics of study participants at TASH, Addis Ababa, Ethiopia, 2021 (n=152)

Variable	Frequency (%)
Coexisting medical illness	
No	41(27)
Yes	111(73)
ASA physical status	
I	3(2.0)
II	106(69.7)
III	35(23.0)
IV	7(4.6)
V	1(0.7)
Type of surgery	
Elective	114(75.0)
Emergency	37(24.3)
Surgical intervention	
Neurosurgical	82(53.9)
Cardiothoracic	25(16.4)
Vascular	18(11.8)
Gastrointestinal	12(7.9)
Endocrine	4(2.6)
GYN/OBS	5(3.3)
Orthopedics	3(2.0)
ENT	3(2.0)

Intraoperative factors

Mannitol was used in more than half of intraoperative patients whereas intraoperative vasopressors were used in 12.5% of patients. Diastolic blood pressure was below 50 in 45(29.6%) of the patients whereas systolic blood pressure below 90mmHg was seen in 51(33.6%) of the patients. Twenty percent of the patients had estimated blood loss above 1500ml. intraoperative transfusion was given for 40.8% of the patients.

Table 4 Intraoperative characteristics of study participants at TASH, Addis Ababa, Ethiopia, 2021

Variable	Frequency (%)
Mannitol (n=152)	
No	70(46.1)
Yes	82(53.9)
Vasopressors (n=152)	
No	121(79.6)
Yes	19(12.5)
Diastolic hypotension<50 (n=152)	
No	45(29.6)
Yes	107(70.4)
Systolic hypotension<90 (n=152)	
No	51(33.6)
Yes	107(66.4)
Intraoperative transfusion (n=152)	
No	90(59.2)
Yes	62(40.8)
Estimated blood loss(n=139)	
<1500ml	108(71.1)
≥1500ml	31(20.4)
Allowable blood loss(n=137)	
<1000	24(15.8)
>1000	113(74.3)

Postoperative conditions

Postoperatively, 13.8% had diastolic blood pressure below 60 whereas majority (82.2%) had diastolic blood pressure above 60mmHg. Postoperative blood pressure below 100mmHg was seen in 30.3% of the patients. Maximum positive fluid balance above 900ml was seen in 54(35.5%) of the patients. Maximum negative fluid balance above 500ml was seen in 17.8% of the patiens.

Table 5 Postoperative characteristics of study participants at TASH, Addis Ababa, Ethiopia, 2021 (n=152)

Variable	Frequency (%)
Postoperative diastolic hypotension <60mmHg	
Yes	25(13.8)
No	125(82.2)
Postoperative systolic hypotension <100mmHg	
Yes	46(30.3)
No	100(65.8)
Maximum positive fluid balance	
<900ml	54(35.5)
≥900ml	20(13.2)
Maximum negative fluid balance	
< 500ml	23(15.1)
≥ 500ml	27(17.8)

Outcomes

A total of 36 patients were found to have AKI making the prevalence of AKI 23.68% with 95% confidence interval of 16.85-30.52%. Of these 17(11.2%) were stage 1, 11(7.2%) were stage 2 and 8(5.3%) are stage 3. One person required Dialysis and the indication was anuria. The prevalence of AKI with AKIN criteria is 23.0% and using the RIFLE criteria, it is 25.0%.

Overall 15(9.9%) patients required mechanical ventilation for 7 or more days and 29(19.1%) of the patients stayed in the ICU for 7 or more days. A total of 17(11.2%) patients died in the ICU.

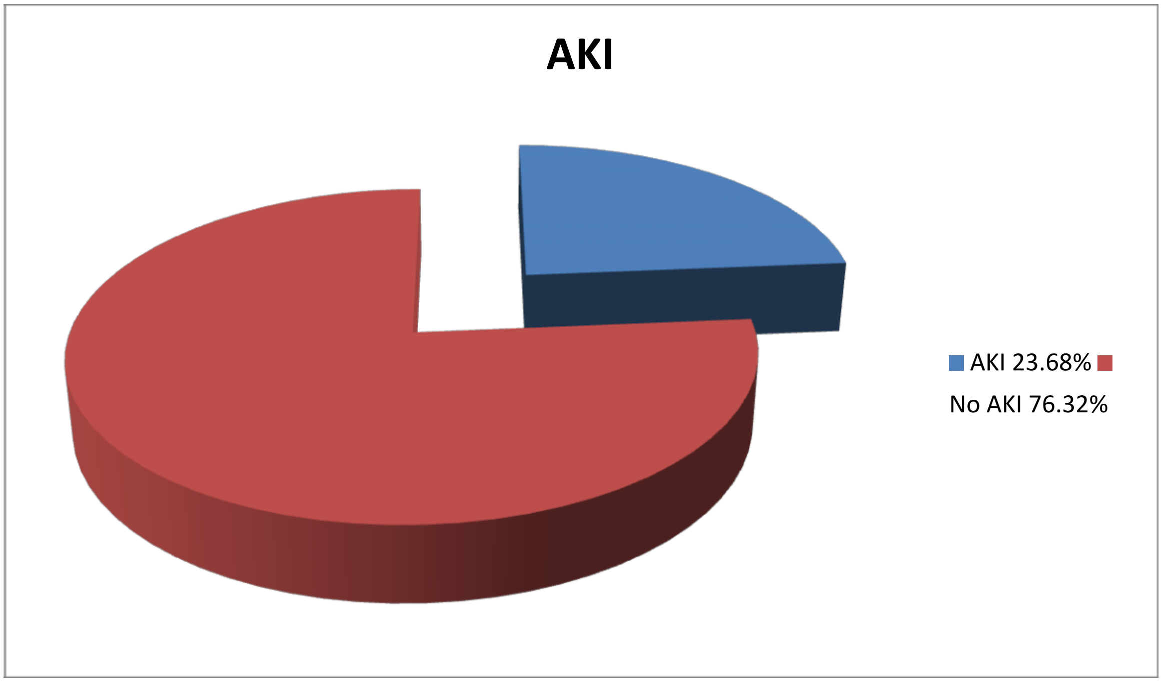

Figure 1 Prevalence of AKI among postoperative patients admitted to TASH ICU, Addis Ababa, Ethiopia, 2021

Table 6 Outcome characteristics of study participants at TASH, Addis Ababa, Ethiopia, 2021 (n=152)

Variable	Frequency (%)
Length of ICU stay	
<7 days	***123(80.9)***
≥7 days	***29(19.1)***
Death in ICU	
Yes	***17(11.2)***
No	***135(89.8)***

Table 7 Distribution of continuous variables by the status of AKI, TASH, Addis Ababa, Ethiopia, 2021 (n=152)

	Non AKI	AKI
	Median (IQR)	Median (IQR)
Age	37 (23)	43(26)
Preoperative Hb	13.80(3.3)	13.68(5.6)
ABL	1500(775)	1277(1130)
Duration of surgery	242.5(210)	202.5(240)
Duration of anesthesia	310.0(195)	277.5(220)
EBL	800(850)	700(1750)
ABL	1500(775)	1200(1130)
Intraoperative UOP	4.1(3.8)	2.8(3.1)
Maximum positive postoperative fluid balance	375(525)	800(1475)
Maximum negative fluid balance	500(400)	150(850)
Postoperative minimum hemoglobin	12.0(3.4)	11.8(11.8)

Bivariate and multivariate analyses

All the variables were analyzed against the presence or absence of AKI according to KDIGO criteria. The results displayed multiple variables with statistically significant association to be included in the multivariate analysis. From the Sociodemographic variables, only age showed significant association. From preoperative conditions, coexisting medical illness, ASA physical status, type of surgery (elective Vs emergency) and the surgical intervention were found to be significantly related to AKI.

Table 8 Bivariate analysis of socio-demographic characteristics with AKI, TASH, Addis Ababa, Ethiopia, 2021

Variable	AKI		COR (95%)	P value
	No	Yes		
Age				
≤ 40	*65(79.3)*	17(20.7)	1	
>40	*51(53.4)*	19(27.1)	1.424(0.673-3.016)	0.355
Sex				
Male	*60(74.1)*	21(25.9)	1	
Female	*56(78.9)*	15(21.1)	0.765(0.359-1.630)	0.488

Table 9 Bivariate and multivariate binary logistic analysis of preoperative characteristics of study participants Addis Ababa, Ethiopia, 2021 (n=152)

	AKI					
	No	Yes	P value	COR(CI)	P value	AOR
Coexisting medical illnesses						
Yes	83(74.8)	28(25.3)		1	-	-
No	33(80.5)	8(19.5)	0.463	1.392(0.575-3.366)		
ASA physical status						
<III	86(78.9)	23(21.1)		1		
≥III	30(69.8)	13(30.2)	0.235	1.620(0.730-3.595)	0.742	0.409(0.147-1.138)
Type of surgery						
Elective	91(79.8)	23(21.1)		1		1
Emergency	24(64.9)	13(30.2)	0.067	2.143(0.948-4.843)	**0.026**	11.5(1.343-98.69)
Surgical intervention						
Cardiothoracic& Gastrointestinal	20(55.6)	16(44.4)		1		1
Others	91(82.0)	20(18.0)	0.002	0.275(0.121-0.622)	**0.08**	0.024(0.03-0.385)

Intraoperative factors

Intraoperative drugs, intraoperative low diastolic and systolic BP as well as durations of anesthesia and surgery, intraoperative urine output, estimated blood loss and allowable blood loss were analyzed.

Table 10 Bivariate and multivariate binary logistics analysis of intraoperative factors with AKI, TASH, Addis Ababa, Ethiopia, 2021

	AKI					
	No	Yes	P value	COR (95%CI)	P value	AOR
Mannitol						
No	48(68.6)	22(31.4)	0.040	0.449(0.209-0.966)	0.242	0.486(0.145-1.628)
Yes	68(82.9)	14(17.1)	1			1
DBP < 50						
Yes	29(64.4)	16(35.6)	1			1
No	87(81.3)	20(18.7)	0.028	0.417(0.191-0.909)	0.139	0.239(0.027-1.426)
SBP < 90						
Yes	35(68.6)	16(31.4)	1			
No	81(80.2)	20(19.8)	0.116	0.540(0.2516-1.164)	0.180	3.792(0.432-17.532)
vasopressor						
No	97(80.2)	24(19.8)	1			1
Yes	12(63.2)	7(36.8)	0.401	2.358(0.839-6.628)	0.167	0.486(0.664-10.627)
EBL						
>1500	88(81.5)	20(18.5)	1			1
≥1500	18(58.1)	13(41.9)	0.193	3.178(1.341-7.532)	**0.023**	10.418(2.016-78.183)
ABL						
<1000	14(58.3)	10(41.7)	1			1
≥1000	90(79.6)	23(20.4)	0.031	0.358(0.141-0.908)	0.944	0.486(0.145-1.628)
UOP						
<2ml/kg/hr	20(66.7)	10(33.3)	1			1
≥2ml/kg/hr	63(78.8)	17(21.3)	0.193	0.464(0.191-1.124)	0.416	0.525(0.180-1.530)

Postoperative clinical characteristics

Postoperative clinical characteristics, including diastolic and systolic blood pressure as well as positive fluid balance were analyzed with binary logistics analysis. All of them were not found to be statistically significant independent predictors.

Table 11 Binary logistic analysis of postoperative characteristics of study participants Addis Ababa, Ethiopia, 2021 (n=152)

	AKI		P value	COR(CI)	P value	AOR
	No (%)	Yes (%)				
Diastolic BP < 60mmHg						
Yes	12(57.1)	9(42.9)		1		1
No	104(83.2)	21(16.8)	0.163	0.288(0.050-1.654)	0.284	2.753(0.015-5.533)
Systolic BP < 100mmHg						
Yes	31(67.4)	15(32.6)		1		
No	85(85.0)	15(15.0)	0.017	0.365(0.160-0.833)	0.384	2.710(0.287-25.631)
Positive fluid balance >900ml						
Yes	42(77.8)	12(22.2)		1		1
No	10(50)	10(50)	0.024	3.500 (1.181-10.371)	0.344	0.284(0.0213.858)

Outcomes

Bivariate analysis was done treating the presence or absence of AKI according KDIGO as independent variable and duration of length of ICU stay and death in ICU and death in hospital as dependent variable each. The results showed statistically significant associations with length of ICU stay and not death in the ICU.

Table 12 Binary Chi square analysis of postoperative outcomes of study participants Addis Ababa, Ethiopia, 2021 (n=152)

	AKI		
	No AKI	AKI	P value
Length of ICU stay			0.010
<7 days	94	23	
≥7 days	16	12	
Death in ICU			0.222
No	100	27	
Yes	11	6	

8. Discussion Prevalence

The prevalence of KDIGO-AKI in our study was found to be 23.7%. This is lower than the prevalence reported from Zimbabwe which is 52.9%. This can be due to the difference in nature of study participants and definition as the study from Zimbabwe predominantly consisted medical patients and considered AKI that occurred in the ICU during and after the first week(11). It is also lower than the Egyptian study which showed 37.4% for similar reason(10).

On the other hand, it is relatively comparable with a prospective cohort from Hungary that showed incidence of 18.1% with AKIN criteria(21). Studies from Portugal and Turkey showed incidence of 7.5% and 6.5% with AKIN and RIFLE respectively. This could be due to early detection and management of AKI in those setups(6)(20).

The finding in this study however is lower than the global data which suggests incidences of 52% and 56% after emergency and elective surgeries respectively. This pertains to factors like inclusion or exclusion of patients with underlying AKI or CKD(17).

Associated factors

Emergency surgery is associated with higher risk of acute kidney injury because shorter time available for resuscitation and the cause of the surgery itself. This study found that these patients are 11.5 times at higher risk of acquiring AKI compared to those who underwent elective surgeries. This is similar to the findings from other studies which showed 3 times increased risk of AKI in patients who underwent emergency surgery.(25)

The study found cardiothoracic and gastrointestinal surgeries are independently associated with increased risk of postoperative AKI. This is confirmed by a prospective study from Hungary that showed increment of AKI in patients who underwent intra-abdominal procedures(21).

The study also found out that intraoperative diastolic blood pressure was significantly related with postoperative AKI. This is also in congruent with other literatures. Diastolic blood pressure even if in short duration, is associated with higher risk of AKI(26).

Outcomes of AKI

All-cause mortality in our study was found to be 19.3% this is however significantly higher from reports from China (9.3%), and lower than the thirty day mortality from Egypt. This discrepancy can be better follow up and care in China and longer follow-ups in the study from Egypt(10). Mortality in ICU was also not statistically associated with occurrence of AKI in our study. Thus the increased mortality could be due to causes other than AKI.

9. Strength and limitations of the study

9.1. Strengths

This study has established the prevalence of AKI and major associated factors. This serves as a ground for further studies in the area.

The study also identified independent factors contributing to the development of postoperative AKI which should be areas to be studied more and focused in clinical practice.

It has also incorporated variables which were not studied in the reviewed articles.

9.2. Limitations

Since the research model was retrospective, missing data and variable measurement irregularities could not be addressed.

The study was not time weighted which makes it difficult to make a cause and effect analysis.

Due to unavailability of measurement of some parameters, the study could not incorporate well established scores like APACHE II, SOFA and SAPS score.

The study was done in single center making it difficult to generalize to other setups.

10. Conclusion and recommendations

10.1. Conclusion

The study showed that postoperative AKI is highly prevalent. However the prevalence is comparable to studies done in developing countries and lower than studies from medical ICUs as well as global incidence of AKI.

10.2. Recommendations

On the basis of this study, the following recommendations are forwarded

Clinicians should give increased focus to emergency gastrointestinal and cardiothoracic patients in particular and able to maintain intraoperative blood pressure

Further stratification of at risk patients to identify more factors associated with higher risk of AKI

Further prospective and multi-center studies involving larger pool of patients and diverse setup should be done

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12. Annex

Questionnaire

Demography

Eligible patients

Patients who are not diagnosed to have CKD

Patients who are not diagnosed to have obstructive kidney diseases

Patients with age above 14 years

Code__________ Age______ Sex ☐M F ☐

Region_________ Zone_______

1. **Preoperative status**

1.1. Preoperative comorbidities ☐ Yes ☐ No known comorbidity

If yes, please mention

☐ Hypertension

☐ Diabetes

☐ Cardiac illnesses

☐ COPD

☐ Anemia

☐ CLD

☐ Asthma

☐ Infection of any focus

☐ Dyslipidemia

☐ Malnutrition

☐ Alcoholic

☐ Smoker

☐ Malignancy

Other________

1.2. ASA physical status ☐ I ☐ II ☐ III ☐ IV ☐ V

1.3. Preoperative organ function test

BUN______

Cr______

1.4. Preoperative urinary protein______

1.5. Preoperative hemoglobin ________

2. **Surgery**

2.1. Surgical Procedure

☐ Neurosurgery

☐ Gastrointestinal

☐ Vascular

☐ Cardiothoracic

☐ Urosergery

☐ Endocrine

☐ ENT

☐ Orthopedic

☐ Gynecology and Obstetric

2.2. Type of surgery

☐ Elective ☐ Emergency

3. **Intraoperative**

3.1. Vital Signs

3.1.1. Lowest Intraoperative diastolic blood pressure_______

3.1.2. Highest Intraoperative diastolic blood pressure_______

3.1.3. Lowest Intraoperative systolic blood pressure_______

3.1.4. Highest Intraoperative systolic blood pressure_______

4. Vasopressor use

☐ Yes ☐ No

5. Vasopressor type and dose

☐ Adrenaline_______

☐ Noradrenaline______

☐ Phenylephrine_______

☐ Dopamine_________

☐ Other___________

6. Transfusion ☐ Yes ☐ No
7. Type ☐ PRBC___ ☐ Platelet_____ ☐ FFP__ ☐ Whole blood____
8. Intraoperative UOP_______
9. Intraoperative estimated blood loss (in ml)____
10. Allowable blood loss (in ml)_____

Postoperative

11. Lowest diastolic blood pressure_______
12. Highest diastolic blood pressure_______
13. Lowest systolic blood pressure_______
14. Highest systolic blood pressure_______
15. Highest positive fluid balance_______
16. Highest negative fluid balance______

	highest
BUN	
Cr	

Outcome

Length of ICU stays (days) ______

Renal Replacement therapy ☐ Yes ☐ No

Indication_______

Cycles of Dialysis_______

Death in ICU Yes ☐ No ☐