



**SAINT PAUL'S HOSPITAL MILLENNIUM MEDICAL
COLLEGE**

DEPARTMENT OF INTERNAL MEDICINE

**PATTERNS OF ACUTE KIDNEY INJURY AMONG PATIENTS
ADMITTED TO SAINT PAUL'S HOSPITAL MILLENNIUM
MEDICAL COLLEGE, ADDIS ABABA, ETHIOPIA**

BY

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APPROVAL SHEET

This is to certify that the thesis study entitled “Patterns of Acute Kidney Injury among patients admitted to Saint Paul’s Hospital Millennium Medical College, Addis Ababa, Ethiopia. It is the record of original thesis carried out by Mekbib Alamnie Jemberie under my supervision.

No part of the thesis has been submitted for any other degree or diploma. The assistance and the help received during the course of this study have been duly acknowledged. Therefore, I recommend that this research thesis would be accepted as partial fulfillment of the requirement for the subspecialty in Adult Nephrology.

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Date

2. Mr. Kasim Muhammed

Advisor

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DECLARATION

I declare that this thesis is my original work and has not been submitted to any other university in achieving any academic awards and all sources of materials used for the thesis have been duly acknowledged.

Declared by:

Name: Mekbib Alamnie Jemberie

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ACRONYMS AND ABBREVIATIONS

AGN ... Acute Glomerulonephritis	ICU ... Intensive Care Unit
ACEi ... Angiotensin Converting Enzyme Inhibitor	IRB ... Institutional Review Board
AIN ... Acute Interstitial Nephritis	KDIGO ... Kidney Disease Improving Global Outcome
AKD ... Acute Kidney Disease	LMIC ... Low To-Middle-Income Countries
AKI ... Acute Kidney Injury	LRTI ... Lower Respiratory Tract Infection
AKIN ... Acute Kidney Injury Network	MODS ... Multiorgan Dysfunction Syndrome
AOR ... Adjusted Odds Ratio	MPGN...Membranoproliferative Glomerulonephritis
ARB ... Angiotensin Receptor Blocker	NSAID ... Nonsteroidal Anti-Inflammatory Drug
ART ... Antiretroviral Therapy	OUP... Obstructive Uropathy
ATN ... Acute Tubular Necrosis	PI ... Principal Investigator
BPH ... Benign Prostatic Hyperplasia	PSGN...Post Streptococcal Glomerulonephritis
	RPGN ... Rapidly Progressive Glomerulonephritis
CRS ... Cardiorenal Syndrome	RRT ... Renal Replacement therapy
CKD Chronic Kidney Disease	SCD ... Sickle Cell Disease
COVID ... Corona Virus Disease	SCr ... Serum Creatinine
DM ... Diabetes Mellites	SLE ... Systemic Lupus Erythematosus
ESKD ... End Stage Kidney Disease	SPHMMC ... Saint Paul's Hospital Millennium Medical College
GC ... Gregorian Calendar	SSA ... Sub-Saharan Africa
GE ... Gastroenteritis	SUB ... Soba University Hospital
GN ... Glomerulonephritis	TASH ... Tikur Anbesa Specialized Hospital
HD... Hemodialysis	TB ... Tuberculosis
HIC ... High-Income Countries	TDF ... Tenofovir Disoproxil Fumarate
HIV... Human Immunodeficiency Virus	TIN ... Tubulointerstitial Nephritis
HMIS ... Health Management Information System	
HTN ... Hypertension	TLS ... Tumor lysis Syndrome
HUS ... Hemolytic Uremic Syndrome	UTI ... Urinary Tract Infection

ABSTRACT

Background: Acute kidney injury (AKI) is a frequently occurring syndrome of heterogeneous etiology and various pathophysiological processes that lead to decreased kidney function. Risk factors for the prevalence and pattern of AKI include environmental, socioeconomic, cultural and patient factors. In HIC, AKI occurs more frequently in older hospitalized patients with multiple comorbidities. In LMIC, AKI risk factors are often modifiable, community-acquired, and affect younger individuals. The first step in management of AKI is to determine the patterns and possible causes.

Objectives: To determine the patterns of AKI among patients admitted to medical ward at SPHMMC, Ethiopia.

Methods: Retrospective cross-sectional study was conducted at SPHMMC, Addis Ababa, Ethiopia on 155 adult patients who were admitted to medical ward from 01 May 2022 to 30 April 2023 GC and selected by systematic random sampling method. Data was collected by reviewing medical records from patients' card and electronic record. The data was filled in prepared checklists, analyzed using SPSS version 25 and Multinomial Logistic Regression Model was used

Result: The study showed that the most common cause of AKI among medical ward admitted AKI patients is AGN which attributes for 56.8% of patients. ATN or AIN were the causes for 29% of patients whereas pre-renal AKI, post-renal AKI and other intrinsic-renal were the causes for the remaining 14.2%. Patients with age group 15 to 44 yrs, stage 1 or stage 2 AKI patients, stage 3 non dialysis requiring AKI patients and patients who are neither pregnant nor in peripartal period have significantly lower probability of having ATN or AIN compared to that of AGN. Patients with stage 3 non dialysis requiring AKI, no underlying CKD, no underlying comorbidities and neither pregnant nor in peripartal period have significantly lower probability of having Pre-renal AKI or Post-renal AKI or others compared to that of AGN.

Conclusions: Among medical ward admitted AKI patients, intrinsic-renal cause (AGN followed by ATN or AIN) is the most frequent pattern of AKI followed by pre-renal and post-renal causes. Age of the patient, Severity of AKI, AKI on CKD, comorbidity and pregnancy are significantly associated with patterns of AKI. Serologic tests and kidney biopsy might be much helpful to identify specific causes of AGN.

Key words: AKI, pattern, risk factors, causes

1. INTRODUCTION

1.1. Background of the study

Acute kidney injury (AKI) is a frequently occurring syndrome of heterogeneous etiology and various pathophysiological processes that lead to decreased kidney function. AKI is defined as a sudden loss of kidney function determined on the basis of the accumulation of end products of nitrogen metabolism or reduced urinary output or both limited to a duration of 7 days. AKI is not a single disease but rather a loose collection of syndromes. AKI is part of a spectrum acute kidney disease (AKD) which can lead to chronic kidney disease (CKD) and end stage kidney disease (ESKD). AKI can range from mild and self-limiting to severe and persistent disease. Currently AKI is one of the diseases with a global concern (1) ; (2) ; (3) ; (4) ; (5).

The diagnosis of AKI is frequently delayed, because of unlike myocardial infarction and other acute organ failures, AKI do not present with immediate onset of alarming symptoms. AKI is diagnosed if serum creatinine increases by ≥ 0.3 mg/dl within 48 hours or increase serum creatinine by ≥ 1.5 times from baseline, which is known or presumed to have occurred within the prior 7 days or urine volume <0.5 ml/kg/h for 6 hours (1); (5).

The severity of AKI can be staged based on urine output or serum creatinine level. Stage1; serum creatinine increased by ≥ 0.3 mg/dl or 1.5–1.9 times from the baseline or urine output <0.5 ml/kg/h for 6–12 h. stage2; serum creatinine increased by 2.0–2.9 times from the baseline or urine output <0.5 ml/kg/h for 12 h. stage3; serum creatinine increased by 3.0 times from the baseline or increase in serum creatinine to ≥ 4.0 mg/dl or initiation of renal replacement therapy or urine output <0.3 ml/kg/h for 24 h or anuria for 12 hours (1).

The global burden of AKI-related mortality exceeds by far that of breast cancer, heart failure or diabetes, with mortality remaining high during the past 50 years. The incidence of AKI is increasing globally and its impact on long-term health and cost is far greater than formerly acknowledged. The etiology and incidence of AKI varies between high-income (HIC) and low-to-middle-income countries (LMIC). Estimates of AKI prevalence ranges from $<1\%$ to 66%. The variations are due to population differences and inconsistent use of standardized. The landmark study that defined AKI according to KDIGO 2012 reported community-acquired AKI in 8.3% of

patients and hospital acquired AKI in 20.0–31.7% of patients. In other studies, AKI occurred in 10–15% of hospitalized patients, up to 50% intensive care unit (ICU) admitted patients. It occurs in as low as 2% in community hospitals and up to more than 20% in large academic institutions. HIC show a lower incidence of AKI than do LMIC. Globally, the mean age of patients with AKI is 60 years but lower in LMIC (50 years). Sub-Saharan African (SSA) is one of the LMIC where no reliable statistics on the incidence of AKI. The available few epidemiological data are from only a few countries or hospitals and remain very diverse in SSA where it is difficult to interpret data on the incidence of AKI due to the no uniformity of cohorts, the difference in definitions used in the diagnosis of AKI and the different methods of reporting results. Despite the scarcity of reliable data, the available few studies showed that both the incidence and mortality rate of AKI is very high in SSA (2) ; (3) ; (4) ; (5) ; (6) ; (7).

The causes of AKI have three patterns; pre-renal causes (hypoperfusion, Cardiorenal syndrome and others), intra-renal causes (Nephrotoxin exposure, Sepsis, AGN, AIN and others) and post-renal causes (obstructive uropathy). Risk factors for the prevalence and pattern of AKI include environmental, socioeconomic and/or cultural factors, factors related to the process of care and patient factors. In HIC, AKI is more severe and occurs in older patients with multiple comorbidities, more frequently in the context of hospital-related risk factors. In LMIC, AKI risk factors are often modifiable, community-acquired, and affects younger individuals with a relatively high prevalence of volume depletion, sepsis, obstetric complications or toxins as causes. In USA, AKI accounts for approximately 40% hospitalization among persons with diabetes of all such hospitalizations. There are no adequate studies in Ethiopia regarding the pattern and specific etiologies of AKI in medical ward admitted patients. One report showed that AKI patients in Ethiopia are younger than similar patients in the developed world and common causes include; hypovolemia, AGN, and obstetric complications. COVID-19 is also the newly emerged risk factor for AKI in all world regions (3) ; (4) ; (5) ; (6) ; (7) ; (8) ; (9) ; (10).

AKI results retention of water and other waste products, impaired electrolyte homeostasis and altered drug concentrations. AKI affects almost all systems of the body. Fluid retention due to AKI can result cardiorespiratory failure, intestinal barrier dysfunction. AKI also affects the function of the brain, the heart, bone marrow and the immune system. AKI is associated with increased morbidity and mortality and adverse long-term patient and kidney outcomes.

Depending on the severity of AKI, various degrees of nephrons can be irreversibly destroyed and causes CKD and ESKD. The additional risk of CKD after AKI has been estimated at 10 extra cases per 100 person-years. Based on the available evidences patients with AKI have increased risk of HTN by 22%, subsequent heart failure by 58%, myocardial infarction by 40% and stroke by 15% (3) ; (4) ; (5).

The management of AKI includes identification and treatment of the likely causes and general management of its complications. Since AKI is not a single disease, the first step in management of AKI is to determine the patterns and possible causes cause. Only a minority (<5%) of patients with AKI require RRT. It is crucial to know the incidence and etiology of AKI to promote prevention strategies (5) ; (9) ; (11).

1.2. Statement of the problem

The incidence of AKI is increasing globally and it is associated with increased morbidity and mortality and adverse long-term patient and kidney outcomes. Its impact on long-term health and cost is far greater than formerly acknowledged. Socioeconomic, geographical and genetic factors play important roles in determining the prevalence and pattern of renal diseases. Treatment and preventive strategies of AKI require an understanding of the epidemiology and etiology of AKI (3) ; (5) ; (9).

Across the world there are differences in epidemiology, clinical characteristics of AKI and availability of therapeutic modalities offered to affected patients. Despite the evidences showed that there is increased incidence AKI in LMIC including SSA, there are limited reliable epidemiologic studies regarding the prevalence, pattern, and specific etiologies of AKI. Even though few epidemiological data on AKI are available from a few countries, it remains very diverse in SSA and difficult to interpret the data. In Ethiopia no adequate studies done about patterns of AKI on admitted patients except in particular patients like emergency, ICU and patient requiring RRT. There is no study done about patterns of AKI on patients admitted to SPHMMC (7) ; (12) ; (13).

Studying the patterns and etiologies of AKI at SPHMMC is needed since the socioeconomic, geographical and genetic factors play important roles in determining the prevalence and pattern

of AKI and there are only limited reliable studies in SSA including Ethiopia and not done at all at SPHMMC.

1.3. Significance of the study

This study may contribute by filling the gap of lack of enough large studies regarding the prevalence patterns and specific etiologies of AKI among patients admitted to SPHMMC. Since knowing the etiologies is crucial for the management of AKI and promote prevention strategies, this research will be much helpful in this regard. Since this study is done at SPHMMC, a tertiary center which accepts many cases from both rural and urban areas, and from all corners of the country, it may help as a reference about the epidemiology of hospitalized AKI patients in Ethiopia. It may also be used as supplementary and stepping stone for other researchers in this area to do wider studies at country level as well as SSA.

1.4. OBJECTIVE

1.4.1. General Objective

- ✓ To determine the patterns of AKI and associated factors among patients admitted to medical ward

1.4.2 Specific Objectives

- ✓ To determine the patterns of AKI among patients admitted to medical ward
- ✓ To asses associated factors of AKI among patients admitted to medical ward

2. LITERATURE REVIEW

Metanalysis of 312 studies including 50 million patients from 40 countries worldwide was done from 2004 to August 23, 2012. Most studies (49.0%) originated from America followed by Europe (31.4%), Asia (14.15%), Australia and New Zealand (3.2%), and Africa (1.3%). The mean age for adults was 60 yrs. and 65% of the patients were males. AKI occurred at Critical care (18%), Cardiac surgery (31%), Trauma (4%), Heart failure 1%, Hematology/oncology 2%, Nephrotoxins 4%, and unspecified 52%. The incidence of AKI was 21.6% in adults and the OR for stage 1–3 AKI was 3.37, 7.52 and 13.19 respectively (14).

A retrospective observational study done on patients admitted to internal medicine ward at a tertiary hospital in Portugal from 01 July 2017 to 31 December 2017. The median age was 77 years. The most frequent comorbidities were HTN (77.2%), CVD (55.3%), DM (46.4 %,) and CKD (45.7%). The major causes of AKI were sepsis (22.0%) and acute heart failure (22.0%) (15).

Based on the study done on patients older than 80 yrs. admitted to People's Liberation Army General Hospital, China, from June 1, 2008 to December 31, 2009, the overall incidence of AKI was 14.8%. The most common causes of AKI were hypovolemia, nephrotoxic drugs, cardiac dysfunction and respiratory failure. Patients with AKI on CKD were older, higher rate of complication with MODS, hyperlipidemia and recurring AKI (16).

A prospective study was done on 404 AKI patients at Nephrology Department in Singapore General Hospital, tertiary hospital in Singapore, from 15th July to 22nd October 2016. Of the 404 patients, 58.2% were male and 41.8% were females. The mean age was 65.8 ± 14.1 years, with 58.9% older than 65 years. Identified the comorbidities were HTN (74.8%), DM (56.9%), IHD (46.3%) and malignancy (19.3%). Among AKI patients 58.9% of patients had stage 1 AKI, 24.5% stage 2 AKI and 16.6% stage 3 AKI. The most frequent cause of AKI was pre-renal causes (27.7%) followed by sepsis-associated AKI (26%) and ATN (15.3%). Dialysis was carried out in 27% of AKI patients (17).

The Hospital based prospective study done at Northern California, USA, from 1996 to 2003 comparing 1,746 hospitalized adult patients who developed dialysis-requiring AKI with 600,820

hospitalized patients who didn't develop AKI showed that patients with stage 3 to stage 5 CKD were at higher risk of AKI than stage 1 and 2 CKD patients. From 1746 dialysis-requiring AAKI cases, 74% were stage 3 to stage 5 CKD patients. DM, HTN and proteinuria were independent risk factors for developing AKI in CKD patients. An ICU stay (62.4% vs. 5.7%), mechanical ventilation requirement (31.2% Vs. 1.1%), sepsis (27.7% Vs. 1.1%) and hyperbilirubinemia (19.7% Vs. 1.1%) were more frequent in patients who developed AKI (18).

Based a meta-analysis done on 31 cross-sectional, retrospective, and prospective cohort studies (57,529,841 participants) published between 1980 and 2021 including all regions of the world (India, China, Pakistan, USA, Brazil, Morocco, Canada, Mexico, Egypt, Turkey, Greece and Malawi), the incidence of pregnancy related AKI was 2.0%. The most common cause (36.6%) of pregnancy related AKI was preeclampsia. Other causes were septic abortion (21%), unknown causes or other causes of abortion (16.6%), antepartum hemorrhage (15.1%), acute gastroenteritis (14.1%), HELLP syndrome (13.3%), postpartum hemorrhage (13.2%), pyelonephritis (5.8%), acute fatty liver of pregnancy (4.5%) and glomerulonephritis (3.5%) (19).

A prospective observational study was conducted in a tertiary care teaching hospital in South India on 193 patients admitted to Emergency medicine department. Mean age was 52.1 ± 14.8 years and male to female ratio is 1.7. The identified comorbidities were DM (33.7%), HTN (41.5%), smoking (18.1%) and alcoholics (20.7%). Of 193 patients, 12% classified under AKIN 1, 19.2% AKIN 2 and 66.8% patients AKIN 3. The most common etiologies were sepsis (14%), acute gastroenteritis (11.9%), snake bite (6.7%), nephrotoxicity (5.1%), obstetrics causes (5.1%) and CHF (1.6%). RRT was required in 56.4% of the study population (20).

Single center prospective observational study was done at Tapua Tamasese Meaole Hospital, a tertiary referral hospital of Samoa, Pacific Island, on 114 patients admitted with a diagnosis of AKI between December 1, 2019 and May 31, 2020. Age ranged from 18 to 92 years and 57.9% of the participants were male. There were a total of 114 AKI admissions over the 6-month study period. Of 114 AKI patients 80% of patients were admitted to the Department of Internal Medicine, 19% to the Department of Surgery, and 0.9% to the Department of Obstetrics and Gynecology. The hospital-based incidence of AKI was 26.8 per 1000 admissions per 6 months. The causes of AKI were dehydration (79%) and sepsis (64%) and cardiovascular events (36%), shock (16%), nephrotoxins (10%), urinary obstruction (3.6%), acute liver failure (1.8%), and

pregnancy related (0.9%). On admission, 52.6% of cases presented with Stage 1 AKI, followed by Stage 3 AKI (27.2%) and Stage 2 AKI (20.2%). (21).

A retrospective observational study was done on 728 AKI and 243 AKI on CKD patients who presented to acute HD unit in Kasr Al-Aini Hospital, a tertiary care center at Cairo University from October 2012 to October 2014. The mean age was 48.15 years and 51.85% of them were females. Referrals from cardiology and cardiothoracic departments represented 23.5% of total AKI cases (heart failure 9%, post-coronary artery bypass graft 2.9%, contrast induced AKI 9% and endocarditis 2.7%). Other causes of AKI were hematemesis (67%), hepatorenal syndrome (1.37%), burns (1.5%), drugs (15.5%) obstetric causes (6.6%), extra-urological malignancy (18%), glomerulonephritis (13.87%), OUP (9%) and uncertain etiology (5.5%). The most common cause of AKI on CKD was OUP due to urinary stone disease (82.8%) and urological malignancies (12.75%) (9).

A prospective observational study done on general medical admissions to Queen Elizabeth Central Hospital, a tertiary hospital in Blantyre, Malawi between 27th April and 17th July 2015 showed that the prevalence of AKI was 17.2% and the commonest comorbidities were HIV infection (43.8%) and HTN (12.2%). The median age was 37 years. Most of the patients had stage 3 AKI (60.8%) followed by stage 1 (21.6%) and stage 2 (17.7%) respectively. The causes of AKI were sepsis and hypoperfusion (86.9%), GE (19.0%), dehydration of other cause (7.8%), TB (11.8%), heart failure (10.5%), Malaria (7.8%), LRTI (6.5%), sepsis of unclear source (5.9%), liver failure (5.2%), meningitis (4.6%), UTI (0.7%), OUP (4.6%), parenchymal kidney disease (2.6%), and nephrotoxins (1.9%). HD was provided for 38.1% of AKI patients (13).

A retrospective review carried out on 324 AKI patients who were initiated dialysis at the Chris Hani Baragwanath Hospital Johannesburg, South Africa, from July 2009 to June 2011 showed that the leading indications for dialysis were CKD (38.9%), ATN (38.3%), HIV-related kidney disease (13.6%), malaria (5.7%), pregnancy-related kidney disease (7.4%) and GN (7.4%). The mean age was 40 ± 13 years and 57% of patients were males. HIV positivity occurred in 26% of patients. (22).

Based on the prospective cross-sectional study conducted among 145 patients admitted to the medical and the surgical wards at the Cape Coast Teaching Hospital, Cape Coast, Ghana from

April 2017 to April 2018, the prevalence of AKI was 15.9%. Stage 1 AKI occurred in 56.5% of the participants followed by stages 2 (4.1%) and stage AKI 3 (2.8%) respectively. AKI occurred in 20% of medical ward and 12% of surgical ward admitted patients. The prevalence of severity of AKI among patients admitted to the medical ward were 60.0%, 26.7% and 13.3% for stages 1, 2 and 3 AKI respectively (23).

In a prospective study done on 2402 acute admissions in the Internal Medicine (1822 patients) and the ICU (580) of a tertiary referral hospital in Cameroon from January 2015 to June 2016, the incidence of AKI was 22.3%. Of the 536 patients with AKI, 54.7% were males and the median age was 56 years. The main comorbidities were HTN (32.2%), DM (17.6%), HIV (12.6%), cancer (9.3%) and CKD (6.1%). The patterns of AKI were pre-renal AKI (61.4%), ATN (28.9%) and post-renal (4.10%). The etiologies of AKI were sepsis/bacterial infection (50.4%), volume depletion (31.6%), nephrotoxins (10.1%), pelvic tumor (3.0%) and gynecologic/obstetric causes (7.1%). Volume depletion was mainly due to hemorrhage (23.7%), GE (23.1%), decompensated diabetes (21.7%) and heart failure (17.7%). Main causes of obstetric AKI were cervical cancer (34.2%), eclampsia (28.8%) and post-partum hemorrhage (21.1%). Dialysis was indicated 10.1% of patient (24).

Based on a retrospective study done on AKI patients admitted to emergency at University Alassane Ouattara, University Teaching Hospital, Côte d'Ivoire from 01 January to 31 December 2019, the prevalence of AKI was 12.4%. The mean age was 54 ± 19 years and the male/female ratio was 1.40. Identified comorbidities were 95.9% of patients HTN (40.4%), cardiac disease (16.9%), diabetes (14.3%) and HIV infection (6.3%). The severity of AKI according to the AKIN criteria were stage I (63.8%), stage II (22.1%) and stage III (14.1%). HD was indicated in 6.8% of patients (25).

In a retrospective cohort study conducted on 6769 adult patients admitted to Soba University Hospital, a tertiary Hospital in Sudan from 01 January to 31 December 2014, the prevalence of AKI was 5.7%. The commonest causes of AKI identified were Sepsis(44%), volume depletion (38.5%), OUP (8.9%), heart failure (5.7%), acute glomerulonephritis (4.7%) and severe malaria (3.1%) (26).

In a retrospective study done on 520 patients admitted to the nephrology unit SUH, a tertiary referral center in Khartoum, Sudan, and received emergency HD between January 1, 2013 and

December 31, 2014, 14% of patients had AKI. Intrinsic renal disease was the most common cause of AKI (25.3%). Pre-renal causes were identified in 14.1% of patients and OUP was seen in 17.5% of men and in 6.5% of women. Glomerular and tubulointerstitial diseases were the leading cause of AKI, followed by envenomation and intoxication by hair dye. No cause was conclusively determined in 19.7% of patients including 5.6% of patients with acute on CKD (27).

A prospective study done on 208 patients admitted to the general medical and surgical wards at University of Gondar Hospital over a 6-week period in July and August 2012. The majority of patients were on the medical wards (151) with the remainder under the care of general surgical (53) and trauma (14). Of all ward admitted patients, 23 patients (10.6%) had AKI and three (13%) of the AKI patients had underlying CKD. Among patients with AKI, seven were classified as stage 1, five as stage 2 and 11 as stage 3 by the AKIN criteria. For patients with AKI the etiology was related to sepsis in seven, cardiac disease in seven, obstetric complication in two and intrinsic renal disease (pyelonephritis, PSGN, nephrotic syndrome and renal vein thrombosis) in four patients. The mean age of the patient with AKI was significantly older than the medical patients with no documentation of impaired renal function (49.6 vs 41.0) There was a significantly higher proportion of AKI patients with a documented history of cardiac disease (4 of 23 vs 4 of 105) and hypertension (9 of 23 vs 18 of 105) compared with those with no AKI (12).

Based on a Hospital-based prospective observational study conducted on patients admitted to medical ward of Jimma Medical Center, South West Ethiopia, from October 2019 to January 2020, the most common causes of AKI were hypovolemia (39%), sepsis (22%), pyelonephritis (11%) and unspecified causes (19%). One-third of patients (33%) had infectious causes of AKI. The mean age was 47.51 ± 14.52 years and 60% of AKI patients were males. Using the KIDGO criteria, 32% patients were classified as stage 3 AKI, 45.5% stage 2 AKI and 22.5% stage 1 AKI. The identified comorbidities were HTN (43%), heart failure (31%), DM(14%) and CKD (17.5%). RRT needed in 7% of patients (28).

According to a hospital based prospective observational study done on 288 patients admitted to Medical Ward of Jimma Medical Center, South West Ethiopia from 15 August 2020 to 14 October 2020, the prevalence of AKI was 23.32%. The mean age of the respondents was 44.16

(± 18.29) years. Cases at baseline having hemoglobin level ≤ 10.9 mg/dl, being cancer cases and scr > 1.36 mg/dl were significantly associated with AKI (29).

A prospective observational study was conducted on adult AKI patients admitted to the medical ward of Jimma medical center, Southwest Ethiopia, from 01 April 2019 to 30 July 2019. The mean age was 49.91 ± 15.17 years and 58.6% of the patients were males. Almost one third (33.1%) had KIDGO stage 3 AKI. More than half of AKI patients (53%) had pre-renal AKI, 17% had intrinsic AKI, and 9% had post-renal AKI. Hypertension (44.4%), heart failure (44.4%), and anemia (7.1%) were common underlying comorbidities (30).

A retrospective cross-sectional study was done on AKI patients above 14 years of age admitted to adult ICU of Tikur Anbessa Specialized Hospital (TASH) and enrolled over a two-year time period. There were 71 critically sick patients with AKI included in the study. The median age was 43 years and 50.7% were males. Thirty-seven patients (52.1%) had AKI before admission to the ICU. Fifty-five (77.5%) were medical patients, 8 (11.3%) had obstetric complications related to eclampsia and/or HELLP syndrome and 8 (11.3%) were surgical patients. The leading causes of AKI included septic ATN (40.8%) followed by ischemic ATN and pre-renal azotemia (29.6%). Nineteen (26.8%) patients had the indications for dialysis (31).

A prospective Cross-sectional study done on 144 AKI patients admitted to adult Emergency Unit TASH, Addis Ababa, Ethiopia from 01 August 2018 to 01 May 2019 showed that the most common causes of AKI were sepsis (43.2%), volume depletion (25%), cardio renal syndrome (16%), OUP (16%), AGN (8%), hypertensive crisis (7%), drugs (3.5%) and tumor lysis syndrome (2.8%). The mean age of the patients was 46.6 ± 16.6 and around 40% of the patients are found in the age group between 30-50 years. Male patients accounted 54.9% of the cases. AKI on CKD found in 27.1% of the patients. The main underlying cause of CKD was extra-renal OUP (25.6% of the cases) followed by HTN (23.1%) and DM (20.5%) (32).

Based on the study done on 151 dialysis requiring AKI patients at SPHMMC, Ethiopia from 01 August 2013 to 01 February 2015, the causes of AKI were hypovolemia (22.5 %), AGN (21.9%), pregnancy related causes {18.5 % (severe preeclampsia/eclampsia 12.5 %, puerperal sepsis in 3.3 %, postpartum hemorrhage 1.3 % and septic abortion 0.7 %)}, post-renal cases (5.35%) and Nephrotoxic Drugs (5.3%). The mean age of the patients was 36.7 years and 50.3% of the patients were males. AKI on CKD was found in 16.9% of patients. The identified

comorbidities were HIV infection (15.9 %), HTN (14.1%), cerebrovascular accident (3.3 %) and DM (2.6 %) (33).

3. METHODOLOGY

3.1. Study area and period

The study was conducted at SPHMMC, Addis Ababa, Ethiopia, starting from 01 May 2023 to 10 December 2023 GC. The Hospital was first established as a government hospital near Atobis tera (regional bus terminal) in 1947 Gc. In 1969 Gc, the Hospital built in its current place Gulele area, North West of Addis Ababa and became one of the seven institutions in the country giving training in nursing. The Medical School was opened in 2007GC and the name of the institution was changed to Saint Paul's Hospital Millennium Medical College. Currently, SPHMMC is one of the largest government Hospitals and academic institutions in the country. It currently has an inpatient capacity of 700 beds and more than 2000 emergency and outpatient clients daily with an annual average of 500,000 patients and a catchment population of more than 5 million. In addition to its clinical service, the college has undergraduate, postgraduate and sub specialty teaching programs. The College has more than 2500 clinical, academic and admin staffs in over 14 departments. The Hospital has hemodialysis center serving mainly for AKI patients and ESRD patients who are transplant candidates. It also gives kidney transplant service in the National Kidney Transplantation Center through its Nephrology unit since 2015Gc.

3.2. Study design

A Hospital-based retrospective, cross-sectional study was conducted from 01 May 2023 to 10 December 2023 Gc.

3.3. Study population

The study population consists of AKI patients admitted to SPHMMC medical ward from 01 May 2022 to 30 April 2023 Gc.

3.4. Eligibility criteria

3.4.1. Inclusion criteria

- ✓ Both males and females with age of 15 yrs. and above admitted to medical ward from 01 May 2022 to 30 April 2023 Gc.
- ✓ Fulfill the KDIGO definition of AKI

3.4.2. Exclusion criteria

- Age <15
- ESKD
- Died or discharged before the underlying cause identified
- No clear evidence of AKI in those patients admitted with the diagnosis of AKI on CKD
- If the information that are important for diagnosis and characterization of AKI are missed from the chart

3.5. Sample size determination

The proportion of AKI patients admitted to medical ward is 23.32%, as reported from an earlier study done at Medical Ward of Jimma Medical Center, South West Ethiopia (29). The required sample size was determined by using single population proportion formula:

$$n_0 = \frac{Z^2 p (1-p)}{w}$$
$$n_0 = \frac{(1.96)^2 (0.23) (1-0.23)}{(0.05)^2}$$
$$n_0 = 272$$

Based on the HMIS document finding, the number of AKI patients admitted to medical ward in one year from 01 May 2022 to 30 April 2023Gc were 354. Therefore, for a population size (N) of 354, the required initial sample size (n_0) was 272. However, since this sample size (n_0) exceeded 5% of the population ($272/354 = 0.77$), Cochran's (1977) correction formula was used to calculate the final sample size.

$$n_1 = \frac{n_0}{1 + \frac{n_0}{N}}$$
$$n_1 = \frac{272}{1 + \frac{272}{354}} = 153.815 \approx 154$$

Adding the 10% non-response rate, n_1 was 169.

Therefore, the minimum required sample size of 169 was employed.

N = population size

n_0 = initial sample size

n_1 = required sample size

P= estimated proportion (23.32%)

W= margin of error (5%)

Z= confidence level (95%)

3.6. Sampling technique and procedures

Systematic random sampling technique was applied and data was collected using standardized questionnaire at SPHMMC. The data was collected from the cards of AKI patients admitted to SPHMMC medical ward and registered on medical ward HMIS log books from 01 May 2022 to 30 April 2023 Gc. Among the 169 selected cards, 14 cards were avoided because of they were either incomplete or didn't fulfill the criteria of AKI. Therefore only 155 patients were candidate for the study. The data was collected by the researcher and professional nurses. Training was given for data collectors on the definition of variables on the questionnaire and chart review.

3.7. Operational definition

- ✓ **Acute Kidney Injury (AKI):** Acute onset of renal dysfunction resulting in failure of the kidneys to excrete waste products. According to KDIGO, AKI is an increase in serum creatinine by ≥ 0.3 mg/dL within 48 hours, or to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior seven days, or urine volume < 0.5 mL/kg/hour for six hours (1).
- ✓ **AKI on CKD:** CKD with acute exacerbation due to different clinical problems
- ✓ **Comorbidity:** The presence of other underlying diseases in addition to AKI which have direct relation to AKI and CKD (DM, HTN, CVD and chronic infectious disease like HBV, HCV, RVI, TB and others)
- ✓ **Patterns of AKI:** presence of AKI with different characteristics depending on its causes and pathophysiologic mechanisms.
 - **Pre-renal AKI:** AKI caused by impaired renal perfusion which includes cardio-renal syndrome, hepato-renal syndrome, GI loss, bleeding abdominal compartment syndrome, medication and others
 - **Intrinsic-renal AKI:** AKI caused by different diseases that directly affect the kidney (glomerulonephritis, ATN, vasculitis and others)
 - **Post-renal AKI:** AKI caused by urinary tract obstruction like urolithiasis, BPH, stricture, malignancy and others

- ✓ The severity of AKI can be staged based KDIGO 2012 staging using urine output or serum creatinine level
 - Stage1; serum creatinine increased by ≥ 0.3 mg/dl or 1.5–1.9 times from the baseline or urine output < 0.5 ml/kg/h for 6–12 h.
 - Stage2; serum creatinine increased by 2.0–2.9 times from the baseline or urine output < 0.5 ml/kg/h for 12 h
 - Stage3; serum creatinine increased by 3.0 times from the baseline or increase in serum creatinine to ≥ 4.0 mg/dl or initiation of renal replacement therapy or urine output < 0.3 ml/kg/h for 24 h or anuria for 12 hours (1)
- ✓ **Sepsis:** Life-threatening organ dysfunction caused by a dysregulated host response to infection
- ✓ **Septic shock:** Sepsis with persistent hypotension that needs vasopressors to maintain a MAP ≥ 65 mm Hg
- ✓ **Renal replacement therapy:** Therapeutic options for patients with ESRD or AKI. It includes dialysis and kidney transplantation

3.8. Variables

3.8.1. Dependent variable

- ✓ Patterns of AKI

3.8.2 Independent variables

- ✓ Age
- ✓ Sex
- ✓ Severity of AKI
- ✓ AKI on CKD
- ✓ Comorbidity
- ✓ Pregnancy and peripartal period

Table3.1. Dependent variables

Variable	Category	
AKI	Pre-renal AKI	0. No pre-renal AKI 1. Heart failure 2. Liver failure 3. GI loss 4. Bleeding
	Intrinsic-renal AKI	0. No intrinsic-renal AKI 1. Glomerulonephritis 2. Interstitial nephritis 3. ATN 4. Others
	Post-renal AKI	0. No post-renal AKI 1. BPH 2. Urolithiasis 3. Urethral stricture

Table3.2. Independent variables

Variable	Category
Age	0. 15-44 yrs. 1. 45-59 yrs. 2. =>60 yrs.
Sex	1. Male 2. Female
	0. Stage 1 AKI 1. Stage 2 AKI 2. Stage 3 non dialysis requiring AKI 3. Stage 3 dialysis requiring AKI
AKI on CKD	1. Yes 2. No
Comorbidity	0. No comorbidity 1. HTN 2. DM 3. Cardiac disease 4. HTN and DM 5. DM, HTN and Cardiac disease 6. Chronic infections (HBV, RVI and TB)
Pregnancy and peripartal period	0. No pregnancy 1. AGN 2. Preeclampsia/eclampsia 3. APH/PPH 4. Abortion 5. Others

3.9. Data Quality control

Data quality was assured by repeated crosschecking of the data filled to the checklists from what is documented in each patient medical record.

3.10. Data processing and analysis

SPSS version 25 was used for data entry and analysis. Multinomial Logistic Regression Model was used to determine the association of independent variables with dependent variable. An AOR with 95% confidence interval was used to estimate the strength of the association at $P \leq 0.05$. The result was presented with paragraphs, tables, pie charts and bar graphs.

3.11. Ethical consideration

Ethical clearance was obtained from the Institutional Review Board of SPHMMC. A formal letter with the seal of SPHMMC from department of Internal medicine was taken and given to the medical ward and data station managers for possible cooperation. The personal information of the participants was not disclosed to the public and will not be displayed on the research publication.

3.12. Dissemination of the findings

The result of the thesis is submitted to SPHMMC. The study will be published in recognized journals and serve as a reference about the pattern of AKI at the SPHMMC, in Ethiopia as well as developing countries.

4. RESULT

4.1. Results of descriptive statistics

Among 155 AKI patient admitted to SPHMMC Medical ward, AGN was the most common cause of AKI which attributed for 88 (56.8%) patients. ATN or AIN were the causes for 45 (29%) patients whereas pre-renal AKI, post-renal AKI and others were the causes for the remaining 22(14.2%) patients (Table4.1).

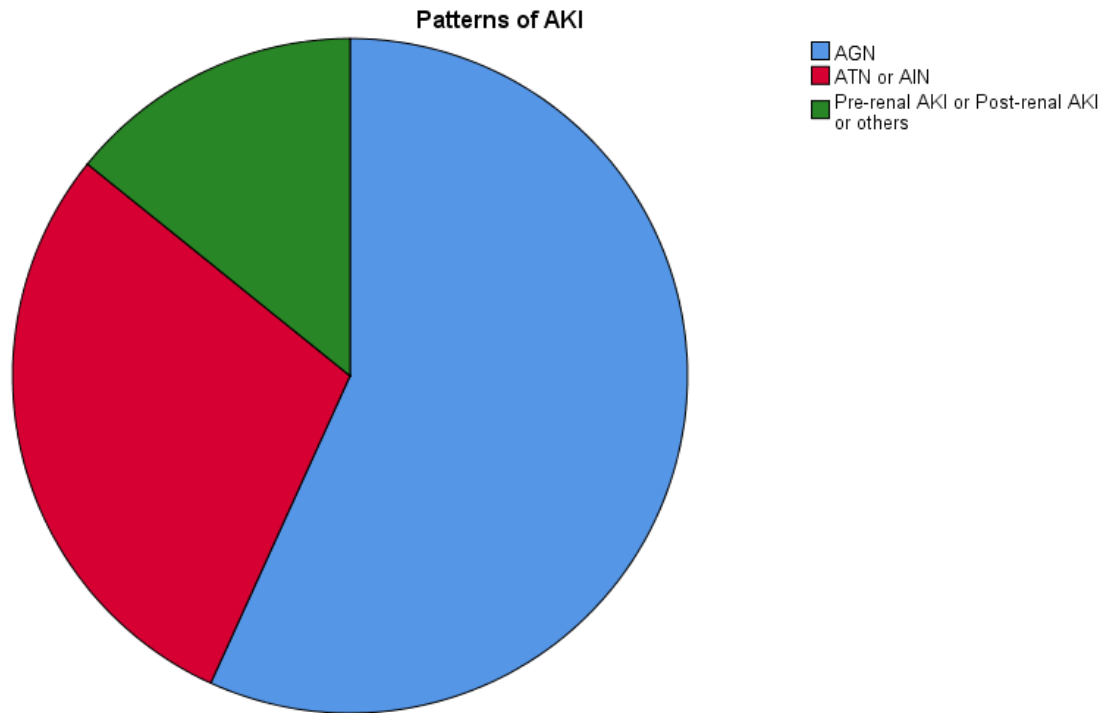


Figure4.1. Patterns of AKI

Table4.1. Frequencies of patterns of AKI

Patterns of AKA	Frequency	Percent	Valid percent	Cumulative percent
AGN	88	56.8	56.8	56.8
ATN or AIN	45	29.0	29.0	85.8
Pre-renal AKI or Post-renal AKI or others	22	14.2	14.2	100.0
Total	155	100.0	100.0	

The age group of 15 to 44 yrs was the commonest age group which accounted for 91(58.7%) patients whereas the age group 45 to 59yrs and ≥ 60 yrs accounted for 42(27.1%) and 22(14.2%) patients respectively. Females were the predominant gender among admitted AKI patient (58.1% vs. 41.9%) (Table4.2).

Of the 155 admitted AKI patients, 40(25.8%) patients had stage 1 or stage 2 AKI whereas 75(48.4%) and 40(25.8%) patients had stage 3 non dialysis requiring AKI and stage 3 dialysis requiring AKI respectively (Table4.2).

In 21(13.55%) patients, there was chronic kidney disease prior to developing AKI. Comorbidities that can be frequently associated with AKI were identified in 55 (35.5%) patients. HTN was identified in 21(13.5%) patients. Patient who had DM or both MD and HTN or DM, HTN and cardiac disease or only cardiac disease were identified in 24 (15.5%) cases (table). Chronic Infectious disease (RVI or HBV or TB) were identified in 10(6.5%) patients (Table4.2).

Only 15(9.7%) patients were pregnant or peripartal period at the time of developing AKI (Table4.2).

Table4.2. Frequencies of associated factors of Patterns of AKI

Variables		Frequency	Percent	Valid percent	Cumulative percent
Age	15-44	91	58.7	58.7	58.7
	45-59	42	27.1	27.1	85.8
	>=60	22	14.2	14.2	100.0
Sex	Male	65	41.9	41.9	41.9
	Female	90	58.1	58.1	100.0
Severity of AKI	Stage 1 or Stage 2 AKI	40	25.8	25.8	25.8
	Stage 3 non dialysis requiring AKI	75	48.4	48.4	74.2
	Stage 3 dialysis requiring AKI	40	25.8	25.8	100.0
AKI on CKD	No	134	86.5	86.5	86.5
	Yes	21	13.5	13.5	100.0
Comorbidity	No Comorbidity	100	64.5	64.5	64.5
	HTN	21	13.5	13.5	78.1
	DM OR MD and HTN OR DM, HTN and cardiac disease or cardiac disease	24	15.5	15.5	93.5
	Chronic Infectious disease (RVI or HBV or TB)	10	6.5	6.5	100.0
Pregnancy	Not pregnant	140	90.3	90.3	90.3
	Pregnant	15	9.7	9.7	100.0

Among age groups of 15 to 44 yrs and 45 to 59 yrs, AGN was the commonest cause of AKI (62.6% and 52.4%) followed by acute ATN or AIN (22.0% and 35.7%) and pre-renal AKI or post-renal AKI or other causes (15.4 % and 11.9% %) respectively whereas in age groups of ≥ 60 yrs, ATN or AIN were the commonest causes of AKI (45.5%) followed by AGN (40.9%) and pre-renal AKI or post-renal AKI or other causes (13.6%) respectively (Table 4.3).

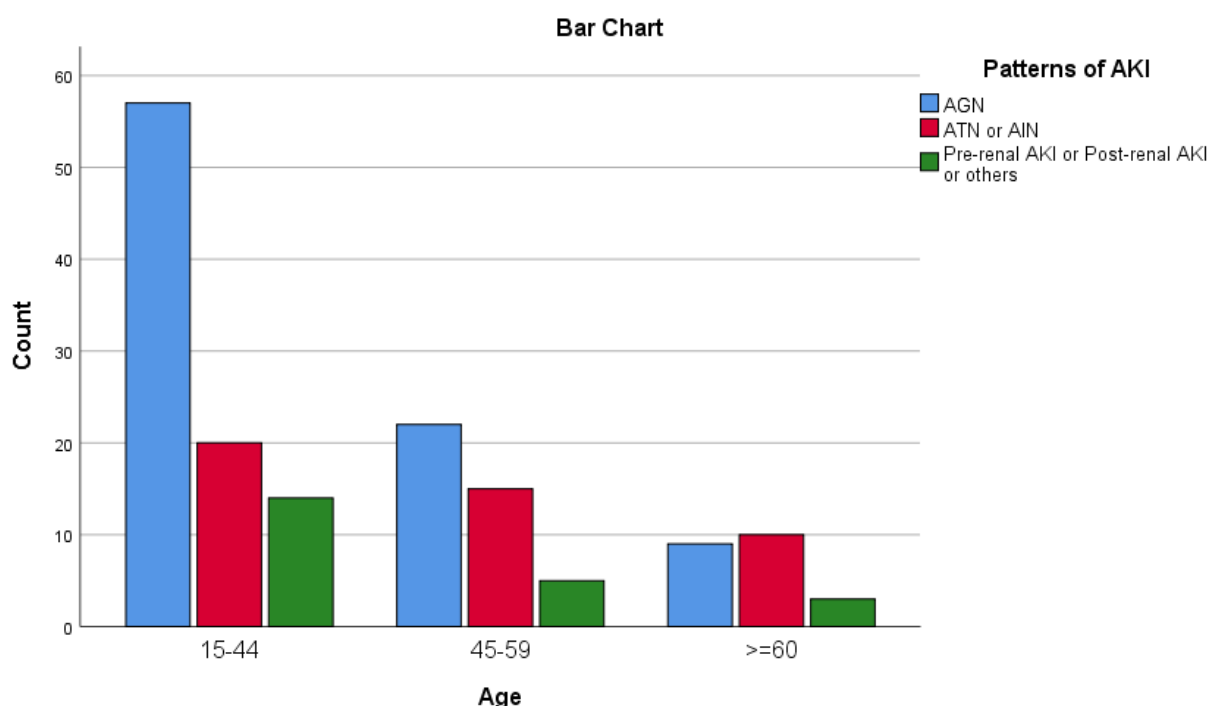


Figure 4.2. Age vs. Patterns of AKI

In both males and females, AGN was the commonest cause of AKI patients among admitted to medical ward (55.4% and 55.4%) followed by ATN or AIN (33.8% and 25.6%) and pre-renal AKI or post-renal AKI or other causes (10.8% and 10.8%) respectively (Table 4.3).

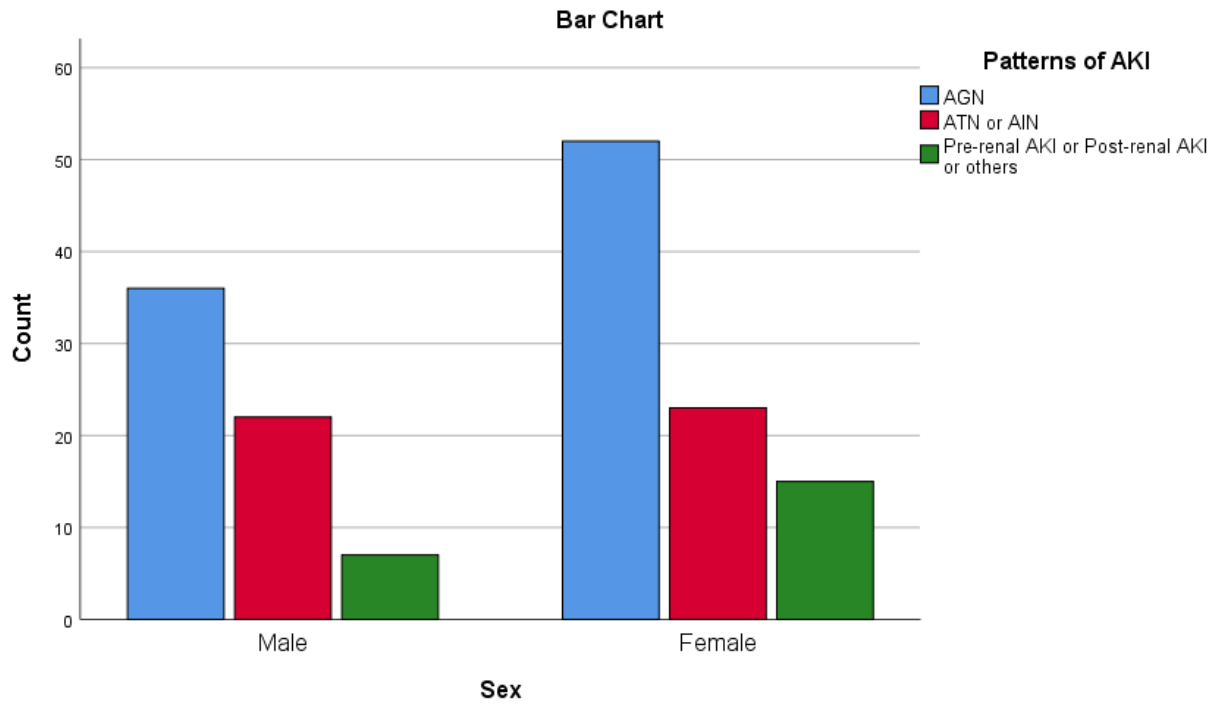


Figure4.3. Sex vs. patterns of AKI

Table4.3. Demographic variables vs. Patterns of AKI

Variable			Patterns of AKI			
Age			AGN	ATN or AIN	Pre-renal AKI or Post-renal AKI or Others	Total
	15-44	Count	57	20	14	91
		% within Age	62.6%	22.0%	15.4%	100.0%
		% within Patterns of AKI	64.8%	44.4%	63.6%	58.7%
	45-59	Count	22	15	5	42
		% within Age	52.4%	35.7%	11.9%	100.0%
		% within Patterns of AKI	25.0%	33.3%	22.7%	27.1%
	>=60	Count	9	10	3	22
		% within Age	40.9%	45.5%	13.6%	100.0%
		% within Patterns of AKI	10.2%	22.2%	13.6%	14.2%
Sex	Male	Count	36	22	7	65
		% within Sex	55.4%	33.8%	10.8%	100.0%
		% within Patterns of AKI	40.9%	48.9%	31.8%	41.9%
	Female	Count	52	23	15	90
		% within Sex	57.8%	25.6%	16.7%	100.0%
		% within Patterns of AKI	59.1%	51.1%	68.2%	58.1%

In all stages of severity of AKI, AGN was the commonest causes of AKI which accounts 52.5%, 65.3% and 45.0% for stage 1 or 2, stage 3 non dialysis requiring AKI and stage 3 dialysis requiring AKI respectively. ATN or AIN was the second commonest cause in stage 3 non dialysis requiring AKI (29.3%) and stage 3 dialysis requiring AKI (40.0%) whereas it is the third commonest cause in stage 1 or 2 AKI (17.5%). Pre-renal, post-renal or other causes of AKI are the second commonest cause in stage 1 or 2 AKI (30.0%) where as it is the third in in stage 3 non dialysis requiring AKI (5.3%) and stage 3 dialysis requiring AKI (15.0%) (Table4.4).

Table4.4. Severity of AKI vs. patterns of AKI

Variable			Patterns of AKI			
Severity			AGN	ATN or AIN	Pre-renal AKI or Post-renal AKI or Others	Total
	Stage 1 or Stage 2 AKI	Count	21	7	12	40
		% within Severity of AKI	52.5%	17.5%	30.0%	100.0%
		% within Patterns of AKI	23.9%	15.6%	54.5%	25.8%
	Stage 3 non dialysis requiring AKI	Count	49	22	4	75
		% within Severity of AKI	65.3%	29.3%	5.3%	100.0%
		% within Patterns of AKI	55.7%	48.9%	18.2%	48.4%
	Stage 3 dialysis requiring AKI	Count	18	16	6	40
		% within Severity of AKI	45.0%	40.0%	15.0%	100.0%
		% within Patterns of AKI	20.5%	35.6%	27.3%	25.8%

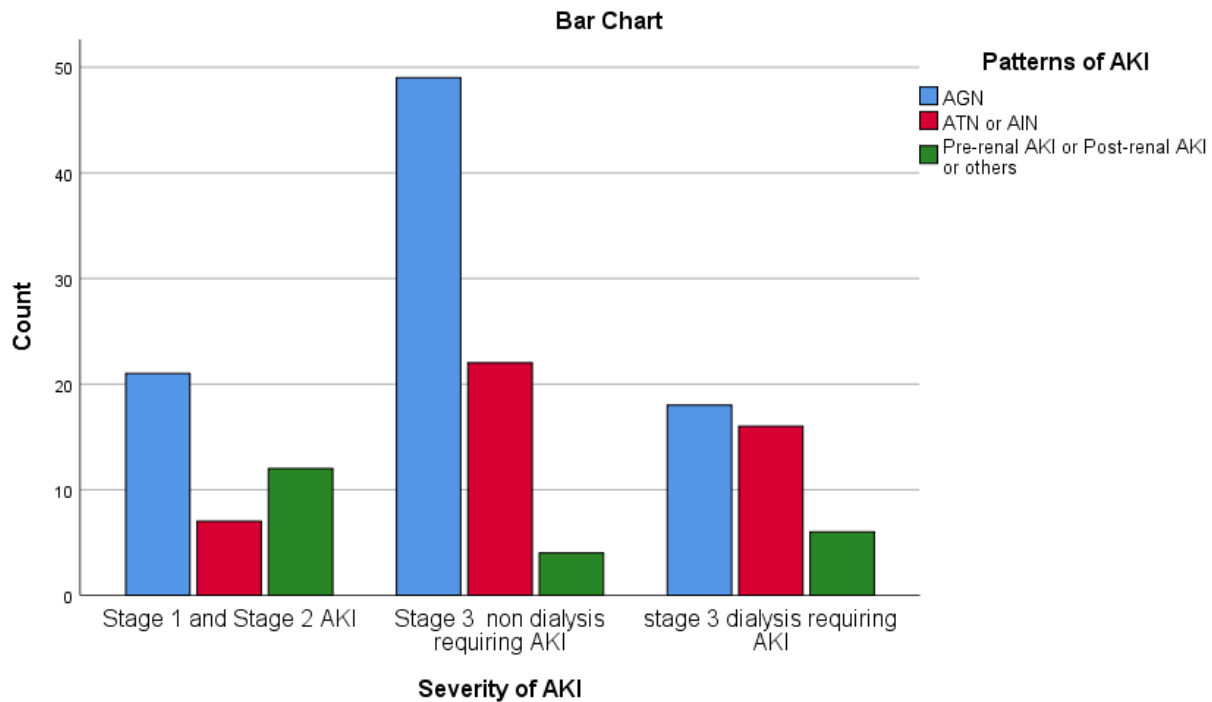


Figure4.4. Severity of AKI vs. Patterns of AKI

Among AKI patients who had no underlying CKD, the commonest cause of AKI is AGN (60.4%) followed by ATN or AIN (26.9%) and pre-renal, post-renal or other causes of AKI (12.7%) respectively. Among admitted AKI patients who had underlying CKD, the commonest cause of AKI is ATN or AIN (42.9%) followed by AGN (33.3%) and pre-renal, post-renal or other causes of AKI (23.8%) respectively (Table4.5).

Table4.5. AKI on CKD vs. patterns of AKI

Variable			Patterns of AKI			
AKI on CKD			AGN	ATN or AIN	Pre-renal AKI or Post-renal AKI or Others	Total
	No	Count	81	36	17	134
		% within AKI on CKD	60.4%	26.9%	12.7%	100.0%
		% within Patterns of AKI	92.0%	80.0%	77.3%	86.5%
	Yes	Count	7	9	5	21
		% within AKI on CKD	33.3%	42.9%	23.8%	100.0%
		% within Patterns of AKI	8.0%	20.0%	22.7%	13.5%

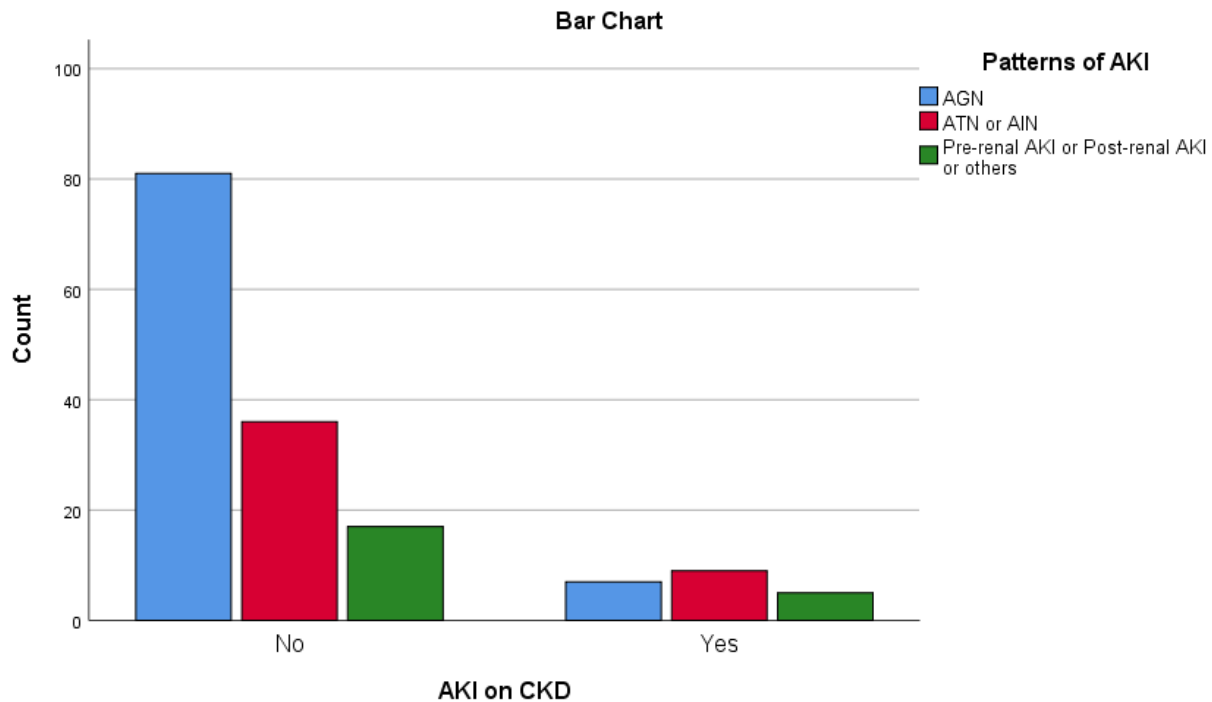


Figure4.5. AKI on CKD vs. Patterns of AKI

In those patients who had no underlying comorbid conditions the commonest case of AKI was AGN (69.0%) followed by ATN or AIN (22.0%) and Pre-renal AKI or Post-renal AKI or other causes (9.0%) respectively. Among patients who had only HTN as comorbidity, the commonest cause was ATN or AIN (47.6%) followed by AGN (38.1%) and Pre-renal AKI or Post-renal AKI or others causes (14.3%) respectively whereas in those AKI patients who had Chronic Infectious disease the commonest cause was AGN (40.0%) followed by ATN or AIN (30.0%) and Pre-renal AKI or Post-renal AKI or Others (30.0%). Among patients who had comorbidity of DM only or DM and HTN OR DM, HTN and Cardiac disease or Cardiac disease, the commonest cause of AKI was ATN or AIN (41.7%) followed by AGN (29.2%) and Pre-renal AKI or Post-renal AKI or others causes (29.2%) (Table4.6).

Table4.6. Comorbidity vs. patterns of AK

Variable			Patterns of AKI			
Comorbidity			AGN	ATN or AIN	Pre-renal AKI or Post-renal AKI or Others	Total
	No Comorbidity	Count	69	22	9	100
		% within Comorbidity	69.0%	22.0%	9.0%	100.0%
		% within Patterns of AKI	78.4%	48.9%	40.9%	64.5%
	HTN	Count	8	10	3	21
		% within Comorbidity	38.1%	47.6%	14.3%	100.0%
		% within Patterns of AKI	9.1%	22.2%	13.6%	13.5%
	DM OR DM and HTN OR DM, HTN and Cardiac disease or Cardiac disease	Count	7	10	7	24
		% within Comorbidity	29.2%	41.7%	29.2%	100.0%
		% within Patterns of AKI	8.0%	22.2%	31.8%	15.5%
	Chronic Infectious disease (RVI or HBV or TB)	Count	4	3	3	10
		% within Comorbidity	40.0%	30.0%	30.0%	100.0%
		% within Patterns of AKI	4.5%	6.7%	13.6%	6.5%

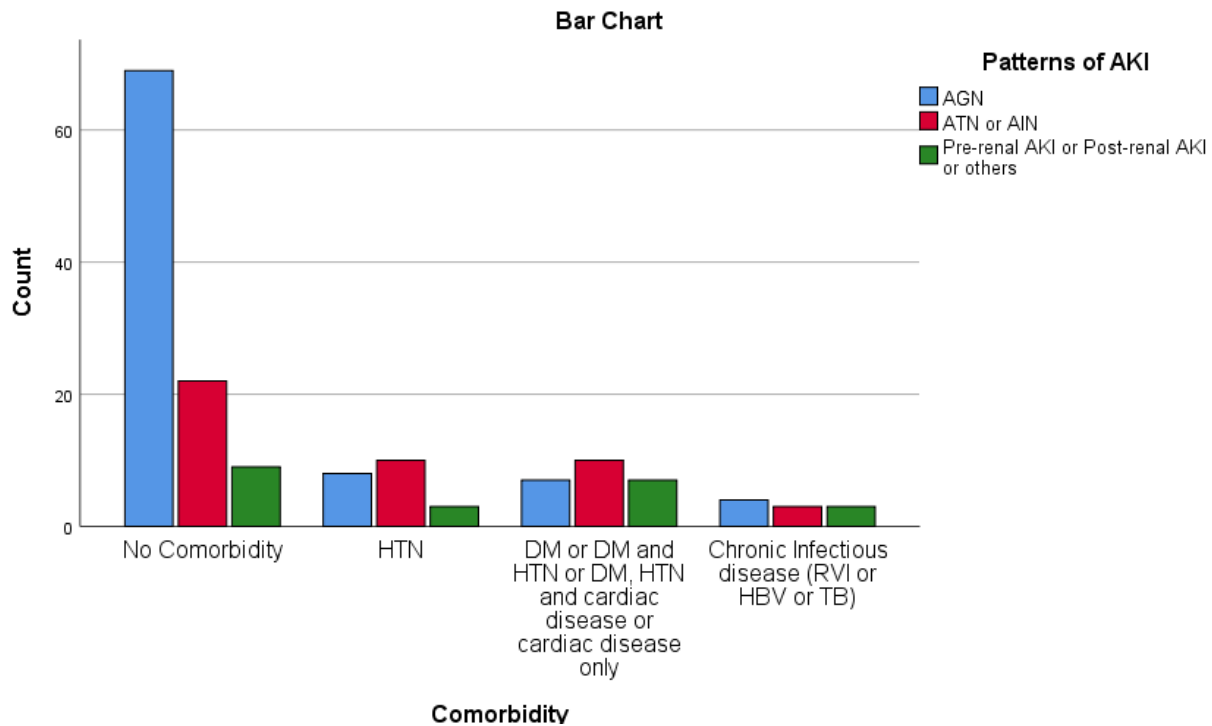


Figure4.6. Comorbidity vs. patterns of AKI`

Patients who are neither pregnant nor in peripartal period, the commonest cause of AKI was AGN (61.4% followed by ATN or AIN (27.9%) and Pre-renal AKI or Post-renal AKI or Others (10.7%) respectively whereas patients who are pregnant or in peripartal period, the commonest cause of AKI was Pre-renal AKI or Post-renal AKI or Others (46.7%) followed by ATN or AIN (40.0%) and AGN (13.3%) respectively (Table4.7)

Table4.7. Pregnancy vs. patterns of AKI

Variable			Patterns of AKI			
Pregnancy			AGN	ATN or AIN	Pre-renal AKI or Post-renal AKI or Others	Total
	Not pregnant	Count	86	39	15	140
		% within Pregnancy	61.4%	27.9%	10.7%	100.0%
		% within Patterns of AKI	97.7%	86.7%	68.2%	90.3%
	Pregnant	Count	2	6	7	15
		% within Pregnancy	13.3%	40.0%	46.7%	100.0%
		% within Patterns of AKI	2.3%	13.3%	31.8%	9.7%

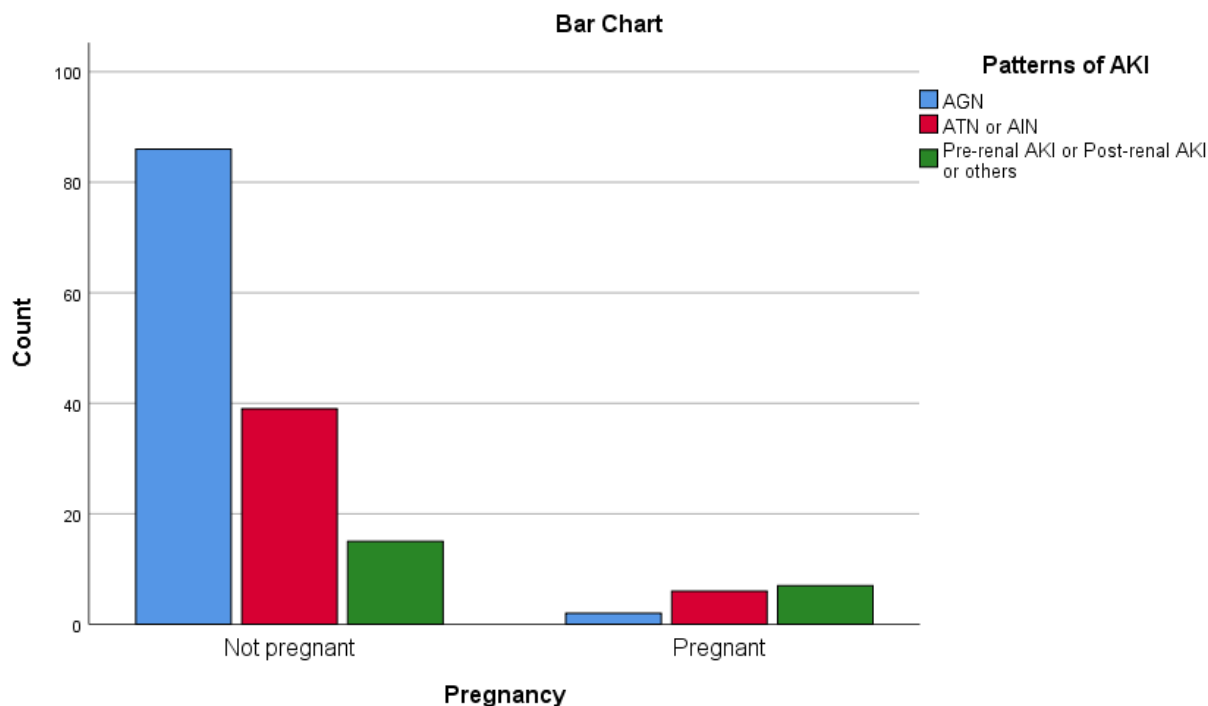


Figure4.7. Pregnancy vs. Patterns of AKI

4.2 Interpretation of the result

Chi-square test was used to determine the independent variables of patterns of AKI. Variables with chi-square p-value of less than or equal to 0.25 on bivariate analysis were candidates for the multinomial logistic regression analysis. Statistical significance was considered at p-value of less than 0.05 on multivariate analysis. All the variables had chi-square p-value of less than or equal to 0.25 and analyzed using multinomial logistic regression model (table).

Table4.8. Likelihood ratio test

Effect	-2 Log Likelihood of Reduced Model	Chi-Square	Df	Sig.
Intercept	155.613a	0.000	0	.
Age	163.822	8.209	4	0.084
Sex	158.983	3.370	2	0.185
Severity of AKI	175.766	20.153	4	0.000
AKI on CKD	159.732	4.119	2	0.128
Comorbidity	168.609	12.997	6	0.043
Pregnancy	178.941	23.328	2	0.000

Any variable with multinomial logistic regression analysis result p-value of <0.05 is considered significant. The results displayed in Table... showed that age, Severity of AKI, AKI on CKD, comorbidity and pregnancy or peripartal period are significantly associated with patterns of AKI.

Among admitted AKI patients, those patients with age group 15 to 44 yrs, stage 1 or stage 2 AKI patients, stage 3 non dialysis requiring AKI patients and patients who are neither pregnant nor in peripartal period have less probability of having ATN or AIN compared to that of AGN with p-value of 0.021 (OR=0.227, CI; 0.064 - 0.802), 0.003 (OR=0.121, CI; 0.030-0.481), 0.023 (OR=0.317, CI; 0.118-0.853) and 0.000 (OR=0.030, CI; 0.004-0.198) respectively.

In patients with stage 3 non dialysis requiring AKI, the probability of having Pre-renal AKI or Post-renal AKI or others decreases by 0.161 times compared to that of AGN with p-value of 0.023 (OR 0.161=CI; 0.033-0.777).

Among admitted AKI patients, those who have no underlying CKD and underlying comorbidities have less probability of having Pre-renal AKI or Post-renal AKI or others by 0.188 times and 0.104 times with p-value of 0.041 (OR= 0.188, CI; 0.038- 0.933) and 0.021 (OR=0.104, CI; 0.015 - 0.706) respectively compared to that of AGN

Medical ward admitted AKI patients who are neither pregnant nor in peripartal period are at decreased probability of having Pre-renal AKI or Post-renal AKI or others by 0.024 times compared to that of AGN with p-value of 0.000 (OR=0.024, CI; 0.003-0.186).

Table4.9. Result of Multinomial Logistic Regression Analysis

Patterns of AKI ^a		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
ATN or AIN	Intercept	5.239	1.680	9.724	1	0.002			
	[Age=0]	-1.484	.644	5.299	1	0.021	0.227	0.064	0.802
	[Age=1]	-.344	0.649	0.280	1	0.597	0.709	0.199	2.531
	[Age=2]	0 ^b	.	.	0	.	.	.	.
	[Sex=0]	0.649	0.458	2.008	1	0.156	1.914	0.780	4.700
	[Sex=1]	0 ^b	.	.	0	.	.	.	.
	[Severity of AKI=0]	-2.113	0.705	8.986	1	0.003	0.121	0.030	0.481
	[Severity of AKI=1]	-1.149	0.505	5.171	1	0.023	0.317	0.118	0.853
	[Severity of AKI=2]	0 ^b	.	.	0	.	.	.	.
	[AKI on CKD=0]	-0.645	0.692	0.867	1	0.352	0.525	0.135	2.039
	[AKI on CKD=1]	0 ^b	.	.	0	.	.	.	.
	[Comorbidity=0]	-0.842	0.858	0.961	1	0.327	0.431	0.080	2.318
	[Comorbidity=1]	-0.292	1.046	0.078	1	0.780	0.747	0.096	5.799
	[Comorbidity=2]	0.832	1.006	0.684	1	0.408	2.298	0.320	16.498
	[Comorbidity=3]	0 ^b	.	.	0	.	.	.	.
	[Pregnancy=0]	-3.514	0.967	13.214	1	0.000	0.030	0.004	0.198
	[Pregnancy=1]	0 ^b	.	.	0	.	.	.	.
Pre-renal AKI or Post-renal AKI or others	Intercept	6.614	2.107	9.856	1	0.002			

	[Age=0]	-1.142	0.954	1.433	1	0.231	0.319	0.049	2.071
	[Age=1]	-.563	0.976	0.333	1	0.564	0.569	0.084	3.856
	[Age=2]	0 ^b	.	.	0	.	.	.	.
	[Sex=0]	-0.503	0.688	0.535	1	0.465	0.605	0.157	2.328
	[Sex=1]	0 ^b	.	.	0	.	.	.	.
	[Severity of AKI=0]	-0.120	0.768	0.024	1	0.876	0.887	0.197	3.998
	[Severity of AKI=1]	-1.828	0.804	5.175	1	0.023	0.161	0.033	0.777
	[Severity of AKI=2]	0 ^b	.	.	0	.	.	.	.
	[AKI on CKD=0]	-1.671	0.817	4.183	1	0.041	0.188	0.038	0.933
	[AKI on CKD=1]	0 ^b	.	.	0	.	.	.	.
	[Comorbidity=0]	-2.262	0.977	5.365	1	0.021	0.104	0.015	0.706
	[Comorbidity=1]	-1.615	1.259	1.646	1	0.200	0.199	0.017	2.345
	[Comorbidity=2]	-0.467	1.103	0.180	1	0.672	0.627	0.072	5.442
	[Comorbidity=3]	0 ^b	.	.	0	.	.	.	.
	[Pregnancy=0]	-3.748	1.054	12.63 1	1	0.000	0.024	0.003	0.186
	[Pregnancy=1]	0 ^b	.	.	0	.	.	.	.

a. The reference category for the dependent variables is AGN

b. Reference variable

4.3. Discussion

The study showed that the most common cause of AKI among medical ward admitted AKI patients is AGN which attributes for 88 (56.8%) patients. ATN or AIN were the causes for 45 (29%) patients whereas pre-renal AKI, post-renal AKI and others were the causes for the remaining 22(14.2%). This shows that intrinsic-renal cause (AGN, ATN or AIN) is the most frequent pattern of AKI followed by pre-renal and post-renal causes. This is consistent with the study done at SUH in Sudan. But, it is not consistent with the studies done at a tertiary hospital in Portugal, Queen Elizabeth Central Hospital in Malawi, a tertiary referral hospital in Cameroon, University of Gondar Hospital in Ethiopia, Jimma Medical Center in Ethiopia and SPHMMC in Ethiopia. But most of the studies included all general admissions (medical, surgical

and obstetrics, emergency and ICU). In our study we didn't include emergency admissions where most OUP patients (post-renal causes) are expected to be admitted before transfer to urology ward or discharged to home. Excluding emergency admissions also expected to underestimate the number of pre-renal causes where most patients can be resuscitated and discharged home before admission. In some of the studies even though they included only ward admissions, they have higher number of elderly population than our study. The above mentioned reasons might contribute for the difference with our study (12) ; (13) ; (15) : (17) ; (24) ; (27) ; (28) ; (33).

The study showed that age group of 15 to 44 yrs was the commonest age group which accounted for 91(58.7%) patients whereas the age group 45 to 59yrs and ≥ 60 yrs accounted for 42(27.1%) and 22(14.2%) patients respectively. Among admitted AKI patients, those with age group 15 to 44 yrs, have significantly less probability of having ATN or AIN compared to that of AGN with p- value of 0.021(OR=0.227, CI;0.064 - 0.802). The age prevalence among admitted AKI patients is consistent with the studies done at Queen Elizabeth Central Hospital in Malawi, Chris Hani Baragwanath Hospital in South Africa, TASH in Ethiopia and SPHMMC in Ethiopia. But, it is not consistent with a multicenter study done in Europe, Asia, Australia and Africa, studies done at a tertiary hospital in Portugal, at a tertiary referral hospital in Cameroon, at Jimma Medical Center in Ethiopia. There is no a study found which directly assesses age vs. patterns of AKI (13) ; (14) ; (15) ; (22) ; (24); (31) ; (33) ; (29).

Of the 155 admitted AKI patients, 40(25.8%) patients had stage 1 or stage 2 AKI whereas 75(48.4%) and 40(25.8%) patients had stage 3 non dialysis requiring AKI and stage 3 dialysis requiring AKI respectively. Stage 1or stage 2 AKI patients and stage 3 non dialysis requiring AKI patients have less probability of having ATN or AIN compared to that of AGN with p-value of 0.003 (OR=0.121, CI;0.030-0.481) and 0.023(OR=0.317, CI;0.118-0.853) respectively. Stage 3 non dialysis requiring AKI patients have less probability of having Pre-renal AKI or Post-renal AKI or others than AGN with p- value of 0.023 (OR=0.161, CI;0.033-0.777). The prevalence of severity of AKI is consistent with the studies done) at a tertiary care teaching hospital in South India, Queen Elizabeth Central Hospital in Malawi, Jimma medical center in Ethiopia. But, it is not consistent with studies done at Singapore General Hospital in Singapore, Cape cost Teaching Hospital in Gana, University of Gondar Hospital in Ethiopia, Jimma Medical

Center in Ethiopia. There is no study found which showed severity of AKI significantly associated with specific patterns of AKI (12) ; (13) ; (17) ; (20) ; (23) ; (28) ; (30).

In 21(13.55%) patients, there was chronic kidney disease prior to developing AKI. Among admitted AKI patients, those who have no underlying CKD have less probability of having Pre-renal AKI or Post-renal AKI or others by 0.188 times with p- value of 0.041 (OR= 0.188, CI; 0.038- 0.933) compared to AGN. The prevalence of AKI on CKD is consistent with the study done at University of Gondar Hospital in Ethiopia and lower than the findings done at Jimma Medical Center in Ethiopia, TASH in Ethiopia and SPHMMC in Ethiopia. The significant correlation of absence AKI on CKD with AGN is consistent with the study done at Kasr Al-Aini Hospital in Egypt where post renal cause were more prevalent among AKI on CKD patients and the study done at Northern California, USA where sepsis is the commonest etiology identified than AGN (9) ; (12) ; (18) ; (28) ; (32) ; (33).

Comorbidities that can be frequently associated with AKI were identified in 55 (35.5%) patients. HTN was the most frequently identified comorbidity (13.5%). Patient who had only DM or only cardiac disease or had both DM and HTN or had three comorbidities at a time (DM, HTN and cardiac disease) were only 15.5%. Chronic Infectious disease (RVI or HBV or TB) were identified in 6.5% of the patients. Among admitted AKI patients, those who have no underlying comorbidities have less probability of having Pre-renal AKI or Post-renal AKI or others by 0.104 times with p- value of 0.021 (OR=0.104, CI; 0.015 - 0.706) compared to that of AGN. The frequencies of comorbidities among different patterns of AKI is consistent with the studies done at tertiary hospital in Portugal, Singapore General Hospital in Singapore, a tertiary care teaching hospital in South India, a tertiary referral hospital in Cameroon, University Alassane Ouattara in Côté d'Ivoire, University of Gondar Hospital in Ethiopia and Jimma Medical Center in Ethiopia where HTN is most frequent comorbidity across all patterns of AKI. But, it is not consistent with the studies done at Queen Elizabeth Central Hospital in Malawi, Chris Hani Baragwanath Hospital in South Africa and SPHMMC in Ethiopia where HIV infection is the most frequently identified comorbidity rather than HTN. But, there is no study found with comorbidities significantly associated with specific patterns of AKI (12) ; (13) ; (15) ; (17) ; (20) ; (22) ; (24) ; (25) ; (30) ; (33).

Only 9.7% of admitted AKI patients were pregnant or in peripartal period. Among admitted AKI patients, those patients who are neither pregnant nor in perinatal period, the commonest cause of AKI was AGN (61.4%) followed by ATN or AIN (27.9%) and Pre-renal AKI or Post-renal AKI or Others (10.7%). They have significantly less probability of having ATN or AIN and Pre-renal AKI or Post-renal AKI or others compared to that of AGN with p-value of 0.000 (OR=0.030, CI; 0.004-0.198) and 0.000 (OR=0.024, CI; 0.003-0.186) respectively. Previous studies also showed that among pregnant mothers, AGN is the less likely cause AKI than pre-renal, other intrinsic-renal and post-renal causes (31) ; (33) ; (34).

4.4. Strength and limitation of the study

4.4.1. Strengths of the study

Since this study is done at a tertiary care center which receives patients from all parts of the country and all socioeconomic status, likely representative of diverse group of Ethiopian population. This is the first in kind in our country which specifically focused on medical ward admitted AKI patients. Of the 6 associated variables of patterns of AKI, 5 variables are statistically significant that makes the study reliable reference for future studies in this area.

4.4.2. Limitations of the study

It is Single center and retrospective study. Since this study is done on medical ward admitted patients. Pre-renal and post-renal AKI patients who are mainly treated at emergency department might be underrepresented.

5. Conclusion and Recommendation

5.1. Conclusions

The study showed that the most common cause of AKI among medical ward admitted AKI patients is AGN followed by ATN or AIN and pre-renal AKI, post-renal AKI and others respectively. This shows that intrinsic-renal cause (AGN, ATN or AIN) is the most frequent pattern of AKI followed by pre-renal and post-renal causes. Age of the patient, Severity of AKI, AKI on CKD, comorbidity and pregnancy or peripartal period are significantly associated with patterns of AKI. Age group 15 to 44 yrs, stage 1 or stage 2 AKI, stage 3 non dialysis requiring AKI and being neither pregnant nor in peripartal period have less probability of having ATN or AIN compared to that of AGN.

5.2. Recommendation

In our study AGN is common among admitted patients especially those who have no underlying comorbidities. Therefore, nephrologist evaluation and specific etiologic diagnosis using serology and kidney biopsy is needed for admitted AKI patients. It is also good to do larger multicenter studies including emergency and ICU patients as well as health institutions from all parts of the country.

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ANNEXES

Annex I: Questionnaire

Part I: Socio Demographic variables

Number	Questions	Possible Answer
1	Sex	Male
		Female
	Age	15, 16, ...

Part II: Patterns of AKI

Number	Variables	Category	Possible responses
1	Patterns of AKI	Pre-renal AKI	1. No pre-renal AKI
			2. Heart failure
			3. Liver failure
			4. GI loss
			5. Bleeding
			6. Others
		Intrinsic-renal AKI	1. No intrinsic-renal AKI
			2. Glomerulonephritis
			3. Interstitial nephritis
			4. ATN
			5. Others
		Post-renal AKI	1. No post-renal AKI
			2. BPH
			3. Urolithiasis
			4. Urethral stricture
			5. Others

Part III: Associated factors of AKI

Number	Variables	Possible responses
	Severity of AKI	1. Stage1 AKI
		2. Stage2 AKI
		3. Stage3 non dialysis requiring AKI
		4. Stage 3 dialysis requiring AKI
	AKI on CKD	1. Yes
		2. No
	Comorbidity	1. No comorbidity
		2. DM
		3. HTN
		4. Cardiac disease
		5. HTN and DM
		6. DM, HTN and Cardiac disease
		7. Chronic infections (HBV, HCV, RVI and TB)
		8. Others
	Pregnancy or peripapartal period	1. No pregnancy or peripapartal period
		2. AGN
		3. Preeclampsia/eclampsia
		4. APH/PPH
		5. Abortion
		6. Others

Annex II: Parameter estimates resulting from bi-variable logistic regression

Goodness-of-Fit

	Chi-Square	Df	Sig.
Pearson	126.027	104	.070
Deviance	116.767	104	.185

Pseudo R-Square

Cox and Snell	.357
Nagelkerke	.418
McFadden	.230

Likelihood Ratio Tests

Effect	Model Fitting Criteria			
	Model	Likelihood Ratio Tests		
		Chi-Square	df	Sig.
Intercept	155.613 ^a	.000	0	.
Age	163.822	8.209	4	.084
Sex	158.983	3.370	2	.185
Severity of AKI	175.766	20.153	4	.000
AKI on CKD	159.732	4.119	2	.128
Comorbidity	168.609	12.997	6	.043
Pregnancy	178.941	23.328	2	.000

Model Fitting Information

Model	Model Fitting Criteria			
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	224.015			
Final	155.613	68.403	20	.000

Annex III: Analysis of Maximum Likelihood

Parameter Estimates

Patterns of AKI ^a		B	Std.	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
ATN or AIN	Intercept	5.239	1.680	9.724	1	.002			
	[Age=0]	-1.484	.644	5.299	1	.021	.227	.064	.802
	[Age=1]	-.344	.649	.280	1	.597	.709	.199	2.531
	[Age=2]	0 ^b	.	.	0	.	.	.	.
	[Sex=0]	.649	.458	2.008	1	.156	1.914	.780	4.700
	[Sex=1]	0 ^b	.	.	0	.	.	.	.
	[Severity of AKI=0]	-2.113	.705	8.986	1	.003	.121	.030	.481
	[Severity of AKI=1]	-1.149	.505	5.171	1	.023	.317	.118	.853
	[Severity of AKI=2]	0 ^b	.	.	0	.	.	.	.
	[AKI on CKD=0]	-.645	.692	.867	1	.352	.525	.135	2.039
	[AKI on CKD=1]	0 ^b	.	.	0	.	.	.	.
	[Comorbidity=0]	-.842	.858	.961	1	.327	.431	.080	2.318
	[Comorbidity=1]	-.292	1.046	.078	1	.780	.747	.096	5.799
	[Comorbidity=2]	.832	1.006	.684	1	.408	2.298	.320	16.498
	[Comorbidity=3]	0 ^b	.	.	0	.	.	.	.
	[Pregnancy=0]	-3.514	.967	13.214	1	.000	.030	.004	.198
	[Pregnancy=1]	0 ^b	.	.	0	.	.	.	.
Pre-renal AKI or	Intercept	6.614	2.107	9.856	1	.002			
Post-renal AKI	[Age=0]	-1.142	.954	1.433	1	.231	.319	.049	2.071
or others	[Age=1]	-.563	.976	.333	1	.564	.569	.084	3.856
	[Age=2]	0 ^b	.	.	0	.	.	.	.
	[Sex=0]	-.503	.688	.535	1	.465	.605	.157	2.328
	[Sex=1]	0 ^b	.	.	0	.	.	.	.
	[Severity of AKI=0]	-.120	.768	.024	1	.876	.887	.197	3.998

[Severity of AKI=1]	-1.828	.804	5.175	1 .023	.161	.033	.777
[Severity of AKI=2]	0 ^b	.	.	0 .	.	.	.
[AKI on CKD=0]	-1.671	.817	4.183	1 .041	.188	.038	.933
[AKI on CKD=1]	0 ^b	.	.	0 .	.	.	.
[Comorbidity=0]	-2.262	.977	5.365	1 .021	.104	.015	.706
[Comorbidity=1]	-1.615	1.259	1.646	1 .200	.199	.017	2.345
[Comorbidity=2]	-.467	1.103	.180	1 .672	.627	.072	5.442
[Comorbidity=3]	0 ^b	.	.	0 .	.	.	.
[Pregnancy=0]	-3.748	1.054	12.631	1 .000	.024	.003	.186
[Pregnancy=1]	0 ^b	.	.	0 .	.	.	.

- a. The reference category is: AGN.
- b. This parameter is set to zero because it is redundant.