ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF EMERGENCY MEDICINE AND CRITICAL CARE NURSING

INCIDENCE AND PREDICTORS OF ACUTE KIDNEY INJURY AMONG MECHANICALLY VENTILATED INTENSIVE CARE UNIT PATIENTS IN PUBLIC HOSPITALS OF ADDIS ABABA, ETHIOPIA, 2024 G.C. (RETROSPECTIVE FOLLOW UP)

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APPROVAL BY THE BOARD OF EXAMINATION

This thesis by Ermias Kassa is accepted in its present form by the board of examiners as satisfying the thesis requirement for the degree of master's in emergency Medicine and critical care nursing.

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DECLARATION

Letter of declaration

By my signature below, I declare and affirm that this is entirely my original work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis, and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every effort has been made to avoid plagiarism in the preparation of this thesis. This thesis was submitted to Addis Ababa University College of Health Sciences Department of Emergency and Critical Care Nursing, for partial fulfillment of the requirements for the Master of Science in Emergency and Critical Care Nursing.

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Abstract

Background: Critically ill patients requiring mechanical ventilation are subject to various complications. Acute kidney injury (AKI) is a frequent complication in patients under mechanical ventilation. However, the incidence of acute kidney among mechanically ventilated Intensive Care Unit patients (ICU) remains poorly defined. Therefore, this study aimed to investigate the incidence of AKI and its predictors among mechanically ventilated ICU Patients.

Methods: A retrospective follow-up study was conducted on the charts of 350 mechanically ventilated ICU patients at Addis Ababa public hospitals from January 2022 to the end of December 2023. Data was collected using a checklist and entered into the Epi data manager. Then, exported to STATA V-14 for analysis. The Cox-proportional hazard regression model was used for data analysis. Finally, statistical significance was declared at p-value <0.05, and the hazard ratio was used to determine the strength of the association between an independent variable and AKI.

Result: Of the 350 patients, 65% had developed AKI. The incidence of density of AKI was 28.1(95%CI: 24.6, 32.0) per 1000 Person days of observation, with 8092 person-day. Being known hypertension (AHR=1.8; 95%CI: 1.8, 3.271), myocardial infarction at admission (AHR=1.6; 95%CI: 1.013, 2.604), late tracheostomy (AHR=2.0; 95% CI: 1.059, 3.703), higher levels of average peak inspiratory pressure ≥ 35 cmH20 (AHR = 1.7; 95% CI: 1.102, 2.506), length of mechanical ventilation(AHR= 8.3; 95% CI 4.760, 14.569) were found to be significantly associated with development of AKI among mechanically ventilated ICU Patients.

Conclusions and recommendations: The incidence of AKI among mechanically ventilated patients is high, with an incidence rate of 28.1 (95%CI: 24.6, 32.0) per person-day of observations. The risk factors for developing AKI include known hypertension, myocardial infarction, high peak inspiratory pressure, late tracheostomy, and prolonged mechanical ventilation. It is recommended that clinicians implement strict blood pressure control, perform tracheostomy at the earliest possible time, monitor and adjust mechanical ventilation settings, and implement strategies to reduce the length of the mechanical ventilation. By doing these they can reduce the incidence of AKI and improve patient outcomes in mechanically ventilated ICU settings.

Keywords: Incidence, predictors, Acute Kidney Injury, Mechanical ventilation and Ethiopia

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Table of contents

Contents

List of Tables

List of Figure

ACRONYMS AND ABBREVIATION

AIDS = Acquired Immunological Disease Syndrome

AKI= Acute Kidney Injury

AKIN = Acute Kidney Injury Network

ALERTH = ALL African Leprosy and Tuberculosis rehabilitation and training center hospital

CVD = Cardiovascular disease

DM = Diabetics Mellitus

HIV =Human Immune Virus

HTN = Hypertension

ICU= Intensive Care Unit Care

IRB =Institutional Review Board

KDIGO= Kidney disease improving global outcome

MV = Mechanical ventilation

RIFLE = RISK INJURY Failure Loss End stage

SOFA = Sequential Organ Failure Assessment

SPHMMC = Saint Paul Hospital Millennium Medical College

SPSH= Saint Peter Specialized Hospital

TASH = Tikur Anbessa Specialized Hospital

USA = United States of America

v.14 = Version 14

CHAPTER 1 INTRODUCTION

BACKGROUND

Acute kidney injury (AKI) is a prevalent and severe consequence for a patient admitted to the intensive care unit (ICU), with a mortality rate of about 60% and an incidence rate of 35.8%(1). As well as patients who are mechanically ventilated are gravely affected by AKI(2).

The definition of AKI has changed over the past two decades. While there have been various definitions like RIFLE (Risk Injury Failure Loss End stage), KDIGO (Kidney Disease Improving Global Outcome), and AKIN (Acute Kidney Injury Network) that classify and describe AKI, it is also acknowledged that an increase in blood creatinine of $\geq$ 0.3mg/dl from the baseline negatively impacts survival of patients (3)

AKI, characterized by a decrease in glomerular filtration rate (GFR), can occur rapidly in individuals with either normal kidney function or preexisting kidney damage. It is typically, reversible. In the past, the most common method of diagnosis was a reduction in urine volume. However, advancement in the field of biochemistry and pathology now allows clinicopathologic correlations and early detection of AKI (4). AKI is a syndrome characterized by a sudden decline of kidney function, leading to a sharp decrease in the patient's GFR. This can cause an imbalance in water and electrolytes as well as the build-up of nitrogenous metabolites. These factors can result in various clinical symptoms in patients(5). The accumulation of nitrogenous waste is often used for diagnosis(6).

Mechanical ventilation (MV) is the process of moving gas into and out of the lung using an external device that is attached directly to the patient. Mechanical ventilation can have a wide range of clinical goals. Maintaining gas exchange, lowering or substituting breathing effort, lowering the amount of oxygen consumed by the heart and the system. Expanding the lungs, permitting drowsiness, anesthesia, and muscle relaxation, stabilizing the thoracic wall, etc.(7).

MV is an important therapy for critically ill patients. However, it can hurt various organs, including the kidneys and lungs, potentially leading to additional organ failure (1). The exact relationship between MV and the later AKI is not fully understood. One hypothesis is that MV may cause

ventilator-induced lung damage, triggering a pulmonary inflammatory response that releases inflammatory mediators into the system. Alternatively, it may also affect hemodynamic variables, leading to the development of AKI. Several studies have focused on investigating the release of these mediators during MV(8).

AKI will undoubtedly impact ventilator outcomes negatively in a variety of ways. For example, lung-protective ventilation with low tidal volume is challenging in patients with AKI because of their diminished capacity to adjust for the hypercapnic acidosis that is sometimes required with this technique(9).

STATEMENT OF THE PROBLEM

Globally, AKI claims the lives of about 13 million individuals annually and causes 1.7 million deaths. Additionally, as many as 20% of hospitalized patients receive a diagnosis of AKI. It is worth noticing that the developing world accounts for four out of every five hospitalized patients(10). AKI is linked to higher rates of morbidity and death. It is a prevalent clinical issue in the general population, particularly in patients who are critically ill. The incidence of AKI in critically ill patients has been estimated in a wide range of ways by numerous studies, with estimates ranging from 15% to 50%. AKI in ICU is linked to death rates as high as 45-60%, dialysis reliance, decreased life quality, and excessive use of medical resources (6). To reduce the risk of death, extended hospital stay, and the development of chronic kidney disease (CKD) in the future, this calls for earlier detection and care (11).

Thirteen percent of AKI patients who survive the ICU need dialysis and Eighty percent of these patients die due to several factors, including patients with mechanical breathing, advanced age, many comorbidities, and the challenging and delayed diagnosis of AKI. These rates remain high despite care (5). AKI is associated with longer hospital stays, greater medical costs, and death. It is markedly higher in low-middle-income countries (LMIC) like sub-Saharan Africa (SSA). The incidence of AKI in hospitalized in LMIC is 20%, and it can reach 60% in patients admitted to ICU(12). Previous literature revealed that 22% of mechanically ventilated patients developed AKI, of which 74.3% were categorized as stage 1. In contrast, 17.3% and 8.4% had stage 2 and 3 AKI, respectively (13). According to a study reported by Drury et al. in 1947, up to 29% of the patients on MV suffer from AKI after they commence MV(8).

When invasive MV is used on patients, AKI is a frequent consequence. In a recent meta-analysis, Van den Akker et al. demonstrated that invasive MV is linked to a threefold increase in risk of AKI compared to other ICU patients. Early detection of AKI may reduce difficulties associated with the condition, enable the use of appropriate care and preventive measures, and enhance renal recovery(14).

Out of the patients on MV, 45% of them experienced AKI during treatment. Given those patients who had both AKI and respiratory failure have a death rate of 60-80% and AKI has an independent mortality rate of 30-50% in the ICU, the consequences of AKI in a patient on MV

are noteworthy (15). The mortality rate of patients with mechanical breathing increases with several failing organs, particularly in cases when AKI is present. These outcomes are associated with increased ventilator days, longer hospitalization in the ICU, acute renal damage during MV, and poorer respiratory system mechanics (16).

AKI is a serious condition with a significant risk of mortality that can have an immense impact on patient outcomes and medical resources. It is essential to comprehend the prevalence and risk factors of AKI in patients on MV to enhance clinical treatment and patient care. Research on AKI in adult ICU patients who are on MV in Ethiopia and East Africa is scarce. This study will close a significant gap in the body of knowledge and offer insightful new information to the field. In addition, this study will provide insight into particular challenges and variables affecting AKI in this context because it is being conducted in public hospitals in Addis Ababa, Ethiopia. The result can help local healthcare practices, guidelines and recommendations improve the management of AKI in individuals who are severely ill. In conclusion, conducting this study is essential due to the lack of research on this topic in the region, its public health importance, local relevance, and potential impact on clinical practice.

SIGNIFICANCE OF THE STUDY

AKI is not well studied in developing countries like Ethiopia regarding the incidence and risk factors among patients admitted to intensive care units, particularly among mechanically ventilated patients. The limited scientific data in the region about the risk factors, etiology, incidence rate, and outcome of AKI leads to poor recognition of the problem. Therefore, it diminishes the governmental visibility of the problems and hampers struggles for prevention strategies towards AKI. It is a frequent problem worldwide and faced in several settings that result in a poor outcome for patients specifically in the ICU. The outcome of AKI in critically ill patients is based on the severity and duration of the disease. Hence, our study aimed to investigate the incidence rate, and the associated factors of AKI among the mechanically ventilated ICU patients in the study area.

According to our knowledge, no study has been conducted in our study area that evaluates the incidence and risk factors of developing AKI as a problem among mechanically ventilated ICU patients. Hence, for this reason, we intend to conduct this study as it will add advanced knowledge for Health professions and initiate the utilization of Updated protocols and guidelines for the management of AKI. The absence of data in developing countries like Ethiopia makes it unlikely to address the existing problems in the clinical setups by stakeholders like the Ministry of Health, World Health Organization, and Non-governmental Organizations. Therefore, our study will provide essential evidenced data to identify risk factors and incidence of AKI for all health professions that play a significant role in the prevention and management of AKI.

Generally, the results of this study provide key information for health professions, health Facilities and institutions, health administrative offices, and policymakers to apply their efforts to the prevention and risk reduction of acute kidney injury in mechanically ventilated ICU patients. In addition, the result also provides relevant information for the National and International Society of Nephrology that plays a great role in minimizing the risk of developing AKI. Finally, this study will provide the benchmark information for individuals who are interested in conducting further studies in the field of AKI.

LITERATURE REVIEW

INCIDENCE OF AKI

According to the study conducted in India 33% of critically ill patients with normal renal function at admission experienced AKI at a mean of 5.24 days (SD = 3.02) following admission (17). In Iranian research assessing the incidence of AKI in critically sick patients, 37% of the total patients examined had developed AKI after ICU admission. Based on the RIFLE criteria, the patients who acquired AKI were diagnosed and categorized as follows: end-stage renal disease (0.8%), loss of kidney function (1.3%), injury (13.4%), failure (13.2%), and risk (8.2%)(18).

The patients in the ICU of multiple Finland hospitals were diagnosed and classified according to KDIGO criteria. The results indicated that the (95 % CI) incidence of AKI was [39.3 % (37.5–41.1%)] among the patients who were admitted to the ICU; these patients were classified as having stage 1 [17.2% (15.8%–18.6%)], stage [8.0 % (7.0–9.0 %)] of the patients, and stage 3 AKI [14.1% (12.8–15.4 %)] of the patients(19). According to studies done in South Africa, Durban revealed that about 56.6% of ICU patients developed AKI (20). Another study carried out In sub-Saharan Africa, reported an incidence of 22.3% among ICU patients(21).

A study conducted in North-West Ethiopia revealed that the incidence rate of AKI was 19.67 per 1000 people's day observations. It was also reported that the cumulative incidence rate of AKI among patients in this study who were admitted to the ICU and followed up was 13.4% (22).

In another previous study conducted on mechanically ventilated ICU patients, AKI was reported by about 22.0% of the participants. While 122 patients (17.3%) had KDIGO stage 2, and 59 patients (8.4%) had KDIGO stage 3, the majority of them (523, 74.3%) developed KDIGO stage 1 (13). Literature done at the University of California, San Diego Out of the patients on mechanical ventilation (MV), 45% experienced acute renal injury in the ICU. The mortality rate for these patients was 22.4%, while the rate for patients receiving invasive mechanical ventilation without acute kidney injury was 5% (16). A systematic review and meta-analysis reported a pooled prevalence of 3.16% that also reported the mechanically ventilated patients' risk for the development of AKI (23).

RISK FACTOR OF ACUTE KIDNEY INJURY

Socio-demographic risk factors

According to a Finnish study on the incidence and risk factors of AKI in intensive care unit (ICU) patients, the median age of AKI patients in stages 1, 2, and 3 according to KIDIGO criteria was 66, 66, and 65, respectively. and 65.7% of stage 1, 64.7% of stage 2, and 67.6% of stage 3 patients who developed AKI after being brought to the ICU were male (19). An Iranian retrospective cohort study done on risk factors and the clinical outcome of acute kidney injury in critical patients found that the AKI group's average age was 63±5.4 years, while the non-AKI group's average age was 45.1±4.9 years. Age and the incidence of AKI differ statistically significantly ($P < 0.05$). It is undeniable that growing older increases the likelihood of developing AKI. Of the AKI patients, 39.9% were female and 60.1% were male. There were 46.4% and 53.6% females and males in the non-AKI group. Nevertheless, there was no discernible link ($P = 0.24$) between the prevalence of AKI and sex (18). Based on a study done on critically ill patients in South Africa, the patients experiencing AKI had a mean age of 43.7 and a standard deviation of 16.8, respectively. Sixty-one percent of the patients with AKI overall were men (24).

In a study done in northwestern Ethiopia AKI was detected by 29.39% of patients 51 years of age or older who were ICU patients with normal kidney function at the time of admission. AKI was diagnosed in 14.14% of the male and 12.59% of the female study participants, as well as in 12.26% of the urban and 14.33% of the rural study participants over the study period(22). In a prospective observational study carried out at Jimma Medical Center in southwest Ethiopia, of the 203 participants, 121 (or 59.6%) were men, 58 (or 28.6%) were older than 60, and 141 (or 69.5%) had an acute renal injury that was acquired in the community (25). An investigation conducted on patients with mechanical ventilation revealed that an increased age group was associated with an increased incidence of acute kidney injury (AKI) following MV exposure(13).

A retrospective investigation of patients on mechanical ventilation revealed that the risk factors for AKI varied according to when the illness first manifested. Patients who got early AKI after being placed on mechanical ventilation had mean ages and standard deviations of 62 and 16.5, respectively, whereas patients who acquired late AKI had mean ages and standard deviations of

58.1 and 18.7, respectively (13). Two study populations—other ICU patients and those on mechanical ventilation—were used in the Sandie-Ago study, which looked into the association between MV and AKI. The study population's average age was 58.6 years, with slightly younger ages for the "AKI before and during IMV" and "AKI during IMV" groups. 2,298 (38.8%) women made up the population. There was a slight but significant difference between the groups for "AKI, no IMV" and "AKI during IMV" (43% vs. 34%; $p < 0.01$) (16).

Comorbidities

Previous studies in different settings reported that hypertension was a significant predictor of acute kidney injury, in Brazil (5), India, (26), in Ethiopia (27), and a prospective cohort study conducted among mechanically ventilated patients indicated hypertension was one of predictor of developing AKI (28). In addition, in another retrospective study conducted among COVID-19 patients on mechanical ventilation, hypertension was reported as a risk factor for AKI (29).

According study conducted in Pakistan reported that cardiac disease is associated with AKI development (30) and a retrospective study done in Zambia revealed that cardiac disease has been associated with the development of AKI among ICU patients (31). A prospective cohort study conducted in Harar, Ethiopia revealed that congestive heart failure was associated with the development of AKI among ICU patients (27), a study in west Amhara Ethiopia showed that congestive heart failure and Anemia had been associated with AKI development among ICU patients(22). In addition, a prospective cohort study, conducted among mechanically ventilated patients in ICU revealed that Cardiac disease is a predictor of developing AKI (28).

Studies conducted in Pakistan, (30), Brazil (5), and Central India (26) reported that Diabetic Mellitus was associated with the development of AKI among ICU patients. In addition, studies conducted in Harar, Ethiopia (27) and West Amara (22) demonstrated that diabetic comorbidity was significantly associated with the development of AKI. A study conducted with a prospective observational study among mechanically ventilated patients indicated that DM was associated with AKI (28).

A study done in Pakistan showed that malignancy and cerebrovascular disease were also reported as risk factors for AKI development among ICU patients (30). A prospective cohort study

conducted in Harar, Ethiopia, showed that obesity was reported as a predictor of AKI (27). Further, in a study conducted among mechanically ventilated patients in Brazil, obesity had been reported as a risk factor for AKI(28). A retrospective follow-up study revealed that patients with neurologic disease were risk factors for the development of AKI (13). A retrospective study done in Zambia demonstrated that Human Immune Virus (HIV) was associated with the development of AKI among ICU patients (31).

Clinical and Management related factor

A retrospective follow-up study conducted in Brazil,(5) and in Zambia (31) revealed that sepsis was statistically significant to the development of acute kidney injury after ICU admission. Furthermore, a retrospective study conducted among mechanically ventilated patients found that sepsis was associated with the occurrence of AKI (32). A multicenter retrospective study conducted in the ICU of West Amhara Ethiopia reported that Sepsis was associated with AKI development(22).

Regarding the vital sign-related factors, a retrospective cohort study involving mechanically ventilated elderly patients in China showed that hypotension and hypoxia were reported as predictors of AKI development among ICU patients (33). In addition, a single-centered retrospective study conducted among MV COVID-19 patients indicated that the mean arterial pressure (MAP) of the patients in the no-AKI group was higher than that of the patients in the AKI group (34). Based on a comprehensive, international database of MV patients, with >24 hours of MV and normal renal function, among the patients who developed AKI after mechanical ventilation 60.6% of them had SOFA > 3 (13) and a study conducted in Brazil among mechanically ventilated patients showed that APACHE score had been associated with development of AKI (28). According to a single-centered retrospective study conducted among MV Patients due to covid 19, there was a significant association between AKI and SOFA (5.06 ± 0.103 vs. 4.492 ± 0.158; P = 0.002) AND cardiovascular SOFA score(34).

Different kinds of literature showed contradicting findings regarding the relationship between fluid balance and the development of AKI. These demonstrated that positive fluid balance is a predictor of developing AKI among ICU patients(35-37) and another contradicted report study data revealed that a negative fluid balance is also a risk factor for the development of AKI(38, 39). A retrospective follow-up study of ICU patients in Brazil(5) and Zambia (31) demonstrated that patients who took a

vasopressor were at high risk of developing AKI. In addition, a multicenter retrospective study conducted in west Amhara Ethiopia showed that Vasopressors) had been associated with AKI development among ICU patients(22). A previous study conducted among mechanically ventilated ICU patients showed that vasopressors also risk for occurrence of AKI in the ICU(28). Another study in China indicated that vasopressors as predictors of AKI among mechanically ventilated patients (33). Furthermore, a single-center retrospective study conducted among COVID-19 patients revealed that individuals with AKI were higher among patients who were on vasopressors (34). Regarding the drug factors, a study conducted in Brazil revealed that aminoglycosides were associated with the development of AKI (5). A retrospective cohort study on mechanically ventilated elderly patients in China showed that there was a significant association between electrolyte disturbance and the development of AKI (33).

Regarding the laboratory variables, a retrospective study conducted among ICU patients in Brazil showed that higher levels of creatinine and urea at admission were also considered to be independent risk factors for AKI (5). Another retrospective cohort study on mechanically ventilated elderly patients in China showed that a significant association exists between serum albumin level and AKI development (33).

MECHANICAL VENTILATOR RELATED FACTORS

A systematic review and meta-analysis revealed that invasive mechanical ventilation was found to be a predictor of developing AKI in ICU patients (8). According to a randomized control trial study that compares pressure-controlled ventilation PCV) with volume-controlled ventilation (VCV), At the time of randomization, there was a trend toward a higher incidence of acute renal injury in the VCV group compared to the PCV group (40, 41). A retrospective study conducted among mechanically ventilated patients showed that the indication for MV and AKI development had been associated. Accordingly, pneumonia, acute or chronic respiratory failure, trauma, sepsis, coma, and CHF were reported as causes of AKI among mechanically ventilated patients (1). Furthermore, a study conducted in China found that the reasons for MV were

significantly different between the AKI and non-AKI groups, including pneumonia P=0.020, acute coronary syndrome P<0.001, emergency or urgent surgery P=0.034, and airway obstruction P=0.018 as the most common indication of MV among AKI group(33). In addition based on a retrospective analysis of patients on mechanical ventilation, hemorrhagic and HAP were considered to be predisposing variables for the development of AKI(32). A previous retrospective study conducted among mechanically ventilated patients suggested that the length of MV has been associated with the development of AKI (32). In addition, a study carried out in Brazil found that increased length of mechanical ventilation highly risk for the development of AKI(28).

A study conducted in China indicated that peak pressure was not significantly related to the development of AKI (32). A retrospective study conducted among mechanically ventilated patients reported that PEEP was a significant risk factor for developing AKI (32) and a study in Brazil also reported that a high level of PEEP (PEEP > 10) was associated with the development of AKI among mechanically ventilated Patients (42). Finally, a retrospective study conducted among mechanically ventilated patients revealed that high tidal volume was a predictor of AKI, greater than 8.5ml/kilogram of the individual (32).

Conceptual Framework

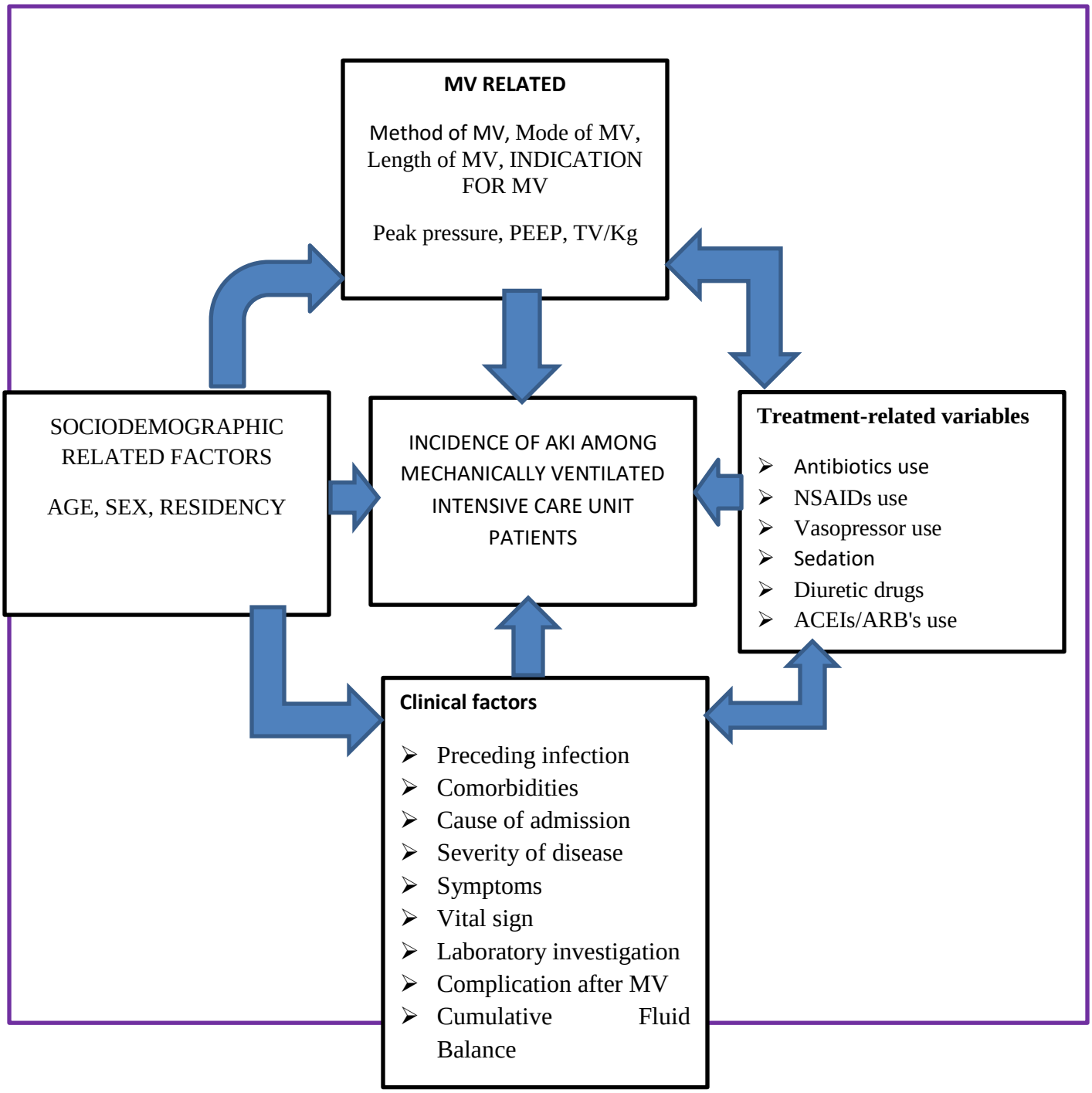


Figure 1 Conceptual framework of incidence and predictors of AKI among mechanically ventilated ICU patients in Addis Ababa public hospitals

Objectives

General Objective

To assess the incidence and predictors of AKI among Mechanically Ventilated intensive care unit patients admitted to the intensive care unit of a public hospital in Addis Ababa, Ethiopia, 2024 G.C.

Specific Objective

To determine the incidence of acute kidney injury in Mechanically Ventilated intensive care unit patients.

To identify predictors of acute kidney injury in Mechanically Ventilated intensive care unit patients.

Methodology

Study Area and Period

The study was conducted in the intensive care unit of a public hospital in Addis Ababa, which is the capital and largest city of Ethiopia. Addis Ababa is a highly developed and important center for culture, art, finance, and administration in Ethiopia. It also serves as the headquarters of the African Union. As of 2014, Addis Ababa had more than 52 hospitals, with 12 of them being state-run and over 40 being private. For this study, four public hospitals with advanced ICU facilities and contemporary recording systems were included. These hospitals were the African Leprosy and Tuberculosis Rehabilitation and Training Center Hospital (ALERT), Tikur Anbessa Specialized Hospital (TASH), Saint Peter Specialized Hospital (SPSH), and Saint Paul Hospital Millennium Medical College (SPHMMC). The study period was from March 1 to June 30, 2024, by reviewing two years of follow-up data on charts of ICU patients who were on MV in the selected public hospitals from January 1, 2021, to December 30, 2023, GC.

ALERT is a medical facility located on the outskirts of Addis Ababa, specializing in Hansen's disease, also known as leprosy. Established in 1970, ALERT is also home to the Armauer Hansen Research Institute (AHRI), which focuses on leprosy research. The facility features a 240-bed teaching hospital with various departments, including dermatology, ophthalmology, and surgery. Additionally, there is an orthopedic workshop and a rehabilitation program. The ICU department has a large room that houses general medicine and surgical beds. It accommodates 12 ICU beds. The staff of the ICU consists of 4 anesthesiologists, 4 emergency medicine and critical care senior, 3 emergency medicine and critical care nurses, and 30 nurses. And also, it is well equipped with the material. The ICU has 12 MV. In addition, 360 patients were mechanically ventilated between January 2022 and to end of December 2023.

TASH, School of Medicine, College of Health Sciences, Addis Ababa University, is the largest referral hospital in Ethiopia. It serves as the primary teaching center for clinical and preclinical training across various disciplines. Additionally, it provides specialized clinical services that are not available in other public or private institutions, catering to the entire nation. The ICU department at Black Lion consists of a large room with designated ICU beds. Within this room, there are [8] general medicine and [8] surgical beds. The staff of the ICU consists of 06

anesthesiologists, 06 emergency medicine and critical care senior, 08 emergency medicine and critical care residents,08 emergency medicine and critical care nurses,04 internal medicine specialists, and 36 nurses. And also, it is well equipped with the material. The medical ICU has 04 MV while the surgical ICU has 04 MV. A total of 336 patients had been mechanically ventilated in the study time.

SPHMMC, originally known as St. Paul General Specialized Hospital until 2008, was constructed in 1969 through a partnership between Emperor Haile Selassie and the German Evangelical Church. Its main objective was to provide medical care to underserved populations. Currently, the hospital has a total of 392 beds and serves an annual average of 200,000 patients. It caters to a catchment population of over 5 million people. The ICU department consists of a major room accommodating ICU beds. It contains 14 general ICUs and 4 HDU beds. The staff of the ICU consists of 01 Anesthesiologist, 02 emergency medicine and critical care senior, 04 emergency medicine and critical care residents, 03 emergency medicine and critical care nurses, 01 respiratory therapist, and 48 nurses. And also, it is well equipped with the material. The general ICU has 14 MV while the HDU has 04 MV. A total of 432 patients were mechanically ventilated between January 2022 to December 2023.

SPSH is located in Addis Ababa, the capital city of Ethiopia. It is a renowned healthcare facility that provides specialized medical services to patients from all over the country. The hospital offers a wide range of services including cardiology, neurology, oncology, orthopedics, and pediatrics. It also has state-of-the-art diagnostic and imaging equipment to ensure accurate and timely diagnosis for its patients. Saint Peter Specialized Hospital was established in 2006 to provide high-quality healthcare services to the people of Ethiopia. Since its inception, the hospital has been committed to delivering compassionate care and innovative treatments to its patients. The ICU department consists of a major room accommodating 12 ICU beds. The staff of the ICU consists of 4 Anesthesiologists, 4 emergency medicine and critical care seniors, 3 emergency medicine and critical care nurses, and 30 nurses. And also, it is well equipped with the material. The ICU has 12 MV. In addition, 360 patients have been mechanically ventilated between January 2021 and the end of December 2023.

Study Design

A retrospective follow-up study was conducted on mechanically ventilated patients at public hospitals in Addis Ababa, Ethiopia, from January 1, 2022, to the end of December 30, 2023.

Population

Source Population

The source population was all adult patients who were admitted to the ICU and had received mechanical ventilation support in the public hospitals, in Addis Ababa.

Study population

The study population included selected recordings of adult patients admitted to the ICU and who had received respiratory support with a mechanical ventilator at selected public Hospitals in Addis Ababa.

Eligibility Criteria

Inclusion Criteria

All adult patients aged ≥ 18 years, who were mechanically ventilated for more than or equal 48 hours and admitted during the study period were included in the study

Exclusion Criteria

All adult patients with a history of dialysis, renal transplant, or admission with chronic renal disease and patient records with missing key information (baseline serum creatinine, date of MV initiation, and last follow-up date) were excluded from the study.

Sample size determination

The sample size was determined by using Stata statistical software v.14 by applying Cox model assumptions considering sepsis as a predictor variable from a previous study conducted, with an effect size of (hazard ratio) of 2.0, probability of event 23.4% (22) and considering the probability of withdrawal 20%. Finally, the required sample size was estimated to be 350. Hence, 350 charts were retrieved. A systematic sampling technique was applied to select charts to be reviewed, including every three charts after determining the first case by lottery methods. The subsequent charts were considered if it appeared that any charts had been missed or had incomplete data

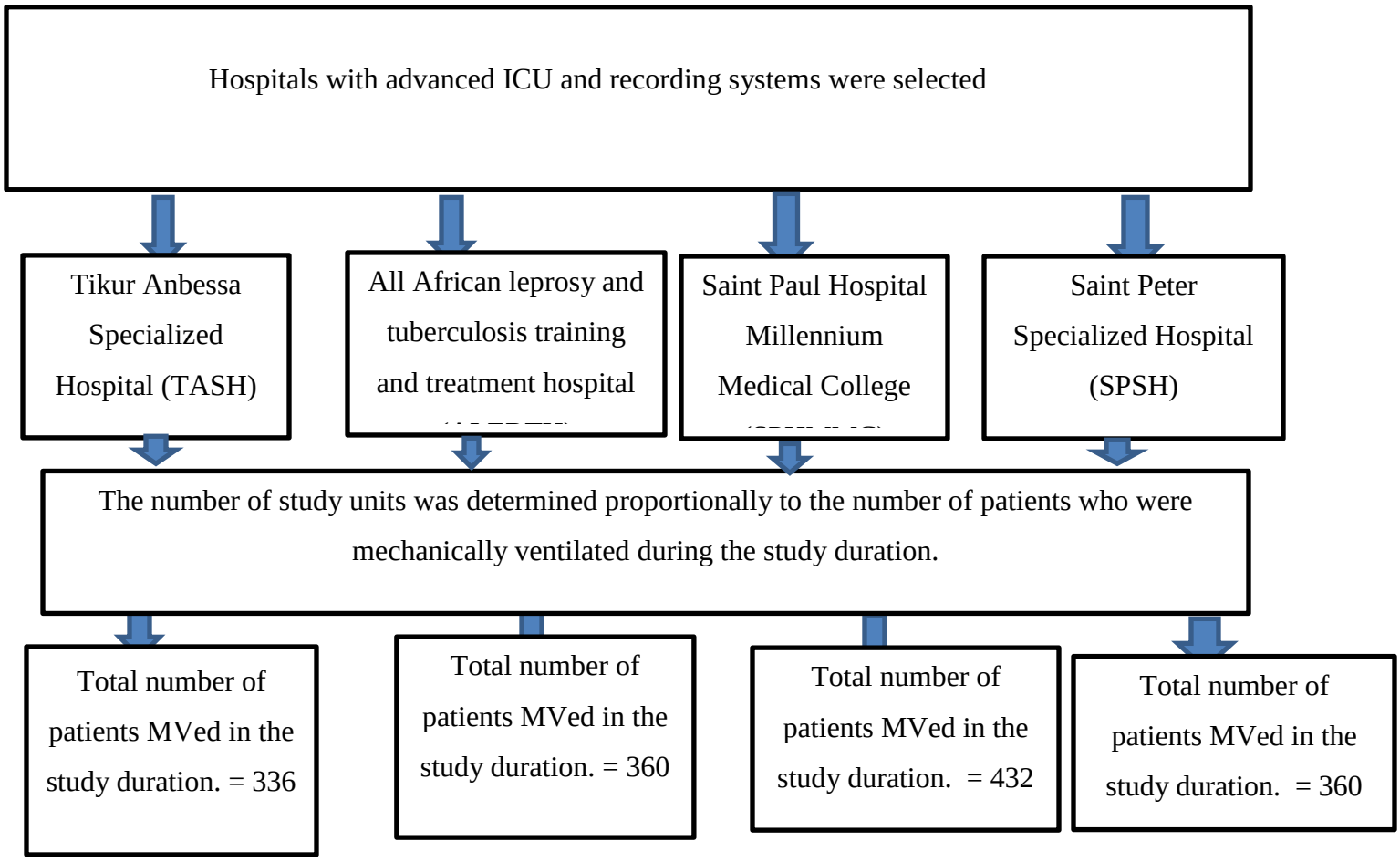
Sampling Technique

A systematic random sampling technique was applied to identify study participants from the adult intensive care unit registration book who were mechanically ventilated. First, the total number of

patients who were mechanically ventilated was determined from the registration logbook, which was obtained by referring to two years of admission registration. Nearly 336, 360, 432, and 360 Adult patients had been mechanically ventilated in those two years at TASH, ALERTH, SPHMMC, and SPSH, respectively. The total number of adult patients mechanically ventilated in the study duration was 1488. Among those 388 of them had been excluded using exclusion criteria. Hence, 1100 charts were eligible for chart review. 350 charts were selected by using a systematic random sampling method to be reviewed; with every three-chart included after determining the first case by lottery method.

Sampling procedure

At first, hospitals with advanced ICUs and contemporary records were selected purposely. Then the number of study units was determined by counting the number of patients placed on mechanical ventilation in each hospital throughout the study duration (two) years. The Figure below will be used to explain further steps.



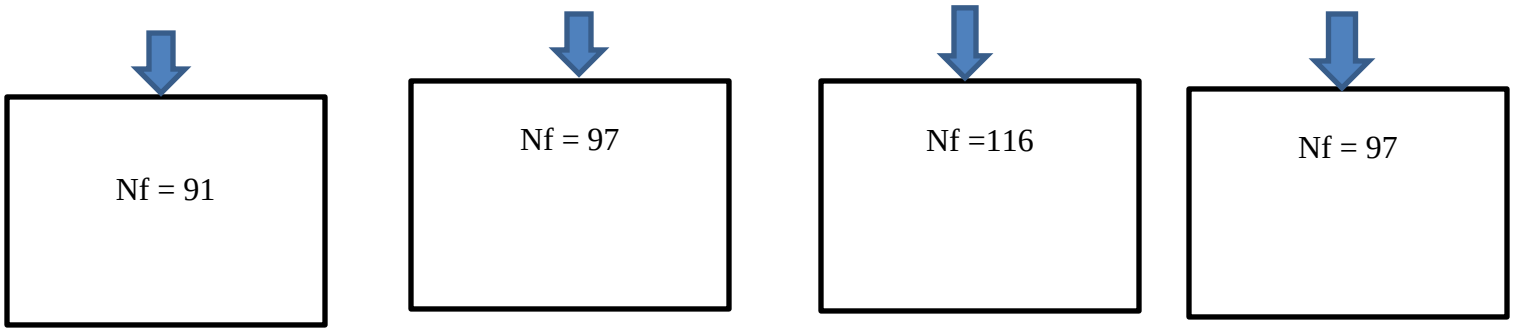


Figure 2 sampling procedure of incidence and predictors of AKI among mechanically ventilated ICU patients in Addis Ababa public hospitals

Study Variable

Dependent variable

- Incidence of Acute Kidney Injury

Independent Variable

- Socio-demographic Characteristics
  - ✓ Age
  - ✓ Gender
  - ✓ Residence
- Comorbidity (DM, Hypertension, Cardiovascular Disease, Obesity, Malignancy, HIV)
- Clinically related variables
- Laboratory related variables
- Management related factors
- Mechanical ventilation variables

Operational Definition

AKI: - Acute Kidney Injury is defined as an increase in serum creatinine by 0.3 mg/dL or more within 48 hours or an Increase in serum creatinine to 1.5 times baseline or more within the last 7

days or Urine output less than 0.5 mL/kg/h for 6 hours using Kidney Disease Improving Global Outcomes (KDIGO) criteria

The event was considered when AKI occurred on follow-up after 48 hours of mechanical ventilation to the end of the study.

Censored was considered when the patients were discharged, remained on the machine beyond the study period, transferred out, extubated or died without developing AKI during the follow-up period.

Time to develop AKI: The time in which, when the mechanically ventilated adult ICU patient develops AKI after Admission initiation of MV.

Data Collection tools

We used secondary data. A checklist prepared from a previous study conducted in different setups and national guidelines was used (1, 8, 22, 42). Forms used for laboratory requests, follow-up cards, ICU registration logbooks, and patient cards were reviewed. The acute Kidney Injury data collection tool to collect relevant information from patient charts consists of Socio-demographic characteristics, date of ICU admission, diagnosis, baseline vital signs, baseline laboratory results, comorbidities, medication given, indication of mechanical ventilation, length of MV, mode of MV, VT/kg, PIP, PEEP, length of MV, Vital signs at the end of follow-up, laboratory results at the end of follow up, Complication, date of Last follow up (date of AKI confirmation or end of Follow up, and patients outcome (recovery or death from ICU). The records of each patient were clustered to develop AKI or non-AKI based on Kidney Disease Improving Global Outcomes (AKI-KDIGO) criteria (rising serum creatinine and reducing urine output < 0.5ml/kg/hour for 6 -12 hours.

Data Quality Assurance

Training was given to three data collectors (BSc level) and one supervisor (MSc level) for the description of the questionnaire and the way how they collect data from the patient records. Each component of the checklist was brought for discussion clearly for data collectors. The data collection procedure was monitored closely by the supervisor and principal investigators on a daily base. Data was collected using systematic randomly selected mechanically ventilated patient charts by using prepared data extract checklists developed specifically for this study. A pretest was

conducted on 5% of the sample before data collection began to assess the clarity of the checklist and accordingly, we incorporated the possible amendments into the checklist. Besides this, the principal investigator carefully entered and cleaned the data before the commencement of the analysis.

Data Processing and Analysis

At the end of data collection, the data was checked for incompleteness, entered into Epi-data Manager version 7.2.2.6, and exported to STATA version 14 for cleaning, editing, coding, and analysis. Explanatory data analysis was done to determine missing values, normality tests, and the presence of outliers before analysis. Then the data was described using relative frequency, percent, mean with standard deviation, and median based on the applicability. A life table was used to estimate the cumulative probability of AKI at different time intervals. A Kaplan-Meier survival curve was used to estimate the median survival time during the follow-up period and a log-rank test was also used to compare survival curves for the presence of differences in incidence of AKI among the groups. The Bi-Variet analysis was computed to identify possible associations between AKI and each independent variable using the Cox proportional hazard model. Variables, significant at $p \leq 20\%$ level in bi-variable analysis were collectively included in the multi-variable analysis, to identify independent predictors of AKI.

Using variable inflation factor (VIF) between independent variables, multi-co-linearity was checked, and all outputs fell within the acceptable range (mean VIF= 1.21). the proportional hazard assumption was also checked using the Global test with the value of p= 0.0916, which was insignificant. The Cox-Snell residuals were also used to check check Cox regression model's fitness to the data. Finally, we concluded that the final model fits successfully. In multivariable analysis, any statistical was considered significant at $p<0.5$. the association between the incidence of AKI and independent factors was declared using an adjusted hazard ratio (AHR) with a 95% confidence interval. Finally, data was presented using tables, graphs and texts.

Ethical Consideration

The study met the ethical and scientific standards outlined in national, and international guidelines, AAU research and community services directorate's ethical principles and was approved by the institutional review board (IRB) College of Medicine and Health Science, School of Nursing, Department of Emergency medicine and critical care nursing. Addis Ababa University research ethics and a letter of permission were dispatched to the administration of African Leprosy and Tuberculosis Rehabilitation and Training Centre Hospital (ALERT), Tikur Anbessa Specialized Hospital (TASH), Saint Peter Specialized Hospital (SPSH), and Saint Paul Hospital millennium medical college (SPHMMC). Informed consent was waived due to the review of records retrospectively, and collected data was kept confidential.

RESULT

Overall, 1234 patients were admitted to an ICU for mechanical ventilation during the study period of January 1, 2022 - December 30, 2023. Of them, 350 charts were selected using a systematic random sampling method to be reviewed in every three charts; after determining the first case by lottery method. The subsequent card was considered if it appeared that, any chart had been missed or had incomplete data.

Socio-demographic characteristics

The mean age of the study participants was 44.7±19.8 years (range, 19-95 years). Above half 176(50.29%) of the study participants were male, of them105 (59.7%) had developed AKI. The proportion of pregnant women among female participants was about 36 (21.7%) admitted to the ICU due to pregnancy-related complications. Only one-fourth 90(25.7%), of the study participants were over the age of 60 years. The majority of 206 (59.03%) study subjects were live at urban. The proportion of AKI among rural study participants was 118 (82.5%) (**Table 1**).

Table 1 Table 1Socio-demographic distribution of Mechanically Ventilated Intensive Care Unit Patients in the Public Hospitals of Addis Ababa, Ethiopia, 2024 (n=350).

Variables		**Outcome**		
	Category	**Event**	**Censored**	**Total**
Age	<40 years	67(41.4%)	95(58.6)	162 (46.3%)
	40-60 years	77(78.6%)	21(21.4%)	98(28.0%)
	>60 years	83(92.2%)	7(7.8%)	90(25.7%)
Sex	Male	104(59.1%)	72(40.9%)	176(50.4%)
	Female	123 (70.7%)	51(27.3%)	174(49.65%)
	Yes	31(86.1%)	5(13.9%)	36(21.7%)
Pregnancy	No	89(68.5%)	41(31.5%)	130(78.3%)
Residency	Urban	111(53.9%)	95(46.1%)	206 (58.9%)
	Rural	116(80.6%)	28(19.4%)	144(41.1%)

Vital Sign-related Variables

Of 350 total observations, the majority of 260(74.3%) respondents had severe illness during ICU admission. The mean baseline systolic blood pressure was 107.2± 22 mmHg. Regarding the baseline vital signs, only 62(17.77%) recorded below 90 mmHg average baseline systolic blood pressure and 95(27.2%) of the study participants also recorded below 60 mmHg in average diastolic blood pressure. Among respondents, 179 (60.7%) of baseline mean arterial pressure was recorded above 65mmHg. From the total observations, 299 (85.4%), 235(67.3%), and 54(15.4%) of them were tachypnea, tachycardia and hypotensive respectively. About two-thirds 226 (64.8%) of the study subjects had urine output less than 0.5ml per kg per hour at the end of follow-up (**Table 2**).

Table 2 Details the vital sign-related variables of mechanically ventilated Intensive Care Unit patients in Addis Ababa public Hospitals, Ethiopia, 2024(n=350).

Variables		**Outcome**		
	Category	**Event**	**Censored**	**Total**
Triage Severity score	Moderate	145(55.8%)	8(8.9%)	90(25.7%)
	Severe	145(55.8%)	115(44.2%)	260 (74.3%)
Baseline average systolic blood pressure	<90 mmHg	56(90.3%)	6(9.7%)	62(17.7%)
	90-120 mmHg	124(56.6%)	95 (43.4%)	219 (62.6%)
	>120 mmHg	47 (68.1%)	22(31.9%)	69(19.7%)
Baseline average diastolic blood pressure	<60 mmHg	86(90.5%)	9(9.5%)	95(27.2%)
	60-80 mmHg	120(53.3%)	105 (46.7%)	225(64.3%)
	>80 mmHg	21(70%)	9(30%)	30(8.6%)
Baseline average means atrial blood pressure	<65 mmHg	48(88.9%)	6(11.1%)	54(15.4%)
	≥ 65 mmHg	179 (60.5%)	117 (39.5%)	296(84.6%)
Baseline average pulse rate	<60 beats/minute	11(33.3%)	22 (66.7%))	33(9.4%)
	60-100 beats/minute	58(53.2)	51(48.2%)	109 (31.1%)

	>100 beats/minute	166 (79.8)	42(20.2%)	208(59.5%)
Baseline average respiratory rate	≤ 24 breaths/ minute	16(31.4%)	35 (68.6%)	51 (14.6%)
	>24 breaths/ minute	227 (64.9%)	123 (35.1%)	299 (85.4%)
Baseline average body temperature	<36°c	13 (76.5)	4 (23.5)	17 (4.8)
	36-37.5 °c	92(46.7%)	105(53.3%)	197 (56.3)
	>37.5 °c	122(89.7%)	14(10.3%)	136 (38.9%)
End follow-up average MAP	<65 mmHg	132 (91.7%)	12 (8.3%)	144 (42.1%)
	≥ 65 mmHg	95 (46.1%)	111 (53.9%)	206 (58.9%)
End follow-up average pulse rate	<60 beats/minute	8 (80%)	2 (20%)	10 (2.8%)
	60-100 beats/minute	16 (28.1%)	41 (71.9%)	57 (16.3%)
	>100 beats/minute	203 (71.7%)	80 (28.3%)	283 (80.9%)
End follow-up average respiratory rate	≤ 24 breaths/minute	9 (12.3%)	65(87.8%)	74(21.1%)
	>24 breaths/minute	218 (79%)	58 (21%)	276 (80.9%)
End follow up average SPO_2	<90%	171 (61.3%)	108(38.7%)	279 (79.7%)
	≥ 90%	56(78.9%)	15(21.1%)	71(20.3%)
End follow-up average urine output	<0.5 ml/kg/hr.	216 (95.6%)	10 (4.4%)	226 (64.8%)
	≥0.5ml/kg/hr.	11 (8.9%)	113 (91.1%)	124 (35.4%)

Abbreviations:

Laboratory-related Variables

Regarding laboratory-related variables, 278 (79.4%) of the study participants had an average baseline serum creatinine ≤1 mg/dl at the beginning of the study. Of these, 171 (61.5%) developed AKI while they were on MV, and 56 (78.9%) of the participants who had average serum creatinine more than or equal to 1 mg/dl also developed AKI. The mean creatinine level at baseline was 0.54 mg/dl (SD=0.6), with minimum and maximum values of 0.15 and 1.31, respectively. Similarly, this study demonstrated that 240 (68.6%), 121(34.6%) and 92(25.9%) of the participants were leukocytosis, anemia and thrombocytopenia respectively. The mean baseline serum albumin was

2.73mg /dl (SD=0.648). Among the total observations, about 190(54.3%) of them had low serum albumin, of them 142(74.7%) developed AKI during the study period. At the end of the follow-up 250(71.63%) of the study subjects creatinine level was greater than or equal to 1.2mg dl (**Table 3**).

Table 3 Distribution of the Laboratory investigations-related variables of mechanically ventilated Intensive Care Unit patients in Addis Ababa public Hospitals, Ethiopia, 2024(n=350).

Variables	Category	Outcome		
		Event	Censored	Total
Average Baseline Creatinine level	<1mg/dl	171(61.3%)	108(38.7%)	279 (79.7 %)
	>=1mg/dl	56 (78.9%)	16 (21.1%)	72 (20.3%)
Average baseline blood urea nitrogen	<30mg/dl	88(55.4%)	72(44.6%)	160(45.7%)
	>=30 mg/dl	142 (75.1%)	48(24.9%)	190(54.3%)
Average baseline white blood cells level	<=11,000cells/l	58 (52.7%)	52(47.3%)	110(31.4%)
	>11,000	169 (70.4%)	71 (29.6%)	240 (68.6%)
Average baseline hemoglobin	<12mg/dl	108(89.3%)	13(10.7%)	121(34.6%)
	≥12mg/dl	119(52%)	110(48%)	229(65.4%)
Baseline platelet level	<150,000	78(86.7%)	14(13.3)	92(25.9%)
	≥150,000	153(59.5%)	105(40.5%)	258(74.1%)
Average baseline serum albumin	<3.4 mg/dl	142(74.7%)	48(25.3%)	190(54.3%)
	≥3.4 mg/dl	85(53.1%)	75(46.9%)	160(45.7%)
Average serum sodium	<135mg/dl	80 (76.2%)	25(23.8%)	105(30%)
	135-145mg/dl	138 (59.5%)	94(40.5%)	232(66.3%)
	>145md/dl	9(69.2%)	4(30.8)	13(3.7%)
Average serum potassium	<3.5 mEq/L	50(74.6%)	17(25.4%)	67(19.1%)
	3.5-5.5 mEq/L	175(62.5%)	105(37.5%)	280(79.9%)
	>5.5 mEq/L	2(66.7%)	1(33.3%)	3(1%)
Average serum calcium	<8.5 mg/dl	46(79.3%)	12(20.7%)	58(16.6%)
	8.5-10.5mg/dl	185(63.6%)	106(36.4%)	291(83.4%)
Creatinine level at the end of follow-up	<1mg/dl	13(10.3%)	113(89.7%)	126(36%)
	≥1mg/dl	214(95.5%)	10 (4.5%)	224 (64%)
BUN level at the end of the follow-up	<45 mg/dl	9(7.4%)	112(92.6%)	121(34.8%)
	≥45mg/dl	222(97.4%)	7(2.6%)	229(65.2%)
WBC level at the end of follow-up	<=11,000cells/l	57(52.8%)	51 (47.2%)	108(30.9%)
	>11,000	170(70.3%)	72(29.8%)	242(69.1%)
	<12mg/dl	206(81.8%)	46(18.3%)	252 (72%)

Hemoglobin level at the end of follow-up	≥12mg/dl	21(21.4%)	77(78.6%)	98(28%)
Platelet level at the end of follow-up	<150,000	125(94%)	8 (6%)	133 (38.2%)
	≥150,000	106 (49.3%)	109 (50.7%)	215(61.8%)
Serum Albumin at the end of follow-up	<3.4 mg/dl	85(53.1%)	75(46.9%)	160(45.7%)
	≥3.4 mg/dl	142(74.7%)	48(25.3%)	190(54.3%)
Serum Sodium at the end of the follow-up	<135mg/dl	23(56.1%)	18(43.9%)	41(11.8%)
	135-146mg/dl	61 (39.4%)	95(60.6%)	156(44.4%)
	>146md/dl	143(93.5%)	10(6.5%)	153(43.8%)
Serum potassium at the end of follow-up	<3.5 mEq/L	39(73.6%)	14(24.6)	53(15.2%)
	3.5-5.5 mEq/L	161(60.3%)	106(39.7%)	267(76.5%)
	>5.5 mEq/L	27(93.1%)	2(6.9%)	29(8.3%)

Clinical-Related Variables

Based on this study, the majority of the participants, 226 (64.5%), were admitted to the ICU due to medical reasons, whereas the remaining were due to surgical. The proportion of AKI among those medical patients was 169 (75.1%), in comparison with those who were admitted due to surgical reasons at 58 (46.8%). Severe pneumonia was the main reason for ICU admission, followed by acute respiratory distress syndrome 77(22.0%). Only, 58(16.6%) of study participants were admitted to ICU with trauma. Among respondents, 252 (72.2%) had at least one comorbidity. Furthermore, a higher proportion of AKI development (86.5%) was noticed among groups that had comorbidity than those who had no comorbidity. This study also revealed hypertension (28%) was the most common comorbidity among the study participants, while bronchial asthma (5.7%) was the least common comorbidity. Among study participants who had preexisting hypertension 77 (90.1%) developed AKI throughout the study period. In addition, only 40 (11.4%) of the study subjects were admitted with HIV, and of them, 32 (80%) developed AKI (**Table 4**).

Table 4 Distribution of Clinical-related Variables of Mechanically Ventilated Intensive Care Unit Patients in Addis Ababa Public Hospitals, Ethiopia, 2024(n=350).

Abbreviation: COPD, chronic obstructive pulmonary disease; HIV, human immune deficiency virus.

Variables	Category	Outcome		
		Event	Censored	Total
Reason for ICU admission	Medical	182 (76.2%)	57(23.8%)	239(68.3%)
	Surgical	45(40.5%)	66 (59.5%)	111(37.7%)
Trauma	No	215(73.6%)	77(23.4%)	292(83.4%)
	Yes	12(20.7%)	46(79.3%)	58(16.6%)
Myocardial infarction	No	177(60.2%)	117(39.8%)	294(84.0%)
	Yes	50(89.3%)	6(10.7%)	56(16.0%)
Bronchial Asthma	No	198(63.9%)	112(36.1%)	310(88.6%)
	Yes	29(72.5%)	11(27.5%)	40(11.4%)
Acute respiratory distress syndrome	No	158(57.9%)	115(42.1%)	273(78.0%)
	Yes	61(79.2%)	16(20.8%)	77(22.0%)
Post operation	No	189(66.1%)	97(33.9%)	286(81.7%)
	Yes	38(59.4%)	26(40.6%)	64(18.3%)
Severe Pneumonia	No	164(638%)	93(36.2%)	257(73.4%)
	Yes	63(67.7%)	30(32.3%)	93(26.6%)
Malignancy	No	214(64.5%)	118(35.5%)	332(94.9%)
	Yes	13(71.2%)	5(27.8%)	18(5.1%)
At least one Comorbidity	No	9(9.2%)	89(90.8%)	98(28%)
	Yes	218(86.5%)	34(13.5%)	252(72%)
Hypertension	No	150(58.8%)	105(41.2%)	255 (72.9%)
	Yes	77(90.1%)	18(9.9%)	95(27.1%)
Diabetic Mellitus	No	146 (55.5%)	117(44.5%)	263 (75.1%)
	Yes	81(93.1%)	6 (6.9%)	87(24.9%)
COPD	No	206(63.6%)	118(36.4%)	324(92.6%
	Yes	21(80.8%)	5(19.2%)	26 (7.4)
Bronchial Asthma	No	211(63.9%)	119(36.1%)	330(94.3%)
	Yes	16(80%)	4(20%)	20(5.7%)
Malignancy	No	190(61.1%)	121 (38.9%)	311 (88.9%)
	Yes	37(94.9%)	2(5.1%)	39(11.2%)
HIV	No	195(62.9%)	115(37.1%)	310(88.6%)
	Yes	32(80%)	8(20%)	40(11.4%)
Stroke	No	207(62.9%)	122 (37.1%)	329(94.3%)
	Yes	19(95%)	1(5%)	20 (5.7%)
Tuberculosis	No	197 (62.7%)	117(37.3%)	314 (89.7%)
	Yes	30(83.3%)	6 (16.7%)	36(10.3%)
Obesity	No	197(64.9%)	131(35.1%)	328 (93.2%)
	Yes	17(77.3%)	5(22.7%)	22(6.8%)

Drug-related Variables

Concerning drug-related factors, the study revealed that the entire participant 350(100%) had taken at least one antibiotic. In addition, most of the patients who had taken meropenum 143(85.1%) and gentamycin 152(68.5%) had developed AKI during the study time. Furthermore, most of the patients 223(63.7%) had received vasopressor in their ICU stay and the majority of these patients 206(92.4%) had experience AKI after being on MV. Only 43(12.3%) and 38(10.9%) of the participants took antifungal and antiviral at the study time respectively. However, the majority of these participants who took antifungal 38(88.4%) and antiviral 34(89.5%) had developed AKI. Moreover, most of the participants 258(73.7%) were on sedatives and ketamine 135(38.6%) was the commonest sedative that had been used. Of the participants who were on sedatives 195(75.6%) of them had AKI during the study time. Concerning receiving a vasopressor, the majority of 223 (63.7%) study participants received a vasopressor, and of them, 154 (68.4%) were reviewed as receiving a double vasopressor (**Table 5**).

Table 5 Distribution regarding Drug-related Variables of Mechanically Ventilated Intensive Care Unit patients in Addis Ababa Public Hospitals, Ethiopia, 2024(n=350).

Variables	**Category**	**Outcome**		
		Event	**Censored**	**Total**
Meropenem	No	84(46.2%)	98(53.8%)	182(52.0%)
	Yes	143(85.1%)	25(14.9%)	168(48.0%)
Ceftazidime	No	114(62.0%)	70(38.0%)	184(52.6%)
	Yes	117(70.5%)	49(29.5%)	166(47.4%)
Vancomycin	No	27(40.9%)	39(59.1)	66(18.9%)
	Yes	200(70.4%)	84(29.6%)	284(81.1%)
Gentamycin	No	152(68.5%)	70(31.5%)	222(63.4%)
	Yes	75(58.6%)	53(41.4%)	128(36.6%)
Streptomycin	No	206(63.6%)	114(35.0)	324(92.5%)
	Yes	21(80.8%)	5(19.2%)	26(7.5%)
Ciprofloxacin	No	185(62.7%)	114(36.4%)	296(84.6%)
	Yes	44(71.5%)	10(18.5%)	54(15.4%)
Antifungal	No	189(61.6%)	118(38.4%)	307(87.7%)
	Yes	38(88.4%)	4(9.3%)	43(12.3%)
Antiviral	No	197(63.3%)	115(36.7%)	312(89.1%)
	Yes	34(89.5%)	5(11.6%)	43(12.3%)
Vasopressor	No	21(16.5%)	106(83.5%)	127(36.3%)
	Yes	206(92.4%)	17(7.6%)	223(63.7%)
Combination therapy of vasopressor	Single	62(87.3%)	9(12.7%)	71(31.6%)
	Double	144(93.5%)	10(6.5%)	154(68.4%)
Immunosuppressant	No	198(63.9%)	112(36.1%)	310(89.1%)
	Yes	29(76.3%)	9(23.7%)	38(10.9%)
Sedation	No	32(34.8%)	60(65.2%)	92(26.3%)

	Yes	195(75.6%)	63(24.4%)	258(73.7%)
Ketamine	No	105(48.8%)	110(51.2%)	215((61.4%)
	Yes	122(90.4%)	13(9.6%)	135(38.6%)
Propofol	No	197(66.3%)	100(33.7%)	297(84.9%)
	Yes	30(56.6%)	23(43.4%)	53(15.1%)
Ketofol	No	149(56.2%)	116(43.8%)	265(75.7%)
	Yes	78(91.8%)	7(8.2%)	85(24.3%)
Diazepam	No	208 (67.3%)	101(32.7%)	309(88.3%)
	Yes	19(46.3%)	22(53.7%)	41(11.7%)
Diuretics	No	119(50.6%)	116(49.4%)	235(67.1%)
	Yes	108(93.9%)	7(6.1%)	115(32.9%)
Antihypertensive	No	131(53%)	116(47%)	247(70.6%)
	Yes	96(93.2%)	7(6.8%)	103(29.4%)
Thrombolytics	No	39(33.3%)	78(66.7%)	117(33.4%)
	Yes	192(82.4%)	41(17.6)	233(66.6%)
NSAID	No	141(60.5%)	92(39.5%)	233(66.6%)
	Yes	89(76.1%)	28(23.9%)	117(33.4%)
Statins	No	147(61.3%)	93(38.7%)	240(68.6%)
	Yes	84(76.4%)	26(23.6%)	110(31.4%)

Abbreviation: NSAID, a non-steroid anti-inflammatory drug.

Mechanical Ventilation Related Variables

Regarding mechanical ventilated related variables, the majority of the participants 216 (61.7%) were intubated for air may protection, while only 40 (11.4%) participants were intubated for impending respiratory failure. Among the participants who were on MV for respiratory failure, the majority of them 162(88.5%) developed AKI. In addition, only 53 (39.6%) of the study subjects who were on MV for airway protection developed AKI. n relation to the place of intubation, a majority of 335 (95.7%) study subjects were reviewed as receiving invasive mechanical ventilation within the ICU. Among intubated participants, 223(66.6%) of them had AKI during the study period. Of the intubated participants, 146(43.7%) of them had a tracheostomy procedure. Among the participants who had a tracheostomy procedure, 136(91.9%) had developed AKI. In addition, the most commonly used mode of ventilation was volume control ventilation (VCV) 272(81.2%). Furthermore, more than half (67%) of the participants had an average tidal volume of 500 ml or more. Out of these participants, 191 (84.1%) had AKI. Moreover, around 148 (42.3%) of the participants were on prolonged mechanical ventilation for 15 days or more, of which 136 (91.9%) of the study subjects developed AKI (**Table 6**).

Table 6 Mechanical ventilator Variables of Mechanically ventilated Intensive Care Unit patients in Addis Ababa Public Hospitals, Ethiopia, 2024(n=350).

Variables	Category	Outcome		
		Event	Censored	Total
Airway protection	No	174(80.6%)	42(19.4%)	216 (61.7%)
	Yes	53 (39.6)	81 (60.4%)	134 (38.3%)
Respiratory failure	No	65(38.9%)	102(61.1%)	167 (47.7%)
	Yes	162(88.5%)	21 (11.5%)	183 (52.3%)
Impending respiratory failure	No	212 (68.4%)	98 (31.6%)	310 (88.6%)
	Yes	15(37.5%)	25 (62.5%)	40 (11.4%)
Method of MV	Non-invasive	4(26.7%)	11 (73.3%)	15 (4.3%)
	Invasive	223 (66.6%)	112 (33.4%)	335 (95.7%)
Tracheostomy	No	88 (47.1%)	99(52.8%)	187(55.8%)
	Yes	136(91.9%)	12 (8.1%)	148 (44.2%)
Timing of tracheostomy	Early	8(42.1%)	11 (57.9%)	19 (13.2%0
	Late	121 (96.8%)	4(3.2%)	125 (86.8%)
VCV	No	12 (19.1%)	51 (80.9%)	63 (18.9%)
	Yes	212(77.9%)	60 (22.1%)	272 (81.1%)
PCV	No	129 (84.3%)	24 (15.7%)	153 (45.5%)
	Yes	95 (51.9%)	88 (48.1%)	183 (54.5%)
PRVC	No	200 (69%)	90(31%)	290 (86.6%)
	Yes	24(53.3%0	21(46.7%0	45(13.4%)
SIMV	No	214(74%)	75(26%)	289(86.3%)
	Yes	10(21.7%)	36(78.3%)	46(13.7%)
CPAP	No	211(78.2%)	59(21.8%)	270(80.6%)
	Yes	13(20.0%)	52(80.0%)	65(19.4%)
Average Tidal Volume	<500 ml	36(31%)	80(69%)	116(33.1%)
	≥500 ml	191(81.6%)	43(18.4%)	234(66.9%)
Average Peak airway Pressure	<35cmH2O	195(63.5%)	112(36.5%)	307(87.7%)
	≥35cmH2O	32(74.4%)	11(25.6%)	43(12.3%)
Average positive end-expiratory pressure	<10 cmH2O	49(32.7%)	101(67.3%)	150(42.9%)
	≥10cmH2O	178(89.0%)	22(11.0%)	200(57.1%)
Length of Mechanical Ventilation	<15 days	91(45.1%)	111(54.9%)	202(57.7%)
	≥15days	136(91.9%)	12(8.1%)	148(42.3.0%)

Survival Function and Incidence Rate of AKI among Mechanically Ventilated Patients

This study revealed that the patients were followed for a minimum of 2 days and a maximum of 93 days, with the median follow-up period being 30 days (95%CI: 27, 31). The Total Person time observation was 8092 person days. The incidence rate of AKI among mechanically ventilated ICU patients was 28.1% (95%CI: 24.6, 32.0) per 1000-person days of observation. The finding of this study showed that the overall prevalence of AKI among Mechanically ventilated ICU patients was 65% with (95% CI; 59.7, 69.8), and the rest 35% of the study participants were censored. Among those who had developed AKI (n=227), 84.5.4% (212) of the patients died, 6.8% (17) of patients

recovered alive, and the rest 8.7% (22) of the patients were transferred to other institutions. The probability of developing AKI at 5, 25, 50, 75 and 90 days were 0.1429, 0.6114, 0.8629, 0.9629 and 0.9914 consecutively (**Table 7**).

Table 7 Life table of mechanically ventilated Intensive care unit patients admitted to Addis Ababa Public Hospitals, Ethiopia, 2024.

Time interval in days	Beginning total	Event	Cumulative survival	Cumulative probability of failure	95% CI
0-5	350	50	0.8571	0.1429	0.110-0.184
5-10	300	87	0.6086	0.3949	0.342-0.445
10-15	213	46	0.4771	0.5234	0.472-0.576
15-20	167	17	0.4286	0.5719	0.520-0.623
20-25	150	14	0.3886	0.6114	0.560-0.662
25-30	136	16	0.3429	0.6574	0.607-0.706
30-35	120	35	0.2429	0.7571	0.7112-0.706
35-40	85	10	0.2143	0.7851	0.741-0.800
40-45	75	21	0.1543	0.8457	0.805-0.827
45-50	54	6	0.1371	0.86217	0.824-0.881
50-55	48	5	0.1229	0.8711	0.840-0.896
55-60	43	4	0.1114	0.8886	0.853-0.918
60-65	39	14	0.0714	0.9286	0.898-0.952
65-70	25	3	0.0629	0.9371	0.908-0.959

70-75	22	9	0.0371	0.9699	0.939-0.979
75-80	13	5	0.0229	0.9771	0.967-0.98
80-85	8	3	0.0143	0.9877	0.968-0.994
85-90	5	2	0.0086	0.9914	0.976-0.997
90-95	3	3	0.0000	1.000	

Survival status using the Kaplan-Meier Curve

The Median Time was 30 days. We note from the Kaplan-Maier graph that at the initial time of diagnosis the probability of developing Acute Kidney injury was lower, but as the follow-up time increased the probability of developing acute kidney injury among mechanically ventilated patients increased (**Figure 3)**.

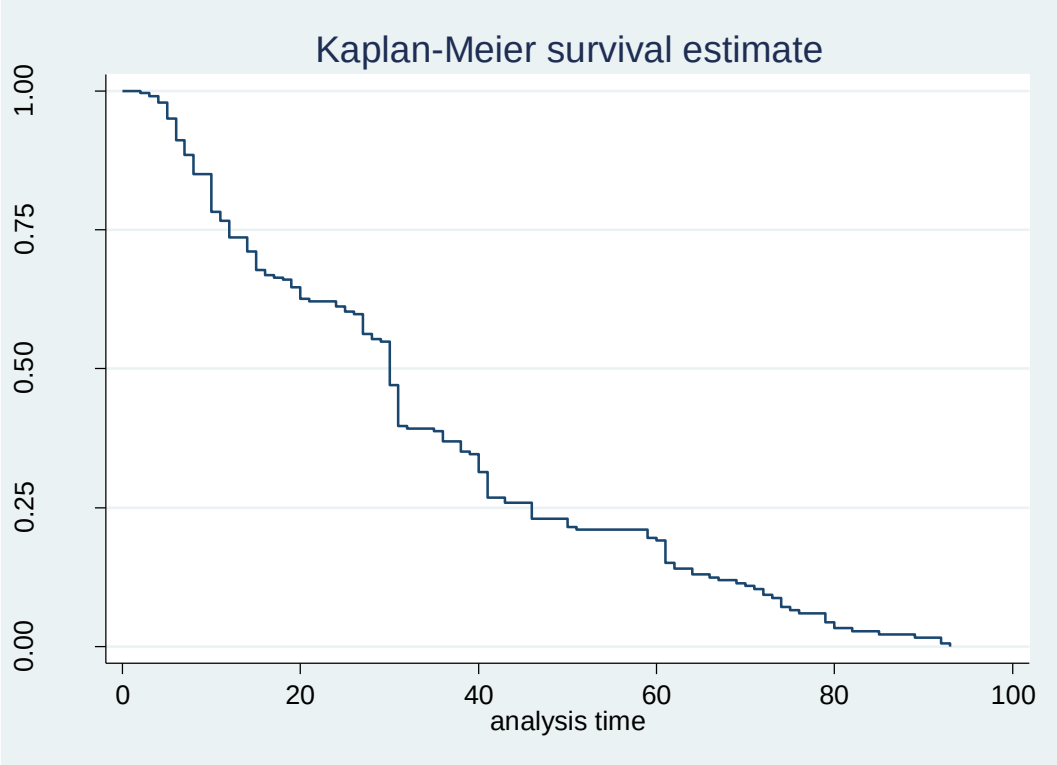


Figure *1* Overall Kaplan-Meier estimates of mechanically ventilated Intensive care patients in Addis Ababa Public Hospitals, Ethiopia, 2024

Survival Function and Comparison of Survivorship Function for Different Categorical Variables

The Kaplan-Meier estimator survival curve gives the estimate of survivor function among different categories to compare the groups. Survivorship function line lying above another means, that groups defined by the upper line curve have better survival than other group line curves within the category. To test the equality of survival curves log-rank test was performed. The test statistics which is obtained from the log rank showed that there is a statistical difference to test the null hypothesis, which shows there is a difference in the distribution of survival times among categorical variables using the chi-square (**Table 8**).

Table 8 Median Survival Time, Log-Rank and Cox regression Test for Equality of Survival functions for various categorical predictors of Acute Kidney Injury among Mechanically Ventilated Intensive Care Unit Patients in Addis Ababa Public Hospitals, Ethiopia 2024

Variables	**Categories**	**Incidence rate /1,000 ventilated patients (95% CI)**	**Median Survival Time (95% CI)**	**Log-Rank Test (Chi^2)**	**P-value**
Sex	Male	25.12(20.34, 30.72)	31(30, 40)	4.08	0.0534
	Female	31.13(26.10, 37.16)	29(20, 30)		
Residence	Urban	25.76(21.39, 31.04	31(28, 38)	2.91	0.0879
	Rural	30.65(25.55, 36.77)	30(24, 30)		
Age	<40 years	28.32(22.29, 35.99)	31(30, 40)	2.77	0.200
	40-60 years	29.88(23.98, 37.36)	30 (27, 40)		
	>60 years	26.36(21.26, 32.68)	27(14, 31)		
Average baseline saturation	<90%	34.40(25.51, 46.38)	30(14, 31)	2.37	0.123
	≥ 90%	26.89(23.27, 31.07)	30(28, 31)		
Cardiovascular disease	No	25.54(21.91, 29.78)	31(30, 36)	8.62	0.0033
	Yes	37.41(29.28, 47.79)	18(14, 30)		
Hypertension	No	23.07(19.66, 27.08)	31(31, 40)	47.3	0.0000
	Yes	48.40(38.71, 60.51)	12(10, 15)		
TB	No	27.34(23.78, 31.44)	30(30, 31)	2.18	0.1392
	Yes	33.82(23.65, 48.37)	19(15, 32)		
HIV	No	26.57(23.30, 30.86)	30(30, 31)	7.22	0.0072
	Yes	38.98(27.56, 55.12)	18(13,31)		
Gentamicin	No	31.75(25.32, 39.82)	30(30, 36)	2.85	0.0915
	Yes	26.52(22.62, 30.10)	25(15, 30)		
Respiratory rate	≤ 24 breaths/ minute	28.61(17.53, 46.72)	27(10, 41)	1.82	0.1774
	>24 breaths/ minute	27.02(24.43, 32.05)	30(28, 31)		
	<35cmH_2o	25.79(22.03, 30,42)	31(30, 36)	6.48	0.0111

Average Peak Inspiratory Pressure	≥35cmH_2o	34.74(27.53, 43.83)	24(15, 30)		
Albumin at baseline	<3.4 mg/dl	38.04(30.76, 47.06)	12(10, 17)	24.73	0.0000
	≥3.4 mg/dl	24.24(20.56, 28.57)	31(30, 38)		

In the current study, the patients with low levels of albumin at baseline had lower survival time with a median day of 12 (95% CI: 10, 17) as compared to patients with high albumin 31(95%CI: 30, 38). The difference was statistically significant with a p-value of 0.000 (**Figure 2**).

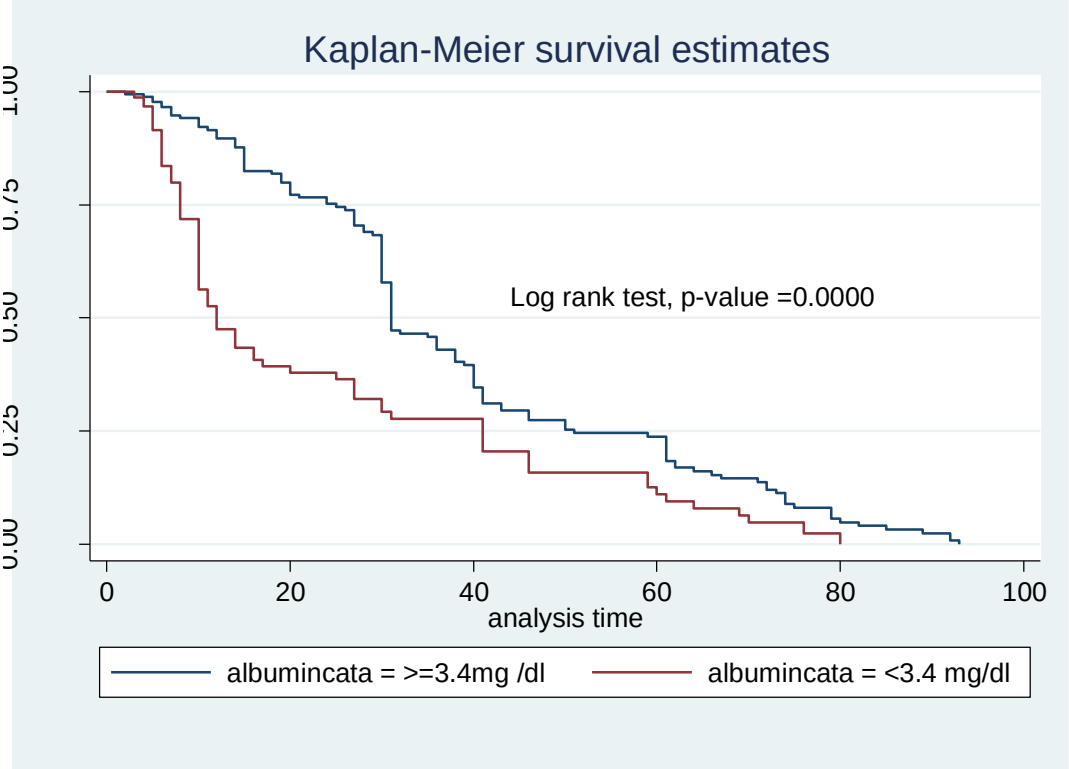


Figure *2* The Kaplan-Meier curve comparison of the level of albumin for the occurrence of acute kidney injury among mechanically ventilated ICU patients admitted in Addis Ababa Public Hospitals, Ethiopia, 2024.

This study revealed that mechanically ventilated patients who were admitted with cardiovascular disease at admission had a higher probability of developing AKI with a median day of 18(95% CI:

14, 30) as compared to patients who had no cardiovascular disease with median times 31(95%CI: 30, 36). The difference was statistically significant with a p-value of 0.0033(**Figure 3**).

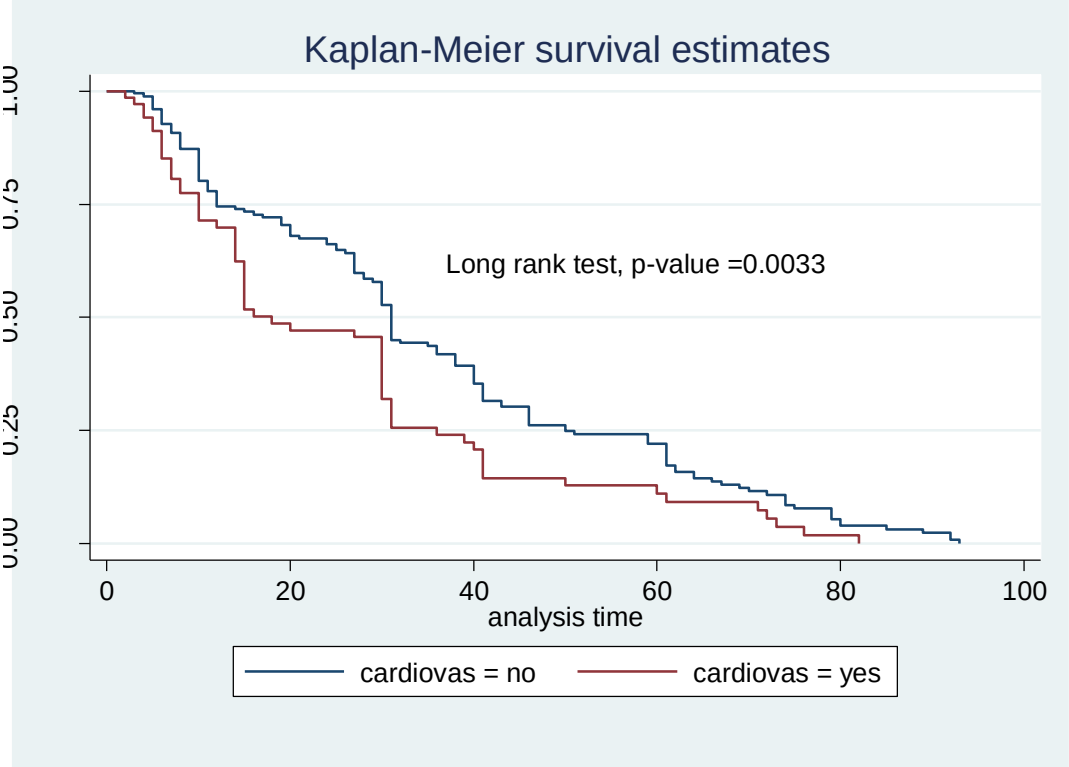


Figure *3* The Kaplan-Meier curve comparison of myocardial infraction for the occurrence of acute kidney injury among mechanically ventilated ICU patients admitted in Addis Ababa Public Hospitals, Ethiopia, 2024.

This study also demonstrated that mechanically ventilated patients who had HIV had a higher probability of survival with a median day of 18(95% CI: 12, 30) as compared to patients without HIV with median times 30(95%CI: 28, 31). The difference was statistically significant with a p-value of 0.0072(**Figure 4**).

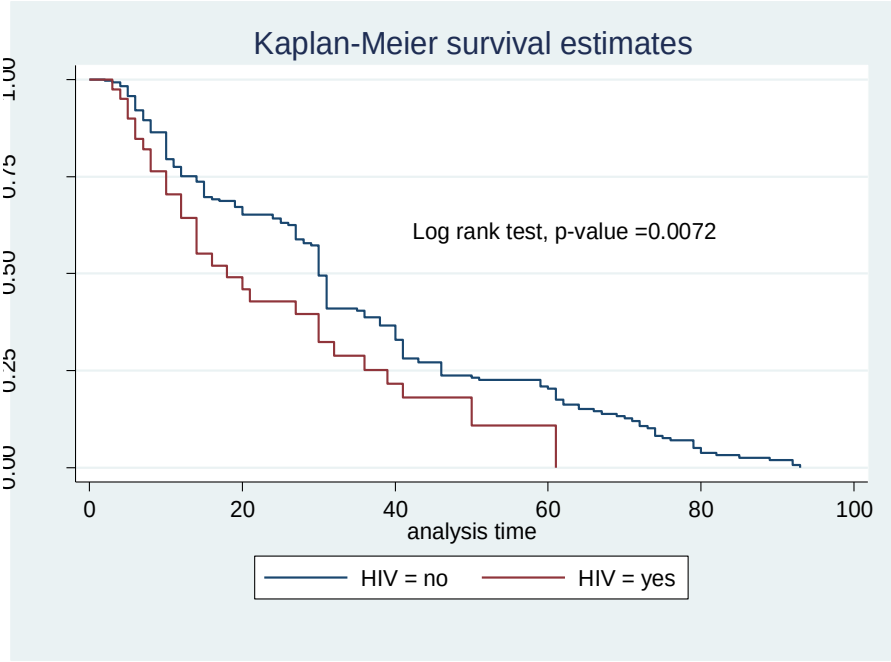


Figure *4* The Kaplan-Meier curve comparison of Human Immune Virus (HIV) for acute kidney injury among mechanically ventilated ICU patients admitted in Addis Ababa Public Hospitals, Ethiopia, 2024.

Study participants who were on greater than or equal to 35 cmH2O peak airway pressure had lower survival median times with median days of 24(95% CI: 15, 30) as compared to those who had below 35 cmH2O peak airway pressure with median times of 31 (95% CI: 30, 36). The difference was statistically significant with a p-value of 0.0111 (**Figure 5).**

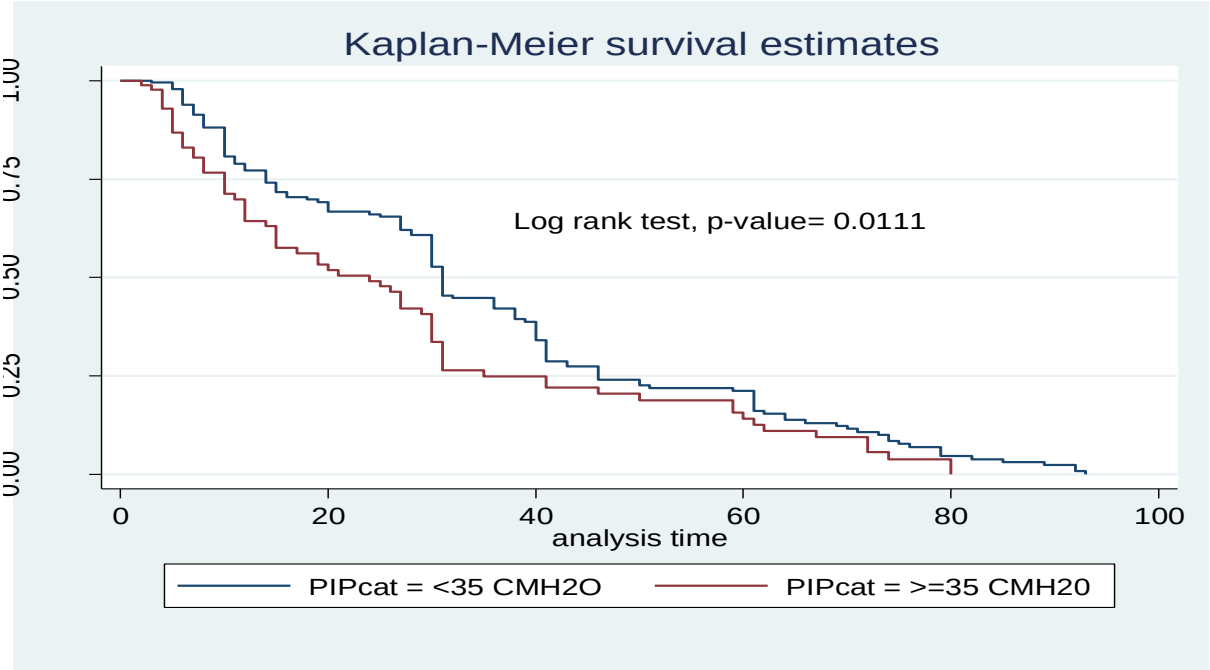


Figure 5 The Kaplan-Meier curve comparison of the peak inspiratory pressure for the occurrence of acute kidney injury among mechanically ventilated ICU patients admitted in Addis Ababa Public Hospitals, Ethiopia, 2024.

In this study, patients who had Hypertension had lower survival times with median days of 12(95% CI: 10, 15) compared to those who had no hypertension with median times of 31 (95% CI: 31, 40). The difference was statistically significant with a p-value of 0.0000 (**Figure 6).**

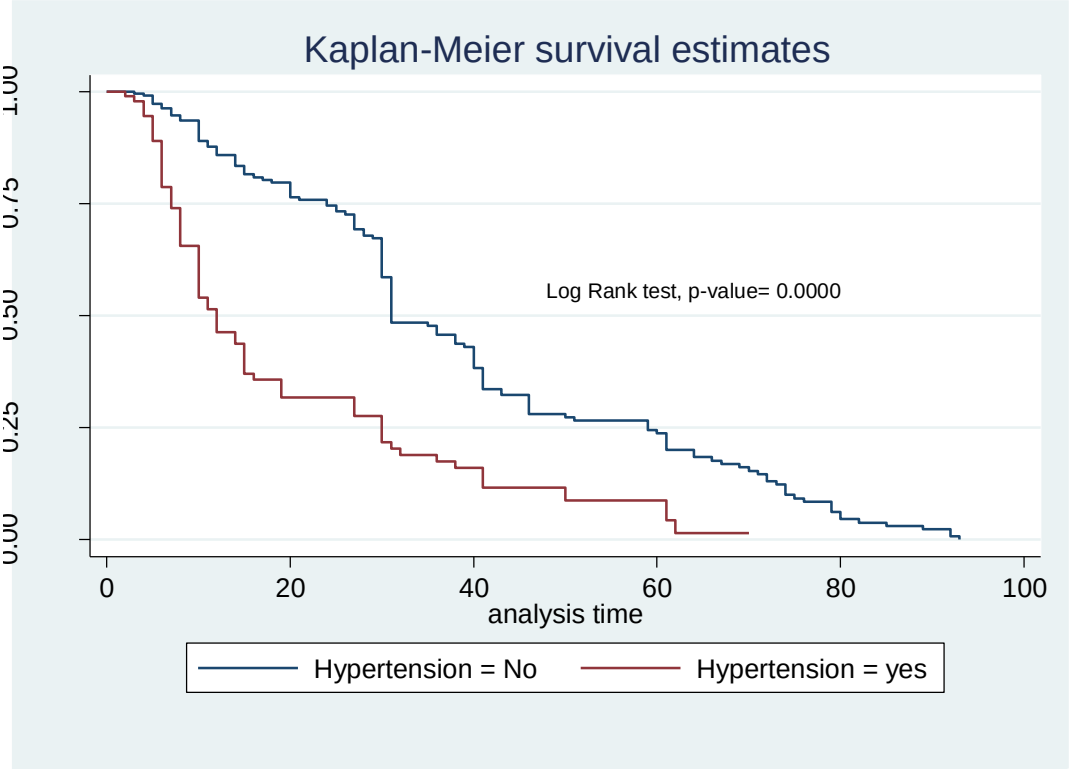


Figure 6 The Kaplan-Meier curve comparison of hypertension for acute kidney injury among mechanically ventilated ICU patients admitted in Addis Ababa Public Hospitals, Ethiopia, 2024.

Test of proportional hazard assumption

Model fitness was checked graphically in this study using the Cox-Snell residuals plot to assess model fitness. As demonstrated in the Cox Snell Residuals graph model was fits. All covariates for model assumption were checked using Cox-Snell residuals. For the residuals test, the hazard function follows close to the baseline hazard, which indicates that the model was well-fitted. Hence, the final multivariate analysis has been accepted and reported accordingly **(Figure 7**). Schoenfeld residuals proportional hazard assumption test for each covariate and the global test was used. Variables that violate the assumptions were rejected (Global test If the P-value is <0.05). The table below shows each covariant P-value is >0.05 and the global test P-value is 0.0921, the result shows proportional hazard assumption test obeyed the proportional hazard assumption (**Table 9**).

Table 9: Table 9 Schoenfeld residual test for proportional assumption of each covariant and overall Cox proportional hazard model among mechanically ventilated ICU patients in public hospitals of Addis Ababa, Ethiopia, 2023.

Covariate	**Rho**	**Chi^2**	**p-value**
Sex	0.365	0.22	0.642
Residency	0.184	6.09	0.1445
Average baseline saturation	0.502	0.38	0.539
HIV	0.050	0.43	0.698
Cardiovascular Disease	0.0306	0.15	0.965
Average PIP	0.0035	1.75	0.1856
	0.332	14.52	0.613
Serum albumin	0.3921	0.26	0.616
Gentamicin	0.0402	0.25	0.688
Tuberculosis	0.0317	0.16	0.898
Respiratory rate	0.0099	0.02	0.131
Hypertension	0.121	2.27	0.529
Age	0.0090	0.42	0.90
Global test	21.41		**0.1212**

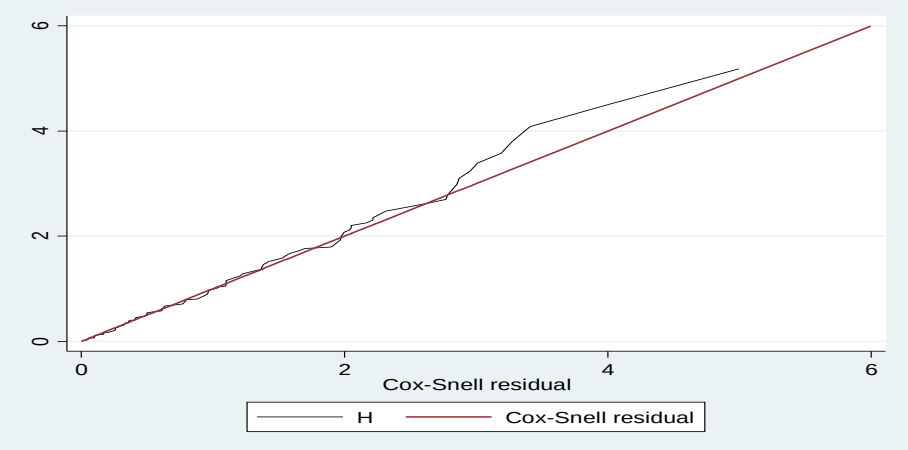


Figure 7 Cox Snell residual test for proportional assumption of each covariant and overall Cox proportional hazard model

Predictors of Acute Kidney Injury

After determining the nature of the data, the Kaplan Meier (KM) curve and life table were used for data description. Then we used a long-rank statistic test to determine if there is a significant difference between groups (**Table 8**). The Cox proportional hazard regression model was used to determine the predictors of acute kidney injury. After a bivariable with a p-value of < 0.20, this included age, sex, residence, baseline saturation, preexisting hypertension, the presence of the human immunodeficiency virus, the presence of TB, cardiovascular disease as a reason for ICU admission, peak inspiratory pressure, gentamycin, baseline respiratory rate, and serum albumin were selected as candidates for multivariable Cox proportional hazard analysis. Variables like reason for ICU admission, asthma, tracheostomy procedure, meropenem, antihypertensive, length of ventilation and antiviral therapy were excluded since they violated the proportional hazard assumption (global test < 0.05) during the Schofield residual test.

From Multivariable proportional hazard model analysis, it was found that preexisting hypertension, cardiovascular disease on admission, human immune virus, Peak Inspiratory Pressure, and albumin at baseline were found to be independent predictors of AKI among mechanically ventilated ICU patients, at a 95% CI. Participants having known hypertension had two times the hazard of developing AKI compared to their counterparts. Those participants who had cardiovascular disease during ICU admission were 1.5 times more likely to have AKI as compared with their counterparts. From this study, it was found that the Human Immune Virus (HIV) was significantly associated with AKI. The hazard of developing AKI among patients with HIV was 1.6 times higher compared to their counterparts. The hazard of participants with higher peak inspiratory pressure (PIP $\geq$35 cmh_2o) had AKI 1.4 times the hazard of those with lower peak inspiratory (PIP< 35 cmH2O). Low serum albumin at baseline was also associated with AKI;

those participants with Low serum albumin at baseline were 1.8 times more likely to have AKI as compared with their counterparts (**Table 10**).

Table 10 Bivariate and Multivariate analysis of mechanically ventilated Intensive Care Unit patients in Addis Ababa Public Hospitals, Ethiopia, 202 4(n=350).

Abbreviation: AHR, adjusted hazard ration; CHR, crude hazard ration; cmH2O, cent meter water; CI, confidence interval; HIV, human immune virus; MV, mechanical ventilation.

*significant at p<0.05.

Covariates	Category	Diseases status		CHR (95%CI)	AHR (95%CI)	P-value
		Event	Censored			
Age	<40 years	67(41.4%)	95(58.6%)	1	1	1
	40-60 years	77(78.6%)	21(21.4%)	0.994(0.712, 1.389)	0.849(0.583, 1.239)	0.398
	>60 years	83(92.2%)	7(7.8%)	0.796(0.573,1.107)	0.902(0.627, 1.297	0.577
Sex	Male	105(59.7%)	71(40.3%)	1	1	1
	Female	126(72.8%)	47(27.2%)	1.07(0.981, 1.660)	0.895(0.981, 1.184)	0.653
Residency	Urban	111(53.9%)	95(46.1%)	1	1	1
	Rural	116(80.6%)	28(19.4%)	1.250(0.957, 1.624)	1.212(0.985, 1.765)	0.063
Cardiovascular	No	177(60.2%)	117(39.8%)	1	1	1
disease	Yes	50(89.3%)	6(10.7%)	1.64(1.136, 2.404)	1.5(1.071, 2.120)	0.011*
Average baseline	<90%	184(61.3%)	116(38.7%)	1	1	1
Oxygen Saturation	≥90%	43(86.0%)	7(14.0%)	1.28(0.922, 1.779)	1.08(0.737, 1.600)	0.675
Hypertension	No	150(58.8%)	105(41.2%)	1	1	1
	Yes	77(90.1%)	18(9.9%)	2.6(1.934, 3.481)	2.3(1.868, 4.271)	0.000*
HIV	No	195(62.9%)	115(37.1%)	1	1	1
	Yes	32(80.0%)	8(20.0%)	1.64(1.127, 2.404)	1.6(1.117, 2.530)	0.007*
Tuberculosis	No	197(62.7%)	117(37.3%)	1	1	1
	Yes	30(83.3%)	6(16.7%)	1.32(0.899, 1.956)	1.406(0.714, 2.770)	0.323
Serum Albumin at	<3.4 mg/dl	142(74.7%)	48(25.3%)	1.95(1.484, 2.579)	1.8 (1.338, 2.392)	0.001*
baseline	≥3.4 mg/dl	85(53.1%)	75(46.9%)	1	1	1
Peak airway	<35 cmH2O	156(59.3%)	107(40.7%)	1	1	1
pressure	≥ 35 cmH2O	71(81.6%)	16(18.4%)	1.63(1.072, 1.889)	1.4(1.045, 1.896)	0.024*
Gentamicin	No	75(58.6%)	54(41.4%)	1	1	1
	Yes	156(70.6%)	65(29.4%)	0.73(0.556, 0.967)	0.8(0.501, 1.130)	0.170
	≤ 24 breaths/ minute	16(31.4%)	35 (68.6%)	1	1	1

Baseline respiratory rate	>24 breaths/ minute	227(64.9%)	123(35.1%)	0.708(0.423, 1.187)	0.906(0.522, 1.572)	0.726

Discussion

AKI remains a major public problem in the Intensive care unit. Mechanical ventilation was recognized as an important risk factor for developing Acute Kidney Injury. This study aimed to assess the incidence of acute kidney injury and its predictors among mechanically ventilated Intensive care unit patients in Addis Ababa selected Public Hospitals from January 2022 to the end of December 2023. In this study, at the end of the follow-up, about 65% (95% CI; 59.7, 69.8) of the study participants developed AKI with a median survival time of 30 days (95%CI; 27, 31).

The finding of this study revealed that the median time to develop acute Kidney Injury (AKI) among mechanically ventilated intensive Care units was 30 days. This indicated half of the patients who developed AKI did so within 30 days of being mechanically ventilated. This finding was higher with a study conducted at Gondar University, which reported 17 days(22). In this study, the prevalence of AKI was reported as 65% with (95% CI; 59.7, 69.8). This finding is also higher than the study conducted in Zambia 52.9%(12).

The overall incidence density of AKI was 28.1% per 1000 Person days of observation. This finding was lower than the study conducted in Iran 37% incidence rate(18). The possible Justification might be due to the discrepancy in AKI diagnosis criteria. However, the current finding was higher than a study done in Gondar, which reported 19.67% per 1000-person day's observation. The Variation could be due to the difference in the study population, which was a study done in Gondar, all patients who were admitted to the intensive care unit. But, the current study was conducted in mechanically ventilated ICU patients.

In this study, Hypertension was found to be a significant predictor of experiencing acute kidney injury among mechanically ventilated ICU patients. For patients with known hypertension, the risk of developing AKI was higher as compared to those who had no hypertension (AHR=1.8; 95%CI: 1.8, 3.271). This finding was supported by studies conducted in Sudan(43), Zimbabwe(44), Norway(45)and the USA(46). The rationale may be that hypertension in stressed-out,

mechanically ventilated ICU patients causes total peripheral blood vessel resistance, extracellular fluid accumulation, nephron tubular tissue necrosis, and impaired kidney function—all of which raise creatinine levels, a marker of acute kidney injury. This is supported by scientific evidence from previous studies (46).

Patients with myocardial infarction (MI) on admission were more likely to develop AKI than those who had no myocardial infarction. The patients who were admitted to ICU with MI had a 1.6 times higher hazard of developing AKI than those who had no MI (AHR=1.63; 95%CI: 1.013, 2.604). This finding was comparable with previous reports (47-49). The possible justification could be due to the hemodynamic instability caused by myocardial infarction and reduced effective blood flow to the kidney in MI patients, particularly in those with cardiogenic shock, which can trigger AKI. More severe MI can lead to hemodynamic compromise (50, 51).

The findings of this study showed that the patients receiving higher levels of average peak inspiratory pressure≥ 35 cmH20 had a higher hazard of developing AKI compared to those who received low levels of average peak inspiratory pressure <35 cmH2O (AHR = 1.7; 95% CI: 1.102, 2.506). This study's finding was similar to the study conducted in Cleveland, USA(52) and The possible reason could be that the proposed mechanism of high intra-thoracic pressure from elevated peak inspiratory pressure and ventilator interaction in reducing cardiac output. This may lead to subsequent gas exchange impairment, hypoxia, hypercarbia and acidosis, which alter renal vascular resistance and renal perfusion pressures, leading to AKI. Further ventilated-induced lung injury from high pressure may propagate multi-organ failure due to inflammatory mediators and hemodynamic compromise. This is supported by previous scientific evidence(52, 53).

Regarding the timing of tracheostomy late tracheostomy after intubation was found to be a significant predictor of developing AKI among mechanically ventilated ICU patients. Hence, mechanically ventilated ICU patients who had late initiation of tracheostomy after intubations had two times higher risk of developing AKI compared to the early tracheostomy after intubation (AHR=2;95% CI: 1.059, 3.703). This study was supported by a study conducted in Japan, in which late tracheostomy was significantly associated with multi-organ failure(54). The possible justification might be due to delayed tracheostomy after prolonged mechanical ventilation caused prolonged laryngeal intubations, which extended the administration of sedation and opioids, which prolonged the ventilation and ICU stay, which resulted in ventilated-associated complications like

AKI(55). We could not find a direct association between the timing of tracheostomy (early and late) after intubation and AKI among ventilated ICU patients. Future control studies are needed to assess the relationship between the timing of tracheostomy and the development of AKI among critically ill patients.

The other factor that was independently associated with the development of AKI among mechanically ventilated ICU patients was the length of ventilation during the follow-up period. The hazard of developing AKI was about eight times higher among patients with longer ventilation (≥15 days) as compared to those who had a shorter length of ventilation9< 15 days) (AHR= 8.3; 95% CI 4.760, 14.569). This finding was supported by a study conducted in Taiwan(56)that reported prolonged mechanical ventilation was associated with poor patient outcomes. Other previous reports indicated that prolonged mechanical ventilation was a predictor of mortality(57). However, further studies are required to investigate the relationship between the duration of mechanical ventilation and AKI among mechanically ventilated intensive care unit patients.

Limitations of the study

As far as we are aware, this is the first study in Ethiopia that looks at the incidence of AKI among mechanically ventilated ICU patients. This study was subject to some limitations, including its retrospective nature of the study, limited sample size, and lack of evaluation of the impact of body mass index, inspiratory to expiratory ratio, fluid balance, and arterial blood gas analysis due to the use of secondary data that was not recorded in the patient's charts.

Conclusion

The study found that 65% of the 350 mechanically ventilated intensive care unit (ICU) patients developed Acute Kidney Injury with an incidence rate of 28.1 (95%CI: 24.6, 32.0) per person-day of observations. The study also found significant risk factors for developing AKI including known hypertension, myocardial infarction, high peak inspiratory pressure, late tracheostomy, and prolonged mechanical ventilation.

Recommendations:

This study recommends that clinicians implement strict blood pressure control, perform tracheostomy at the earliest possible time, monitor and adjust mechanical ventilation settings, and implement strategies to reduce the length of the mechanical ventilation. By implementing these

recommendations, physicians and nurses can reduce the incidence of AKI and improve patient outcomes in mechanically ventilated intensive care unit settings.

The study recommends that the Ministry of Health and policymakers Given that the prevalence of AKI is high, they ought to introduce policies supporting healthcare services in the ICU and Patients' quality care. For researchers: Further research that triangulates qualitative findings must provide strong evidence.

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APPENDIX 1

CHECKLIST Extraction

Part I: Questions to assess socio-demographic data

S.No	Question	Response	Code
101	Age	_____(in years)	
102	Sex	0. Male 1. Female	
103	If Female, is she pregnant?	0. no 1. yes	
104	Residence	0. Urban 1. Rural	

Part II: Questions to assess the clinical & laboratory-related variables of the study

S.No	Question	Response	Code
	Date of ICU Admission	----------	
	ICU admission reason	1 medical 2. surgical reason	

	Reason for icu Admission	CAP, ARDS, Asthma, COPD, CAD, Ca, Sepsis, trauma, postoperative, and others……	
201	The severity of the disease	0. Moderate 1. Severe	
202	Average baseline SBP	----------	
203	Average baseline DBP		
204	Average baseline MABP		
205	Average baseline PR		
206	Average baseline RR		
207	Average baseline Temperature		
208	Average baseline saturation		
209	Average baseline UOP		
210	End of ff Average MAP		
211	End of ff Average PR		
212	End of ff Average RR		
213	End of ff Average SO2		
214	End of ff Average UOP		
215	Is there any comorbidity	1.No 2. yes	
216	If yes, specify	DM, HTN, CAD, COPD, ASTHMA, Malignancy, HIV/AIDS, Stroke, TB, OBESITY OTHERS	
	Laboratory related Variables		
217	Baseline cr.		
218	Baseline BUN.		
219	Baseline WBC		
220	Baseline PLT		
221	Baseline Hgb		
222	Baseline Albumin		
223	Baseline Na		

224	Baseline K		
225	Baseline Ca		
226	End of ff cr. level		
227	End of ff BUN.		
228	End of ff WBC		
229	End of ff PLT		
230	End of ff Hgb		
231	End of ff Albumin		
232	End of ff Na		
233	End of ff K		
234	End of ff Ca		
Part III **Mechanical Related variables**			
301	Date of MV initiation	--------	
302	Indication of MV	Airway protection, RF, Impending RF	
303	Method of Ventilation	1 IV 2. NIV	
304	If NIV,	1 CPAP 2 BiBAP	
305	IF invasive, tracheostomy done	1 No 2 Yes	
306	Duration of tracheostomy	1 Early 2 late	
307	Mode of ventilation	PCV, VCV, PRVC, SIMV, CPAP	
308	Avarge TV		
309	Average PIP		
310	Average PEEP		
311	Average FIO2		
312	Length of MV		
Part IV Management-Related Variables			
401	Taking Antibiotics	1 No 2 Yes	
402	If yes specify	Meropenem, vanco, ceftazidine, Gentamycine, streptomycine, Cipro, Metrondazole, …….	
403	Antifungal	1 No 2 yes	

404	Antiviaral	1 No 2 yes	
405	Vasopressor	1 No 2 yes	
406	If yes	2. single 2. double vaspressor	
407	Sedation	1 No 2 yes	
408	If yes …….	Ketamine, propofol, diazepam,	
409	Dirutics	1 No 2 yes	
410	Anti-HTN	1 No 2 yes	
411	NSAID	1 No 2 yes	
412	Statine	1 No 2 yes	
413	Trombophlaxisis	1 No 2 yes	
414	Complications	1 No 2 yes	
415	If yes, specify	Delirium, HAI, Arrthemia, shock, Pneumothrax, Thromboembolism, Bedsore, GI bleeding, AKI……	
416	Occurrence of AKI	1 No 2 yes	
417	Date of end of follow-up		
418	The end outcome of the patients	Recovery, transfer, death, stay within the ICU	
419	The end outcome of AKI pts	Recovery, transfer, death	