



ST. PAUL HOSPITAL MILLENNIUM MEDICAL COLLEGE

GRADUATE STUDY PROGRAM

SURVIVAL STATUS AND PREDICTORS OF MORTALITY AMONG
MECHANICALLY VENTILATED PATIENTS IN THE INTENSIVE CARE UNIT AT ADDIS ABABA,
ETHIOPIA, 2022: A ONE YEAR RETROSPECTIVE COHORT STUDY

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ADDIS ABABA, ETHIOPIA

AUGUST, 2023



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A THESIS SUBMITTED TO THE DEPARTMENT OF INTENSIVE CARE MEDICINE, PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF RESPIRATORY CARE PRACTITIONER IN ST. PAUL HOSPITAL MILLENNIUM MEDICAL COLLEGE.

ADDIS ABABA, ETHIOPIA

AUGUST, 2023

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Full title of the research project	Survival Status and Predictors of Mortality Among Mechanically Ventilated Patients in the ICU, Addis Ababa, Ethiopia, July 1, 2021–June 30, 2022
Duration of the research project	From March 1, 2023 – March 20, 2023
Study Area	Selected hospital of Addis Ababa, Ethiopia
Total Cost of the project	38,000.00 birr
Source(s) of Funding	Not applicable
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Abstract

Background: Globally, potential demand for invasive mechanical ventilation is increasing, and the incidence of mortality among critically ill patients after mechanical ventilation support is reported to be high, though this is not exactly figured out yet in our country's context. However, there is limited data on the extent of the problem in Ethiopia. Therefore, this study aimed to investigate the survival status and predictors of mortality in mechanically ventilated patients who were admitted to the adult ICU of a governmental hospital in Addis Ababa, Ethiopia.

Objective: The objective of this study was to determine survival status and predictors of mortality among mechanical ventilated patients in ICU, Addis Ababa, Ethiopia, from July 1, 2021, to June 30, 2022.

Methods: A multicenter retrospective cohort study was conducted on 382 mechanically ventilated patient charts admitted to the adult ICU of four selected government hospitals in Addis Ababa, Ethiopia. Participants were selected by using simple random sampling techniques from March 1, 2023, to March 20, 2023. The data were entered into Epi Data Manager V4.2 and exported to Stata/MP V-14 for analysis. Bi-variable and multivariable Cox regression models were fitted in the analysis to determine the predictor variables. A hazard ratio (HR) with a 95% confidence interval (CI) was computed, and a p-value 0.05 was considered statistically significant.

Results: The overall mortality among mechanically ventilated patients in the adult ICU was 67.0%, with an incidence rate of 9.23 cases (95% CI, 8.14–10.46) per 100 person-days of observation, and the median survival time was found to be 6 days. Increased systolic blood pressure (AHR = 2.11, 95% CI: 1.23, 3.61), elevated diastolic blood pressure (AHR = 0.25, 95% CI: 0.12, 0.53), HIV infection (AHR = 2.81, 95% CI: 1.62, 4.88), GCS at the end of follow-up (AHR = 19.29, 95% CI: 8.46, 43.99), serum albumin (AHR = 0.66, 95% CI: 0.46, 0.96), and creatinine level (AHR = 1.17, 95% CI: 1.12, 1.35) were found to be significantly associated with mortality of mechanically ventilated patients in the adult ICU.

Conclusions and Recommendation: The mortality rate of mechanically ventilated patients in the adult ICU was high. Blood pressure, HIV infection, GCS, serum albumin, and creatinine level were the identified predictors of mortality in my study. Further prospective study in the future is needed, with the inclusion of other important predictive variables like malnutrition, body mass index, smoking habit and others, is advocated for better result.

Keywords: Survival, Predictors, Mortality, Mechanical ventilator, Retrospective cohort.

Acknowledgements

First and foremost, I would like to thank the Almighty God for His plentiful mercies and love. I would like to thank St. Paul Hospital Millennium Medical College School of Nursing, Department of Respiratory Therapy, and Critical Care Medicine for giving me this chance and providing support to develop this thesis.

Secondly, my deepest gratitude and special thanks go to Rahel Mezemir (BSc, MSc, and Assistant Professor) and Solomon Oljira (BSc, MSc) for their support and guidance throughout this work.

My thanks also go to the data collectors and chart extractors. Mr. Tolosa Diriba (MSc, Lecturer) for his valuable support during data analysis and interpretation. Last but not least, my appreciation goes to Tenalem Anteneh and Meli, my sister, for their support throughout this thesis's development.

Table of Contents

ACRONYMS AND ABBREVIATIONS	VI
1. INTRODUCTION	1
1.1. BACKGROUND	1
1.2. STATEMENT OF THE PROBLEM	2
1.3. SIGNIFICANCE OF THE STUDY	3
2. LITERATURE REVIEW.....	4
2.1. THE MAGNITUDE OF MORTALITY AMONG MECHANICALLY VENTILATED PATIENTS ADMITTED TO THE ICU.....	4
2.2. PREDICTORS OF MORTALITY AMONG MECHANICAL VENTILATED PATIENTS IN ADULT ICU.....	6
2.3. CONCEPTUAL FRAMEWORK.....	10
3. OBJECTIVES	11
3.1. GENERAL OBJECTIVE:	11
3.2. SPECIFIC OBJECTIVES:.....	11
4. METHODS.....	12
4.1. STUDY AREA AND PERIOD	12
4.2. STUDY DESIGN	13
4.3. SOURCE POPULATION	13
4.4. STUDY POPULATION:	13
4.5. ELIGIBILITY CRITERIA.....	13
4.5.1. Inclusion criteria:	13
4.5.2. Exclusion criteria:	13
4.6. SAMPLE SIZE AND SAMPLING PROCEDURES:	13
4.6.1. Sample size determination	13
4.6.2. Sampling Procedures:	18
4.7. STUDY VARIABLES:	19
4.7.1. DEPENDENT VARIABLE:.....	19
4.7.2. INDEPENDENT VARIABLE.....	19
4.8. OPERATIONAL DEFINITIONS:	19
4.9. DATA COLLECTION TOOL AND PROCEDURES:	19
4.10. DATA QUALITY CONTROL AND MANAGEMENT:	20
4.11. DATA PROCESSING AND ANALYSIS:	20
4.12. ETHICAL CONSIDERATION:	21
4.13. DISSEMINATION OF RESULTS:.....	21
5. RESULTS	22
5.1. SOCIODEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS.....	22
5.2. CLINICAL CHARACTERISTICS OF MECHANICALLY VENTILATED PATIENTS IN ICU	23
5.3. THE MORBIDITY RELATED CHARACTERISTICS OF STUDY PARTICIPANTS.....	26
5.4. MECHANICAL VENTILATOR RELATED CHARACTERISTICS OF STUDY PARTICIPANTS	28
5.5. TREATMENT RELATED CHARACTERISTICS OF STUDY PARTICIPANTS	29
5.6. TIME TO DEATH OF CRITICAL ILL PATIENTS ON MECHANICAL VENTILATION	29
5.7. LOG-RANK TEST FOR MORTALITY PREDICTORS.....	31
5.8. PREDICTORS OF MORTALITY AMONG PATIENTS ADMITTED TO INTENSIVE CARE UNIT.....	34
6. DISCUSSION	39

7. LIMITATION OF THE STUDY:	41
8. CONCLUSION:	42
9. RECOMMENDATION	42
10. REFERENCE	44
11. ANNEXES	50

Acronyms and Abbreviations

AHR	Adjusted Hazard Ratio
ARDS	Acute Respiratory Distress Syndrome
AKI	Acute Kidney Injury
CHR	Crude Hazard Ratio
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Corona Virus Disease of 2019
CKD	Chronic Kidney Disease
DM	Diabetes Mellitus
ETT	Endotracheal Tube
GCS	Glasgow Coma Scale
HAI	Hospital Acquired infection
HTN	Hypertension
ICU	Intensive Care Unit
IMV	Invasive Mechanical Ventilation
IQR	Interquartile Range
IRB	Institutional Review Board
MRN	Medical Record Number
MV	Mechanical Ventilation
PRVC	Pressure Regulated Volume Control
RF	Respiratory Failure
SPHMMC	Saint Paul Hospital Millennium Medical College

LIST OF TABLES

Table 1: Sample size calculated for predictor variables	18
Table 2: Sociodemographic characteristics of mechanical ventilated patients in ICU at Addis Ababa, 2022..	22
Table 3: Clinical characteristics of patients at intubation and extubation	24
Table 4: The Morbidity related characteristics of study participants	27
Table 5: Mechanical ventilator related characteristics of study participants	28
Table 6: Treatment related characteristics of study participants	29
Table 7: Log-rank test for mortality predictors among Mechanical ventilated patients admitted to the ICU, Addis Ababa	31
Table 8: Multivariable Cox regression analysis for mortality predictors among Mechanical ventilated patients admitted to the ICU, Addis Ababa	36

LIST FIGURES

Figure 1: Conceptual framework of survival status of patients admitted to ICU and mechanically ventilated.
..... 10

Figure 2: A diagram representation of proportion allocation sample Size..... 15

Figure 3 A Kaplan–Meir failure estimates of patients admitted to ICU..... 30

1. INTRODUCTION

1.1. Background

In modern medicine, the initial use of ventilators was endorsed by Doctor Bjorn Ibsen for the first time in Copenhagen in 1953. The mechanical ventilator saved polio patients dying with respiratory failure, and mortality dropped from 87 percent to 25 percent (2).

A mechanical ventilator is a device that takes over the work of breathing when an individual cannot breathe sufficiently on their own (3). For seriously ill patients, mechanical ventilation is recognized as the foundation of respiratory life support(1). Invasive mechanical ventilation (IMV) requires the insertion of a plastic or metal tube into the patient's airway (4).

An intensive care unit (ICU) is a unit in a hospital where seriously ill patients are cared for by specially trained staff. It is a well-resourced, isolated, and self-contained area of a health facility aimed at patients with life-threatening conditions. It provides intensive and specialized medical and nursing care, enhanced monitoring capabilities, and multiple modalities of physiologic organ support to sustain life during a period of potentially fatal organ system insufficiency (1).

Globally, there are much more individuals who need MV, particularly those who are older and have other medical conditions. The main goals of MVs are to enhance pulmonary gas exchange and reduce respiratory discomfort. Despite its significance, patients who are placed on ventilators are more likely to have consequences that may be avoided, such as ventilator-associated pneumonia, pneumothorax, pulmonary embolism, and atelectasis (5).

An aging population and a rise in chronic respiratory disorders are predicted to drive up demand for mechanical ventilators globally. In the US, the average daily cost for a patient on mechanical ventilation is thought to be roughly \$2,300. Acute respiratory distress syndrome (ARDS) strikes 20–30% of mechanically ventilated patients during their ICU stay. A mechanically ventilated patient typically stays in an intensive care unit (ICU) for 7 to 11 days on average. Early movement in mechanically ventilated patients may shorten their need for mechanical ventilation and enhance their functional results, according to research (6).

Comorbidities, advanced age, diabetes mellitus, delirium, shock, length of stay of more than two weeks, GCS of less than 9, and acute respiratory distress syndrome were found to be the main predictors of mortality among mechanically ventilated patients in intensive care units, according to a study carried out in various regions of Ethiopia (4,5,7).

According to studies done in Addis Ababa, Egypt, and Atlanta, USA, the death rate for patients receiving invasive mechanical ventilation in intensive care units was 60.7%, 64%, and 33.9%, respectively(8–10).

There is limited information available regarding the time to death and predictors of mortality among mechanically ventilated patients admitted to the ICU. Therefore, this study aimed to determine the survival status and predictors of mortality among mechanically ventilated patients in adult ICUs of selected public hospitals in Addis Ababa.

1.2. Statement of the Problem

Mechanical ventilation is considered a pillar and cornerstone of respiratory life support among critically ill patients. Many of the individuals who require artificial breathing right now need critical care. The major goals of mechanical ventilation are to improve pulmonary gas exchange and decrease respiratory discomfort, which will speed up lung and airway recovery while lowering the risk of iatrogenic consequences (1).

In the ICU, over 40% of patients require mechanical ventilation. In the US, 50,000 patients utilize ventilators on a daily basis. The total mortality rate of mechanically ventilated patients ranges from 35% to 60%, depending on the cause of respiratory failure. (6).

Worldwide, mortality rates in critical care services range from 9 to 61%. Among patients who had invasive mechanical ventilation, hospital mortality was 29.7%, while mortality in the ICU is 28.5% in Atlanta, Georgia. Africa has an ICU mortality rate that is higher than average compared to the other industrialized continents, ranging from 32.9 to 54% (11,12).

In Ethiopia, the range of the ICU mortality rate was between 27 and 38%. A growing pandemic, urbanization, and hospital development have all contributed to a significant increase in the burden of life-threatening illnesses requiring intensive care units in low-income countries. A study conducted in southern Ethiopia showed that the mortality rate at Dilla University (55.4%), Wolaita Sodo University (47.1%), and Hawassa University (38.4%) In Ethiopia, the rate of ICU mortality varied from region to region (13).

study conducted in Ethiopia, 2022 Male gender, comorbidities, length of stay, mechanical ventilation, vasopressor support, low arterial oxygen saturation level (SpO₂ 90%), cardiac arrest in ICU, septic shock, ARDS, infection, trauma, GCS score below 9, necessitating antibiotics in ICU, hyperthermia upon admission to ICU, and aspiration during ICU stay were all screened and identified as potential predictors of mortality in ICU (14).

Patients who use a mechanical ventilator are more likely to experience a number of consequences, including ventilator-induced lung injury, ventilator-associated pneumonia, and other nosocomial infections, pressure ulcers, gastritis, and prolonged hospital stays. Mechanical ventilation support is inversely correlated with an increased risk of experiencing these problems (15)

The primary goal of this research was to determine time to death and predictors of mortality of mechanically ventilated adult ICU patients in selected public hospitals in Addis Ababa. There is high incidence of mortality rate among ICU admitted patients, but there is limited data that describes the survival of ICU patients related to mechanical ventilators. Since mechanical ventilation is the most significant ICU intervention, it was crucial to determine its results and identify the contributing elements to improve the standard of care.

To my knowledge, this is the first study to describe time to death and predictors of mortality in adult patients mechanically ventilated in the ICU of selected public hospitals in Addis Ababa, Ethiopia. Therefore, this study aimed to determine the survival and predictors of mortality of mechanically ventilated patients in the adult ICU of selected public hospitals in Addis Ababa.

1.3. Significance of the Study

The study of survival status and predictors of mortality in patients on mechanical ventilation is important for better utilization of resources and identifying the contributing elements for better outcomes.

It may have an impact on the quality of patient care and may help improve patients' mechanical ventilation management protocols. This can improve the outcome of the patients and shorten the duration of their mechanical ventilation stay.

Therefore, the outcome of the study hopefully provide input for health care professionals and higher-level officials in developing appropriate interventions to achieve the ultimate goal of mechanically ventilating patients receiving respiratory support.

In addition, it would be directed to ICU care providers to avoid unclear inferences regarding factors leading to mortality among mechanically ventilated patients, which could allow for improved patient survival and decrease the economic burden on the country as well. Furthermore, other researchers would use the research findings as input for prospective and interventional studies.

2. LITERATURE REVIEW

2.1. The magnitude of mortality among mechanically ventilated patients admitted to the ICU

An observational cohort study conducted at three Emory Healthcare acute-care hospitals in Atlanta, Georgia, showed that among patients, who received invasive mechanical ventilation, ICU mortality was 28.5% and hospital mortality was 29.7%. The median age of patients who died was significantly older than that of those who survived for 70 years (10).

A retrospective cohort study conducted in Colombia in 2017–2018 revealed that 65.8% of individuals who underwent mechanical ventilation died during hospitalization after a mean of 13.1 ± 13.9 days of total hospitalization and 9.1 ± 11.1 days in the ICU (16).

A prospective cohort study conducted in the Journal of the American Medical Association showed that survival among mechanically ventilated patients depends not only on the factors present at the start of mechanical ventilation but also on the development of complications and patient management in the intensive care unit(17) .

Evidence from a systematic review showed that ICU mortality rates for ventilated patients older than 60 years in the ICU were 9.8% and 51.0%, respectively. One of the highest fatality rates (77.8%) was observed in an ICU study of patients older than 80 years old (18).

A retrospective cohort study was conducted at King Abdul-Aziz Medical City (KAMC) in Riyadh, Saudi Arabia. Patients who received mechanical ventilation had a mortality rate of 37%, with a median survival time of 11 days. The mean age of those patients was 57 years, and the majority were male (64%). The overall survival rate was 82% after the fifth day and 75% after the tenth day(19).

The study conducted in South India showed that mortality in mechanically ventilated patients was 71.5 percent, and of those patients, 28.5 percent survived (20).

A retrospective cohort study conducted in an intensive care unit in San Jose Hospital, Colombia, showed that a total of 357 patients were analyzed. The average age was 64.8 ± 18.9 years; the administration of systemic corticosteroids was associated with a higher probability of survival (14). A retrospective cohort study conducted at Natal, Brazil, revealed that among patients who were admitted to the ICU, 23.6% died (16).

A prospective study conducted in the Intensive Care Unit of the University of Benin Teaching Hospital, Nigeria, revealed that Patients who were mechanically ventilated in the ICU had a 4-fold increased risk of mortality compared with non-ventilated patients. The overall mortality of patients admitted to the ICU during this 6-month period was 63.6% (21).

A retrospective cohort study conducted in Egypt from January 2010 to December 2014 revealed that patients on mechanical ventilation had a 64% mortality rate. Invasive ventilation resulted in a greater mortality rate than noninvasive ventilation. Patients with failed weaning had greater mortality(9).

In a retrospective cohort study conducted in Kenya from January 1, 2013, to April 5, 2015 of 450 patients, ICU mortality was 53.6% and 30-day mortality was 57.3%. Most patients were male (61%), and the median age was 29 years. Causes associated with high adjusted odds of mortality were as follows: ages 35–49 years, and age above 50 years (22).

A multi-center retrospective cohort study conducted in Hamburg, Germany, from February to June 2020, showed that, the ICU mortality was 35% and 44% among mechanically ventilated patients (23).

A Retrospective cross-sectional study was conducted at Saint Paul's Hospital Millennium Medical College (SPHMMC), from June 2013 to June 2018, showed that the mortality rate was 57.1% among mechanically ventilated patients(24).

A retrospective cohort study conducted in patients admitted to the ICU settings of the COVID-19 Care Centers in Addis Ababa, Ethiopia, showed that the overall mortality rate among mechanically ventilated COVID-19 patients was 63.3%(4).

An institutional-based cross-sectional study conducted at Selected Public Hospitals in Addis Ababa, Ethiopia, showed that the mean duration of stay on the ventilator was 7.09 ± 6.06 , and the mortality rate in mechanically ventilated patients was 41.7% (5).

A multi-center cohort study conducted in three teaching referral hospitals in southern Ethiopia showed that the ICU mortality rate was 46.8%. The overall ICU mortality rate in southern Ethiopia was higher than studies carried out in other regions of Ethiopia, including Addis Ababa (39%), Gondar (38.7%), Jimma (37.7%), and Mekelle (27%).(13)

A retrospective cross-sectional study conducted on the outcome of mechanical ventilator use and associated factors at St. Paul's hospital's Millennium Medical College medical intensive care unit (ICU) showed that mortality was 57.1% among mechanically ventilated patients(24) .

A one-year retrospective inception cohort study was conducted using manual chart review in ICU patients (age >13) admitted to Tikur Anbessa Specialized Hospital (Addis Ababa, Ethiopia) and revealed that ICU mortality in ventilated patients is significant. ICU and hospital mortality were 60.7% and 63.1%, respectively (24).

2.2. Predictors of Mortality among mechanical ventilated patients in adult ICU

An observational cohort study conducted at three Emory Healthcare acute-care hospitals in Atlanta, Georgia, showed that comorbid conditions were hypertension, diabetes, and obesity with a body mass index (BMI) of 40 or greater (12).

A retrospective cohort study conducted in Colombia showed that the main factors associated with shorter survival were advanced age. The most frequent admission diagnoses were septic shock, trauma that required a tracheostomy, suffering an HAI, having diabetes mellitus, and requiring support with vasopressors or inotropes, which were associated with a lower probability of survival (16).

A retrospective cohort study conducted at King Abdul-Aziz Medical City (KAMC) in Riyadh, Saudi Arabia, revealed that mortality predictors were ARDS, pneumonia, intracranial hemorrhage (ICH), sepsis, postoperative condition, COPD, cardiac disease, post-cardio-Cerebral- Resuscitation (CPCR), cerebral infarction, and being aged 51–60(19).

The study conducted in a tertiary teaching hospital in South India showed that predictors of mortality in mechanically ventilated patients' Two hundred patients were enrolled in the study. (28.5%) were women, and 137 (68.5%) were men. From those patients, 71.5 percent died, and from those patients, 28.5 percent survived (20).

A retrospective cohort study conducted in an intensive care unit in San Jose Hospital, Colombia, showed that the administration of systemic corticosteroids was related to a higher chance of survival in critically ill patients who needed invasive mechanical ventilation in an intensive care unit. Sepsis/septic shock, heart failure, and trauma (17.4%) were frequently diagnosed (16).

A retrospective cohort study carried out in Brazil in the ICUs, Infection, acute respiratory insufficiency, acute myocardial infarction, dyspnea, cyanosis, edema, and comorbidities not directly related to the current hospitalization were not considered predictors for the death of the elderly persons in the ICU in the present study (25).

A retrospective cohort study conducted in Egypt showed that patients with cardiac conditions had a greater mortality rate than those with respiratory, nervous system, or septic shock conditions. Higher tidal volumes, higher FiO₂ levels, and lower positive end-expiratory pressure levels were associated with increased mortality (9).

A multi-center retrospective cohort study conducted in Hamburg, Germany, revealed that among critically ill adult patients with COVID-19, survival to ICU discharge was 65%, and of 223 critically ill patients, 56% required MV. Septic shock (40%), heart failure (8%), and pulmonary embolism (6%) The length of ICU stay was a median of 13 days, and the duration of MV was 15 days (23).

According to retrospective cohort research carried out in Kenya, factors that were found to be significant predictors of ICU death included age greater than 50, sepsis, acute stroke, acute respiratory failure, and vasopressor support (26).

An institutional-based cross-sectional study conducted at selected public hospitals in Addis Ababa, Ethiopia, showed that the mean duration of stay on the ventilator was 7.09 6.06 and the mortality rate in mechanically ventilated patients was 41.7%. The mortality rate was higher in patients with cardiac diseases (57.70%). Inotropic use, not taking sedation, and length of stay on a mechanical ventilator were independently associated with mortality (5).

A retrospective follow-up study conducted in Dessie Hospital showed that diagnosis category, oxygen saturation, presence of comorbidities, Glasgow coma scale, and use of tracheostomy were statistically significant with survival status (27).

A one-year retrospective inception cohort study was conducted using manual chart review in ICU patients (age >13) admitted to Tikur Anbessa Specialized Hospital (Addis Ababa, Ethiopia). Coma (Glasgow Coma Score 8 with an endotracheal tube (7T), cardiovascular diagnosis, and a very low serum albumin level (2 g/dl) were independent predictors of mortality(8) .

In a multi-center cohort study conducted in three teaching referral hospitals in southern Ethiopia, independent predictors of mortality were cardiac arrest, aspiration, being on a mechanical ventilator, hypoxemia upon admission, low GCS, usage of antibiotics, and duration of stay (13).

A retrospective cohort study on survival status and predictors of mortality among mechanically ventilated patients conducted in Addis Ababa, Ethiopia COVID-19 Care Centers, Distribution of Comorbidities, and Baseline Investigation Findings showed that 314 patients had at least one chronic medical illness, of which 78.7% have died. Conversely, 36.8% of patients who did not have any chronic illnesses ended up dying due

to the COVID-19 infection. Diabetes mellitus (47%) and hypertension (43%) were the most frequently recorded comorbidities. The proportion of deaths was much higher among those with DM (84.5%) and HTN (81.3%) compared to patients who were free of DM (44.5%) and HTN (49.6%). Management and ventilator-related variables: after initiation of artificial ventilation, patients remain on a mechanical ventilator for a median of 10 days. In line with this, more than 55% of deaths were recorded within the first 10 days of MV initiation. According to the study results, 63.5% of patients were intubated. Pressure-regulated volume control (PRVC) was the most widely used (63.5%) mode of ventilation for intubated patients. Overall, 181 (36.5%) patients were ventilated only with the non-invasive method of ventilation, of whom 29 (16%) died. In contrast, 285 (90.5%) deaths were recorded among patients who received invasive ventilator support. The study results also showed that 71.8% (356/496) of study subjects developed ICU complications. All 496 (100%) study subjects received steroid therapy and thromboprophylaxis. The presence of diabetes, shock, and delirium was significantly associated with increased mortality (4).

A retrospective cross-sectional study conducted on the outcome of mechanical ventilator use and associated factors at St. Paul's Hospital Millennium Medical College's medical intensive care unit (ICU) showed that Type I respiratory failure was the commonest indication for mechanical ventilation seen in 97.2% of patients (pneumonia (48.4%), ARDS (32.1%), and septic shock (16.7%)), and the remaining 2.8% were Type II respiratory failure (24).

A cross-sectional study done in three public hospitals in Ethiopia showed that the initial ventilator modes that were used the most frequently were A/C VCV (51.1%), followed by A/C PCV (23.3%), SIMV (19.4%), and CPAP (5%), hypertension (14.4%), diabetes mellitus (10%), HIV/AIDS (7.8%), tuberculosis (3.3%), CHF (5%), stroke (2.8%), and others. 7 (5.6%), the GCS of patients at admission was 8 (37.8%), 9–12 (26.7%), and for the remaining (35.6%) patients, the GCS was from 13 to 15 (5) .

A systematic review and meta-analysis study conducted in Ethiopia, 2022 Male gender, comorbidities, length of stay, mechanical ventilation, vasopressor support, low arterial oxygen saturation level (SpO₂ 90%), cardiac arrest in ICU, septic shock, ARDS, infection, trauma, GCS score below 9, necessitating antibiotics in ICU, hyperthermia upon admission to ICU, and aspiration during ICU stay were all screened and identified as potential predictors of mortality in ICU (7)..

A retrospective study conducted at Hawassa University Comprehensive Specialized Hospital, Ethiopia, the average length of stay spent in the ICU was 3.0 (IQR 1.0 - 6.0). 45.8% of the 310 total patients—died in the intensive care unit. 17.7% of the patients had a lower state of awareness (GCS9) at the time of admission. A third or more of the patients were suffering from shock in some way. 23.5% of the patients out of 310

needed mechanical ventilator assistance. In addition, 42%, of patients experienced acute kidney damage (AKI). 5.3% of the research participants who had hospital-acquired infections reported them. 23.9% of the 310 patients in total experienced aspiration pneumonia. 53.5% of the patients with Respiratory failure were the immediate cause of death (28).

2.3. Conceptual Framework

The conceptual framework for the study was adapted after reviewing the mechanical ventilator guidelines and different literature and articles that are related to the subject matter. It consists of five components that will be related to the main outcome variable (survival status) and predictors of mortality, showing the interaction between socio-demographic, morbidity, clinical, treatment, and mechanical ventilator variables and the association between dependent and independent variables (4,5,8,9).

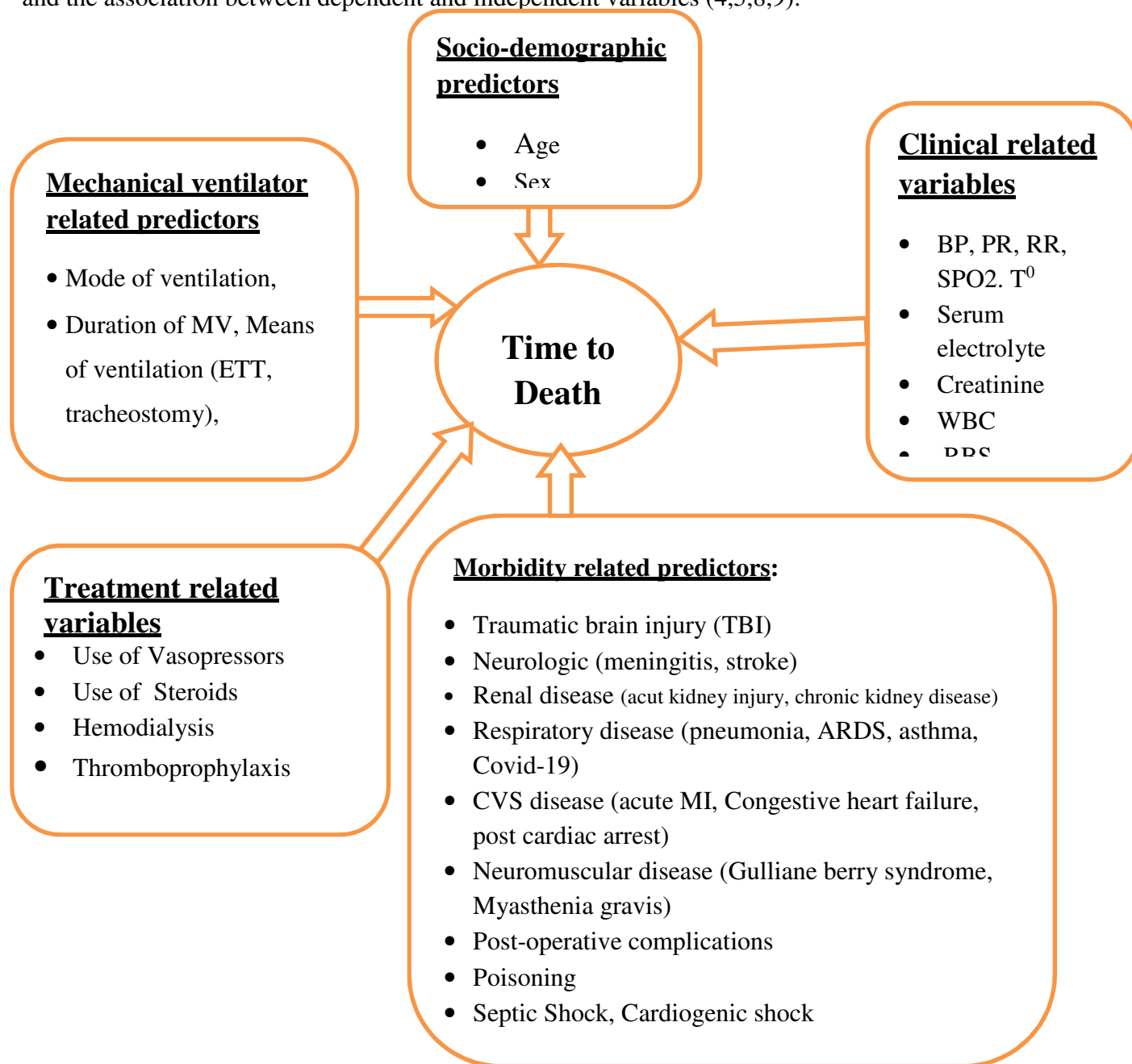


Figure 1: Conceptual framework of survival status and predictors of mortality among mechanically ventilated patients admitted to ICU

3. OBJECTIVES

3.1. General Objective:

To Assess Survival Status and Predictors of Mortality Among Mechanical Ventilated Patients in ICU, Addis Ababa, Ethiopia, from July 1, 2021, to June 30, 2022.

3.2. Specific objectives:

To determine time to death among mechanically ventilated patients in the ICU of Addis Ababa, Ethiopia, from July 1, 2021, to June 30, 2022.

To identify predictors of mortality among mechanically ventilated patients in the ICU, Addis Ababa, Ethiopia.

4. METHODS

4.1. Study area and Period

Addis Ababa, which is the capital city of Ethiopia and the seat of the African Union, The city encompasses 40 private hospitals, 86 health centers, and 13 public hospitals.

Among 13 public hospitals, six are administered by the Addis Ababa Health Bureau, four are administered by the Federal Ministry of Health, and one is administered by Addis Ababa University. The remaining two hospitals (Balcha and Defense Force Hospital) are under self-administration. Amanuel Hospital is excluded due to a lack of ICU service; Balcha Hospital and Defense Force Hospital were also excluded from the study due to self-administration. The study was conducted in four selected public hospitals. Those hospitals (St. Peter Hospital, SPHMMC, Ras Desta Hospital, and Yekatit 12 Hospital Medical College) were selected by simple random sampling.

St. Peter Hospital is one of the federal government's specialized hospitals in Addis Ababa, located in Gullele sub-city. And the hospital has a capacity of 292 beds and a daily patient flow of 600–850 patients. ICU is one of the departments, which has 13 bed capacities with 13 ventilator machines, and profession-wise, there are 28 nurses (BSc, adult MSc nurse, and ECCN), 6 GPs, 2 internists, and 2 anesthesiologists. The nurse-to-patient ratio is 1:1.

Yekatit 12 Hospital Medical College (Y12HMC) is one of the regional hospitals in Addis Ababa city government, located in Arada sub-city. The hospital has a capacity of 350 beds and a daily patient flow of 980–1150 patients. ICU is one of the departments, which has 8 bed capacities with 7 ventilator machines, and profession-wise, there are 28 nurses (BSc and ECCN), 6 GPs, 2 internists, and 2 anesthesiologists. The nurse-to-patient ratio is 1:1.

Ras Desta Hospital (RDH) is one of the regional hospitals in Addis Ababa's city government, located in Arada sub-city. The hospital has a capacity of 165 beds and a daily patient flow of 500–650 patients. ICU is one of the departments, which has six bed capacities with six ventilator machines, and profession-wise, there are 14 nurses (BSc and ECCN), 2 GPs, 1 internist, and 1 anesthesiologist. The nurse-to-patient ratio is 1:1.

SPMMC is one of the federal government hospitals in Addis Ababa, located in Gullele sub-city. The hospital has a capacity of 700 beds, but currently the number of functional beds is around 400, with a daily patient flow of 1000–1200 patients. ICU is one of the departments, which has a 15-bed capacity with 13 ventilator machines, and profession-wise, there are 58 nurses (BSc and ECCN), 6 RT, 10 residents, 2 intensivists, and

2 anesthesiologists. The nurse-to-patient ratio is 1:1. The study was conducted from March 1, 2023, to March 20, 2023.

4.2. Study Design

A Multi-Center Retrospective Cohort Study was conducted in four selected government Hospitals in Addis Ababa, Ethiopia.

4.3. Source population

All patients admitted in Adult ICU of selected public hospitals in Addis Ababa, Ethiopia.

4.4. Study Population:

The study population was all adult patients aged > 18 years old admitted to the ICU of a selected hospital and supported by MV from July 1, 2021, to June 30, 2022.

4.5. Eligibility criteria

4.5.1. Inclusion criteria:

Adult patients who were admitted to the ICU and received mechanical ventilation in selected hospitals in Addis Ababa, Ethiopia, from July 1, 2021, to June 30, 2022

4.5.2. Exclusion criteria:

Incomplete recordings of patient charts (missing discharge or death summary and date of initiation and end of mechanical ventilation) and lost cards

Charts of mechanically ventilated patients with less than 24 hours (Because some lab investigations, like serum albumin, creatinine, and serum electrolytes, are not available at this time due to financial constraints or unavailability of service.)

4.6. Sample Size and Sampling Procedures:

4.6.1. Sample size determination

Sample size calculations for survival status and predictors of mortality among mechanically ventilated patients at selected government hospitals in Addis Ababa for objectives one and two were determined, and the largest one was taken as the sample size for this research.

That is, the sample size for the first objective was calculated using the following data and assumptions: 95% confidence interval, 80% power, and hazard ratio (2.52) (7) the formula having two steps.

Step1:

$$E = \frac{(Z_{\alpha/2} + Z_{\beta})^2}{[\log HR]^2 p(1-p)} = \frac{(1.96 + 0.84)^2}{[\log 2.52]^2 0.5 * 0.5} = 195$$

Where

- E is number of expected events (death)
- $Z_{\alpha/2}$ is the significance level two sides (5% the value is 1.96)
- Z_{β} have the value of 80% power (0.84)
- HR is the hazard ratio (2.52) (7).
- P is the fraction of subjects allocated to the first group (by general cohort study expected ratio of 1 to 1 exposed-non exposed ratio)

$$\text{Step 2: } n = \frac{E}{p(E)} = \frac{194.6}{0.4497} = 432$$

Where; n is the number of subjects to be followed,

E-is the number of events (195) and P is the overall probability of an event (death) at the end of the study (44.97%)(7)

Since we have a total number of patients on mechanically ventilated in one year were 482 which is less than 10,000 correction formulas was required. By using the correction with adding 10% of non-response rate, the sample size became 251.

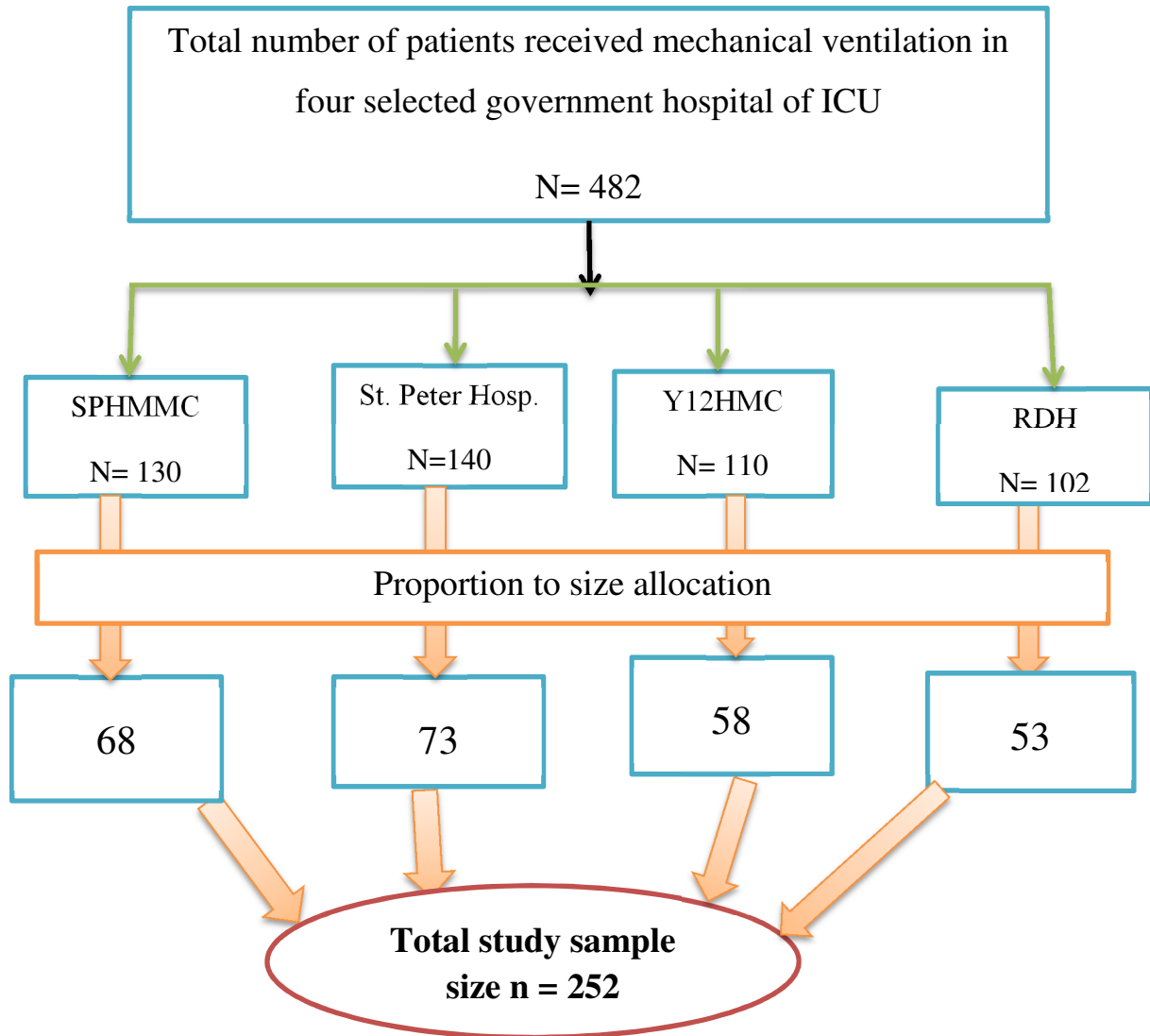


Figure 2: A diagram representation of proportion allocation sample Size

The sample size determined for objective two, which is predictors of death, is computed by Stata version 14 power analysis for the Cox proportional hazards model using data from several sources of literature. By taking into account the following assumptions: By using the general cohort study's CI of 95%, 80% power, and exposed to unexposed ratio of 1:1, as well as its covariate correlations of 0.5 and 0, respectively, the final sample size was 418. As a result, the sample size for this study was 418, making it the biggest sample size among those determined for the first and second objectives.

Table 1: Sample size calculated for predictor variables

Variable	Assumption	Cases in exposed group%	AHR	Sample size	Sample size after 10% non-response rate	Reference
Advanced age	Power: 80%	180/496	1.86	82	90	(4)
Spo ₂ at admission	CI: 95%	178/338	0.75	380	418	(29)
GCS 8 or below	Ratio 1:1	156/376	2.451	40	44	(27)

Where:

$Z_{\alpha/2}$ = is taking 95% CI, which is 1.96.

Z_{β} = 80% power

And r is the non-exposed to the exposed ratio (1:1)

By comparing the sample size of the first specific objective and the second specific objective, we obtained the larger sample size, which are 418.

4.6.2. Sampling Procedures:

To select the study participants from each hospital, the proportional allocation formula was used based on caseloads. There were about 482 mechanically ventilated adult patients (140 from St. Peter Hospital, 130 from SPHMMC, 102 from Ras Desta Hospital, and 110 from Yekatit 12 Hospital Medical College) from July 1, 2021, to June 30, 2022. Medical records of mechanically ventilated adult patients were taken from the identified cards in each hospital, and then a simple random sampling technique with a lottery method was carried out to get participants.

4.7. Study Variables:

4.7.1. Dependent variable:

- Time to death

4.7.2. Independent variable

- Socio-demographic variables: gender, age
- Management- or medication-related variables: vasopressors, steroid use, hemodialysis, thrombolytics, chest tube insertion
- Mechanical ventilator-related variables: means of ventilation (ETT, tracheostomy), mode of ventilation, duration of MV, length of stay on MV
- Morbidity-related variables: comorbidities (RF, AKI, CKD, ARDS, COPD, pneumonia, asthma, HTN, DM, CHF, DVT, cardiac arrhythmias, electrolyte imbalance, neuromuscular disease, sepsis, cardiogenic shock, septic shock, stroke, meningitis, seizure, malignancy, GBS), tachycardia, tachypnea, fever, hypoxia, COVID-19 infection, PTE, poisoning, pneumothorax, delirium, HAI
- Clinically related variables: BP, PR, RR, SPO₂, T⁰, serum electrolyte, creatinine, WBC, and RBS

4.8. Operational Definitions:

- **Time to Death:** For this study, time to death is from the patient's day of intubation up to the day of death and/or extubation.
- **Censored:** The patient's outcome during the study period: recovered patients, discharged to home, discharged against medical advice, or transfer out to other health institutions with an unknown outcome
- **Time scale:** the duration of an incident or censored instance will be measured in days.
- **Mechanical ventilation:** A patient is put on a mechanical ventilation machine invasively for breathing support and airway protection.
- **Survival status:** outcome of a patient; either death or censorship.
- **Mortality rate:** measures the occurrence of death in a defined population during a specific interval.

4.9. Data Collection Tool and Procedures:

The English-language version of the data extraction structured chart review checklist was adapted based on a literature reviews (4,5,7,9,13). The data source was secondary data from recorded documents (charts) and a computer database. Before the actual study, all ICU mechanically ventilated patients were roughly reviewed

(extracted) to identify the study subjects using the medical record number (MRN) obtained from the ICU admission and discharge registration logbook. Then, all charts that included the inclusion criteria were reviewed, and relevant data were extracted. The data extraction tool was comprised of socio-demographic, clinical/morbidity-related, machine-related, and management/medication-related variables. Four data collectors (BSc nurses, MSc ECCN) and two supervisors were recruited after a one-day training and orientation.

4.10. Data Quality Control and Management:

Prior to data collection, the data qualities were assured by applying designed and pre-tested data collection tool. The adapted data abstraction tool was commented by experienced researchers and advisors. And the tool was pre-tested in Zewditu hospital among 20(5%) of the sample size two week prior to the actual data collection to ensure the presence of the recorded variables in the patient's chart and to check its completeness, clarity, and consistence. As a result, the corrective measures were taken; some unrecorded variables were reduced from the data extraction tool before the actual time of data collection. In addition, training was given to data collectors and supervisors on the assessment tool as well as the study's goals and relevance in order to ensure the quality of the collected data. The data collection process was closely followed by supervisors and investigator. When collecting the data, the data collectors were advised to record a card number on the questionnaire in case further cross-checking was required.

4.11. Data Processing and Analysis:

Data were entered, coded, and cleaned using Epi Data Management V.4.2.2, and then transferred to STATA V-14 for data analysis. The nature of the data was determined via exploratory analysis (levels of missing values, presence of influential outliers, and normality). Depending on the type of data, frequency tables, percentages, graphs, means with standard deviations, or medians with interquartile ranges were used to represent the data. To compare survival differences and calculate the median survival time, the Kaplan-Meier curve was employed.

Bivariate analysis was performed using the Cox proportional hazard model to determine the relationship between each independent variable and the dependent variable (time to death). Variables with a p-value of 0.20 were considered for further analysis to identify the net effect of each variable on mortality. After all covariates and the whole model satisfied the proportional hazards assumption based on the global proportional hazards test using the Schoenfeld residual test with a value of $P > \chi^2 = 0.7537$, the data were fitted into the Cox regression model. Finally, based on an adjusted hazard ratio with a 95% CI and a p-value

< 0.05 , significance was declared, and the factors that had an independent association with poor outcomes were selected.

Multicollinearity occurs when predictor covariates in the cox-regression model are correlated. The relationship between each predictor variable and the outcome variable should be independent. Multicollinearity was tested using the VIF to check the variable inflation factor for each predictor variable. According to some guidelines, a VIF value less than 10 is considered an acceptable collinearity level. However, a VIF value greater than 4 needs further investigation. In my study, the maximum VIF value was 1.885, with a mean VIF of 1.40. Therefore, there was no multicollinearity.

4.12. Ethical Consideration:

The study was carried out after getting permission from the ethical clearance committee or institutional review board (IRB) of SPHMMC, and the Addis Ababa Health Bureau has approved the study's ethical conduct. Official letters of cooperation were sent to SPHMMC, St. Peter Hospital, Ras Desta Hospital, and Yekatit 12 Hospital Medical College. Since the study was done by looking through patient files, official letters were filed with the clinical director, and consent was obtained on behalf of patients to provide full access to information. To maintain anonymity and confidentiality, the patient's name was not mentioned in the questionnaire throughout the study process. Data coding and aggregate reporting were utilized to prevent the use of respondents' names or other forms of personal identification.

4.13. Dissemination of Results:

The findings of the study were submitted and presented to St. Paul Hospital Millennium Medical College. Also, the study results were distributed to SPHMMC, St. Peter Hospital, Ras Desta Hospital, Yekatit12 Hospital Medical College, Addis Ababa Health Bureau, and the Federal Ministry of Health with a copy of printed paper, as well as to other concerned bodies who wanted the study results legally either via presentation, hard copy, or soft copy.

An attempt will be made for publication of the study findings in a reputable journal.

5. RESULTS

5.1. Sociodemographic characteristics of study participants

In the study, a total of 382 mechanically ventilated patient charts were incorporated, with a response rate of 91.4%. More than half (59.2%) of study participants were male, and of them, the majority (62.7%) were censored. More than 44.2% of study participants were in the age category of less than or equal to 40 years, and more than 56.3% of the subjects were censored. The overall mean age of study participants was 45.86 years, with a standard deviation of 18.26 years.

Table 2: Sociodemographic characteristics of mechanical ventilated patients in ICU at Addis Ababa, 2022

Variables	Category	Outcome of patients		Total, n (%)
		Death, n (%)	Censored, n (%)	
Sex	Male	147(57.4)	79(62.7)	226(59.2)
	Female	109(42.6)	47(37.3)	156(40.8)
Age group	≤40	98(38.3)	71(56.3)	169(44.2)
	40-60	91(35.5)	36(28.6)	127(33.2)
	>60	67(26.2)	19(15.1)	86(22.5)
	Mean ± SD	47.92 ±18.28	41.67 ±17.55	45.86 ± 18.26

5.2. Clinical characteristics of mechanically ventilated patients in ICU

This study showed that nearly two-thirds (63.4%) of study participants had normal systolic blood pressure at intubation. Of these participants, the majority (65.6%) died. (70%) study subjects had normal diastolic blood pressure at the intubation stage. Almost half (50.8%) of study subjects had greater than or equal to 90% SPO₂ at mechanical ventilation initiation. 207 (54.2%) of the study subjects had tachycardia of the pulse rate at the initiation of mechanical ventilation. Almost three-fourths (75.4%) of study subjects had a respiration rate greater than or equal to twenty breaths per minute at initiation. Almost every six of ten (62.3%) study participants had less than 36.50% at mechanical ventilation initiation.

The study also indicated that, at the end of follow-up, nearly three-fourths (72.5%) of study participants had abnormal systolic blood pressure at the extubation stage. 80.1% of study participants had abnormal diastolic blood pressure. More than half (55.0%) of study participants had greater than or equal to 90% SPO₂ at extubation of MV. 41.1% of study subjects had tachycardia of the pulse rate at the end of mechanical ventilation at the end of follow-up. Nearly two-thirds (64.7%) of study participants had a respiration rate greater than or equal to twenty breaths per minute at the end of follow-up. Similarly, more than two-thirds (69.4%) of study subjects had a temperature of 36.50 °C under mechanical ventilation at the end of follow-up. 42.7% of study participants had less than a 9 on the Glasgow Coma Scale at admission. Nearly two-thirds (63.6%) of study participants had greater than 126 mg/dL of RBS at baseline. 60.8% of study participants had a range of 4.5–11 cells/L (normal) of WBC at baseline. The mean creatinine of study participants at baseline was 1.17 mg/dL, with a standard deviation of 1.40 mg/dL. At the end of follow-up, nearly two-thirds (63.7%) of study participants had less than a 9 on the Glasgow Coma Scale. More than half (54.7%) of study participants had greater than 126 mg/dL. 58.8% of study participants had normal WBC, and more than half (58.8%) of study participants' serum albumin levels were not normal. The mean creatinine level of study participants was 1.48 mg/dL, with a standard deviation of 1.74 mg/dL (Table 2).

Table 3: Clinical characteristics of patients at intubation and extubation

Variables	Category	Outcome of patients		Total, n (%)
		Death, n (%)	Censored,	
Systolic at initiation of MV	<120 (normal)	168(65.6)	74(58.7)	242(63.4)
	120-139(prehypertension)	51(19.9)	21(16.7)	72(18.8)
	>=140(High blood pressure)	37(14.5)	31(24.6)	68(17.8)
Diastolic at initiation of MV	<80(Normal)	189(73.8)	79(62.7)	268(70.2)
	80-89(Prehypertension)	34(13.3)	19(15.1)	53(13.9)
	>=90(High blood pressure)	33(12.9)	28(22.2)	61(16.0)
SPO2 at initiation of MV	<90	135(52.7)	53(42.1)	188(49.2)
	>=90	121(47.3)	73(57.9)	194(50.8)
Pulse rate at initiation of MV	<60(bradycardic)	25(9.8)	3(2.4)	28(7.3)
	60-100(normal)	93(36.3)	54(42.9)	147(38.5)
	>100(tachycardia)	138(53.9)	69(54.8)	207(54.2)
Respiratory at initiation	<10	3(1.2)	0(0.0)	3(0.8)
	10-20	53(20.7)	38(30.2)	91(23.8)
	>=20	200(78.1)	88(69.8)	288(75.4)
Temperature at intubation	<36.5	166(64.8)	72(57.1)	238(62.3)
	36.5-37.5	56(21.9)	43(34.1)	99(25.9)
	>37.5	34(13.3)	11(8.7)	45(11.8)
Systolic at extubation	<120 (normal)	210(82.0)	67(53.2)	277(72.5)
	120-139(prehypertension)	29(11.3)	39(31.0)	68(17.8)
	>=140(High blood pressure)	17(6.7)	20(15.9)	37(9.7)
Diastolic at Extubation of MV	<80(Normal)	229(89.5)	77(61.1)	306(80.1)
	80-89(Prehypertension)	13(5.1)	33(26.2)	46(12.0)
	>=90(High blood pressure)	14(5.5)	16(12.7)	30(7.9)
SPO2 at extubation of MV	<90	160(62.5)	12(9.5)	172(45.0)
	>=90	96(37.5)	114(90.5)	210(55.0)
Pulse rate at extubation of MV	<60(bradycardic)	87(34.0)	5(4.0)	92(24.1)
	60-100(normal)	61(23.8)	72(57.1)	133(34.8)
	>100(tachycardia)	108(42.2)	49(38.9)	157(41.1)

Respiratory extubation	at	<10	26(10.2)	0(0.0)	26(6.8)
		10-20	80(31.3)	29(23.0)	109(28.5)
		>=20	150(58.6)	97(77.0)	247(64.7)
Temperature extubation of MV	at	<36.5	201(78.5)	64(50.8)	265(69.4)
		36.5-37.5	27(10.5)	53(42.1)	80(20.9)
		>37.5	28(10.9)	9(7.1)	37(9.7)
Glasgow Coma Scale at initiation	at	<9	129(50.4)	34(27.0)	163(42.7)
		9-12	97(37.9)	45(35.7)	142(37.2)
		13-15	30(11.7)	47(37.3)	77(20.2)
RBS initiation		<70	20(7.8)	1(0.8)	21(5.5)
		70-126	76(29.7)	42(33.3)	118(30.9)
		>126	160(62.5)	83(65.9)	243(63.6)
WBC at Initiation of MV		<4.5	15(5.9)	4(3.2)	19(5.0)
		4.5-11	148(57.8)	84(67.2)	231(60.8)
		>=11	93(36.3)	37(29.6)	130(34.2)
Creatinine at initiation		Mean± SD	1.35±1.58	0.81±0.80	1.17±1.40
Glasgow Coma Scale at extubation		<9	233(91.7)	9(7.1)	242(63.7)
		9-12	14(5.5)	4(3.2)	18(4.7)
		13-15	7(2.8)	113(89.7)	120(31.6)
RBS extubation		<70	13(5.1)	0(0.0)	13(3.4)
		70-126	104(40.6)	56(44.4)	160(41.9)
		>126	139(54.3)	70(55.6)	209(54.7)
WBC at extubation of MV		<4.5	17(6.7)	3(2.4)	20(5.2)
		4.5-11	130(50.8)	95(75.4)	224(58.8)
		>=11	109(42.2)	28(22.2)	137(36.0)
Creatinine at End		Mean± SD	1.78±1.98	0.86±0.80	1.48±1.74
Serum albumin level		Not done	151(59.0)	71(56.3)	222(58.1)
		Normal	51(19.9)	29(23.0)	80(20.9)
		Hypoalbuminemia	46(18.0)	25(19.8)	71(18.6)
		Hyper albuminemia	8(3.1)	1(0.8)	9(2.4)

5.3. The Morbidity related characteristics of study participants

As shown in Table 4, nearly every second of the ten (18.6%) study participants had neurologic disease. Of these diseases, stroke, epilepsy, and seizures were the main ones that patients were affected by. Similarly, nearly every second of the ten (18.3%) study subjects had renal failure, and acute kidney injury was the main reason for the failure. A small number (4.7%) of study participants had undergone dialysis. More than half (53.7%) of study participants had respiratory disease, and aspiration pneumonia, ARDS, asthma, and SCAP were the types of respiratory disease that the study participants had. More than five out of ten (52.1%) study subjects had a cause for the initiation of mechanical ventilation because of Type 1 respiratory failure. More than one-fourth (28.5%) of study subjects had any cardiovascular disease. Acute MI, HTN, CHF, cardiogenic shock, and post-cardiac arrest were the types of cardiovascular disease among study participants. A small number (11.8%) of study participants had diabetes mellitus. Similarly, a small number (16.5%) of study participants had anemia.

Regarding HIV infection, 27 (7.1%) of the study subjects were infected. A small number (2.6%) of study participants had neuromuscular disease. More than one third (39.8%) of study subjects had referred to shock disease, and sepsis, or septic shock, was the most common. Almost every second of the ten (20.9%) study participants had complications after intubation. The main types of complications after intubation were HAI, pneumothorax, VAP, pulmonary edema, and malnutrition. More than three out of seven (46.9%) study participants had an electrolyte imbalance. The main types of electrolyte imbalance that the study participants had were hyponatremia, hypernatremia, hypokalemia, and hyperkalemia.

Table 4: The Morbidity related characteristics of study participants

Variables	Category	Outcome of patients		Total, n (%)
		Death, n (%)	Censored, n (%)	
Neurologic disease	Yes	48(18.8)	23(18.3)	71(18.6)
	No	208(81.3)	103(81.7)	311(81.4)
Renal failure	Yes	60(23.4)	10(7.9)	70(18.3)
	No	196(76.6)	116(92.1)	312(81.7)
Dialysis done for renal failure patients	Yes	16(6.2)	2(1.6)	18(4.7)
	No	240(93.8)	124(98.4)	363(95.3)
Respiratory disease	Yes	142(55.5)	63(50.0)	205(53.7)
	No	114(44.5)	63(50.0)	177(46.3)
Cause of initiation of mechanical Ventilation	Type -1 respiratory	139(54.3)	60(47.6)	199(52.1)
	Type -2 respiratory	30(11.7)	18(14.3)	48(12.6)
	Coma	87(34.0)	48(38.1)	135(35.3)
Cardiovascular	Yes	75(29.3)	34(27.0)	109(28.5)
	No	181(70.7)	92(73.0)	273(71.5)
DM	Yes	30(11.7)	15(11.9)	45(11.8)
	No	226(88.3)	111(88.1)	337(88.2)
Anemia	Yes	44(17.2)	19(15.1)	63(16.5)
	No	212(82.8)	107(84.9)	319(83.5)
HIV infection	Yes	20(7.8)	7(5.6)	27(7.1)
	No	236(92.2)	119(94.4)	355(92.9)
Neuromuscular disease	Yes	4(1.6)	6(4.8)	10(2.6)
	No	252(98.4)	120(95.2)	372(97.4)
Shock	Yes	131(51.2)	21(16.7)	152(39.8)
	No	125(48.8)	105(83.3)	230(60.2)
Complications after intubation	Yes	61(23.8)	19(15.1)	80(20.9)
	No	195(76.2)	107(84.9)	302(79.1)
Electrolyte imbalance	Yes	130(50.8)	49(38.9)	179(46.9)
	No	126(49.2)	77(61.1)	203(53.1)

5.4. Mechanical ventilator related characteristics of study participants

This study finding indicated that almost two third (67.0%) of study participants used A/C VC mode of mechanical ventilation. More than one-third (35.7%) of study participants were stayed on Mechanical ventilation total length of 1-3 days. The overall percentage of FIO₂ of study participants at baseline was 91.09 % (95%CI: 89.35, 92.72). Similarly, the overall percentage of FIO₂ of study participants at the end of follow up was 72.62% (95%CI: 67.95, 78.52) (Table 5).

Table 5: Mechanical ventilator related characteristics of study participants

Variable	Category	Outcome of patients		Total, n (%)
		Death, n (%)	Censored, n (%)	
Mode of mechanical ventilation	PRVC	17(6.6)	6(4.8)	23(6.0)
	A/C PC	55(21.5)	27(21.4)	82(21.5)
	A/C VC	179(69.9)	77(61.1)	256(67.0)
	SIMV	2(0.8)	4(3.2)	6(1.6)
	CPAP	3(1.2)	12(9.5)	15(3.9)
Total Length of stay on MV	1-3	101(39.5)	35(28.0)	136(35.7)
	4-7	77(30.1)	46(36.8)	123(32.3)
	>=8	78(30.5)	44(35.2)	122(32.0)
FIO ₂ at initiation	Percentage (95% CI)	91.10(88.94,93.26)	91.07(88.52,93.46)	91.09(89.35,92.72)
FIO ₂ at end of follow-up	Percentage (95% CI)	85.23(80.16,92.80)	46.98(41.24,55.61)	72.62(67.95,78.52)

5.5. Treatment related characteristics of study participants

As shown in Table 6, 41.6% of study participants had used vasopressor medication. More than half (53.1%) of study participants used steroids. A small number (2.9%) of study subjects had an inserted chest tube, and the most common type of inserted chest tube by study subjects was pneumothorax.

Table 6: Treatment related characteristics of study participants

Variables	Category	Outcome of patients		Total, n (%)
		Death, n (%)	Censored, n (%)	
Was Vasopressor use?	Yes	139(54.3)	20(15.9)	159(41.6)
	No	117(45.7)	106(84.1)	223(58.4)
Was Steroids use?	Yes	133(52.0)	70(55.6)	203(53.1)
	No	123(48.0)	56(44.4)	179(46.9)
Was there any chest tube inserted?	Yes	11(4.3)	0(0.0)	11(2.9)
	No	245(95.7)	126(100.0)	371(97.1)
Yes to chest tube inserted	Pneumothorax	10(90.91)	0(0.0)	10(90.91)
	Haemothorax	1(9.09)	0(0.0)	1(9.09)

5.6. Time to death of critical ill patients on mechanical ventilation

In this study, patients were followed for a minimum of one day to a maximum of 69 days, with a median follow-up of 5 days and an interquartile range (IQR) of 2–8.25. Based on this, the total person-time observation was 2666 person-days. In this study of 382 observations, 256 (67.0%) study participants were dead. About 126 (33.0%) study participants were censored. Among the censored, 114 (29.8%) of study participants were recovered, and 12 (3.1%) of study participants were discharged.

As shown in the Kaplan-Meier survival curve, it increases promptly as time elapses. So that there is an increase in deaths of critically ill patients on mechanical ventilation as the number of days increases. In critically ill patients on mechanical ventilation analysis, the highest death rate of mechanically ventilated patients was observed on the twentieth day, with a death rate of 88.3% with a 95% CI.

The total death rate of critically ill patients on mechanical ventilation in the ICU was found to be 9.23 cases (95% CI, 8.14–10.46) per 100 person-days. As shown in Figure 3, the cumulative probability of failure on the first day of admission to the ICU was 6.23%; at the tenth day, it was 68.28%; at the twentieth day, it was 80.65%; at the thirtieth day, it was 88.30%; and at the end of the follow-up, it was 98.54%. The median survival time was found to be 6 days with a 95% CI. `

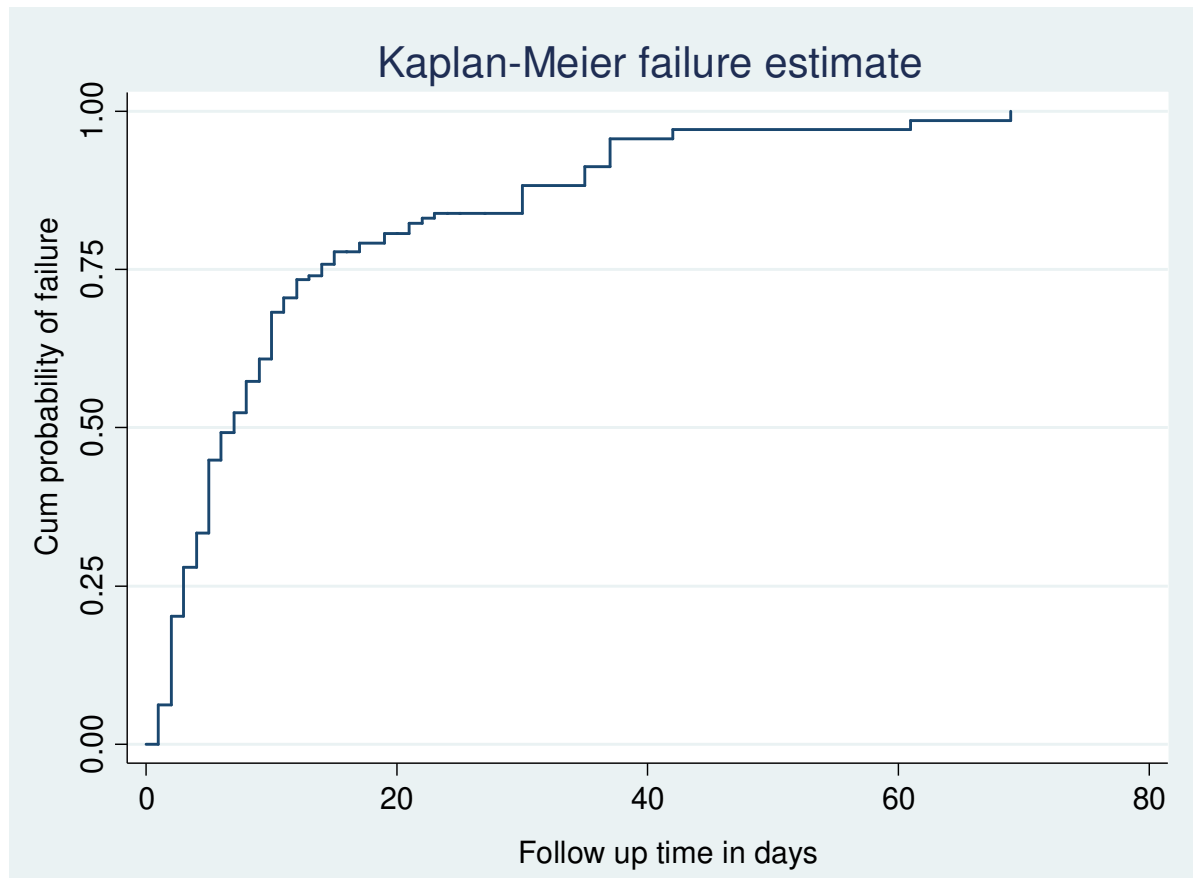


Figure 3 A Kaplan–Meir failure estimates of patients admitted to ICU

5.7. Log-rank test for mortality predictors

A logrank test was run to find the difference in survival rates among many categories of predictor factors. As a result, there were significant differences in survival based on age, systolic and diastolic blood pressure at baseline, pulse rate, and respiratory rate, as well as systolic and diastolic blood pressure at the end of the follow-up, pulse at the final follow-up, mental illness, HIV infection, the presence of shock, RBS at baseline, WBC at baseline, and end of the follow-up, as well as the use of Vasopressor.

Table 7: Log-rank test for mortality predictors among Mechanical ventilated patients admitted to the ICU, Addis Ababa

Variables	Category	Outcome of patients		χ^2	DF	P-value
		Death, n (%)	Censored, n (%)			
Age group	≤40	98(38.3)	71(56.3)	7.21	2	0.0272
	40-60	91(35.5)	36(28.6)			
	>60	67(26.2)	19(15.1)			
Systolic at baseline	<120 (normal)	168(65.6)	74(58.7)	11.24	2	0.0036
	120-139(prehypertension)	51(19.9)	21(16.7)			
	≥140(High blood pressure)	37(14.5)	31(24.6)			
Diastolic at baseline	<80(Normal)	189(73.8)	79(62.7)	5.45	2	0.0654
	80-89(Prehypertension)	34(13.3)	19(15.1)			
	≥90(High blood pressure)	33(12.9)	28(22.2)			
Pulse rate at baseline	Normal	93(36.3)	54(42.9)	4.28	1	0.038
	abnormal	163(63.7)	72(57.1)			
Respiratory rate at baseline	Normal	53(20.7)	38(30.2)	2.64	1	0.104
	abnormal	203(79.3)	88(69.8)			

Systolic at end follow-up	<120 (normal)	210(82.0)	67(53.2)	19.69	2	<0.001
	120-139(prehypertension)	29(11.3)	39(31.0)			
	>=140(High blood pressure)	17(6.7)	20(15.9)			
Diastolic at end follow-up	<80(Normal)	229(89.5)	77(61.1)	22.12	2	<0.001
	80-89(Prehypertension)	13(5.1)	33(26.2)			
	>=90(High blood pressure)	14(5.5)	16(12.7)			
SPO2 at end follow-up	<90	160(62.5)	12(9.5)	0	1	0.9811
	>=90	96(37.5)	114(90.5)			
Pulse rate at end follow-up	Normal	61(23.8)	72(57.1)	15.23	1	<0.001
	abnormal	195(76.2)	54(42.9)			
Neurologic disease	Yes	48(18.8)	23(18.3)	5.87	1	0.0154
	No	208(81.3)	103(81.7)			
Renal failure	Yes	60(23.4)	10(7.9)	16.09	1	<0.001
	No	196(76.6)	116(92.1)			
Cardiovascular	Yes	75(29.3)	34(27.0)	3.34	1	0.0677
	No	181(70.7)	92(73.0)			
HIV infection	Yes	20(7.8)	7(5.6)	6.86	1	0.0088
	No	236(92.2)	119(94.4)			
Neuromuscular disease	Yes	4(1.6)	6(4.8)	4.46	1	0.0347
	No	252(98.4)	120(95.2)			
Presence of Shock	Yes	131(51.2)	21(16.7)	26.46	1	<0.001
	No	125(48.8)	105(83.3)			

Glasgow Coma Scale at baseline	<9	129(50.4)	34(27.0)	24.77	1	<0.001
	≥ 9	127(49.6)	92(73.0)			
Glasgow Coma Scale at end follow-up	<9	233(91.7)	9(7.1)	133.55	1	<0.001
	≥ 9	21(8.3)	117(73.0)			
RBS at baseline	Normal	76(29.7)	42(33.3)	31.76	1	<0.001
	abnormal	180(70.3)	84(66.7)			
WBC at baseline	Normal	148(57.8)	84(67.2)	7.86	1	0.0196
	abnormal	108(42.2)	41(32.8)			
WBC at end follow-up	Normal	130(50.8)	95(75.4)	36.94	1	<0.001
	abnormal	126(49.2)	31(24.6)			
Vasopressor used	Yes	139(54.3)	20(15.9)	19.75	1	<0.001
	No	117(45.7)	106(84.1)			

5.8. Predictors of mortality among patients admitted to Intensive Care Unit

A bivariate Cox proportional hazard regression was done to identify predictor variables. Variables like age group, Systolic blood pressure at baseline, diastolic blood pressure at baseline, pulse rate at baseline, respiratory rate at baseline, systolic blood pressure at end follow-up, diastolic blood pressure at end follow-up, SPO2 at end follow-up, pulse rate at end follow-up, neurologic disease, renal failure, cardiovascular disease, HIV infection, neuromuscular disease, presence of shock, GCS at baseline, GCS at end follow-up, RBS at baseline, WBC at baseline, WBC at end follow-up, creatinine at baseline, creatinine at end follow-up, Serum albumin level, FIO2 at the end of follow-up, and Vasopressor used were variables with a p-value of less than 20% selected for the multivariable Cox proportional hazard regression model.

After all covariates and the whole model satisfied the proportional hazards assumption based on the global proportional-hazards test using the Schoenfeld residuals [$\chi^2_{(36)} = 29.89, P = 0.7537$], data were fitted into the Cox regression model. Then, in a multivariable Cox regression analysis, it was found that only Systolic blood pressure at baseline, Systolic blood pressure at end follow-up, Diastolic blood pressure at end follow-up, HIV infection, GCS at end follow-up, RBS at baseline, Creatinine at baseline, and Serum albumin level were identified as significant predictors for time to death among Mechanically ventilated patients admitted to the ICU ($P < 0.05$).

By keeping all variables constant, the study participants with prehypertension systolic blood pressure at baseline had a 43% lower mortality hazard than those with normal (AHR = 0.57, 95% CI: 0.38, 0.85). On the other hand, the hazard of mortality among mechanically ventilated patients in ICU with a high systolic blood pressure at the end of follow-up was 2.11 times greater than that among those patients with a normal systolic blood pressure condition (AHR = 2.11, 95% CI: 1.23, 3.61). The mortality hazard for patients who had a prehypertension condition of diastolic blood pressure at follow-up to the ICU was 75% less than the hazard for patients with a normal condition of diastolic blood pressure (AHR = 0.25, 95% CI: 0.12, 0.53).

Additionally, the hazard of death for patients who had HIV infection was 2.81 times higher than their counterparts (AHR = 2.81, 95% CI: 1.62, 4.88). Patients with a Glasgow Coma Scale at end follow-up of less than nine was 233(91.7%), patients with GCS at the end of follow-up ≥ 9 was 21(8.3%), GCS of < 9 at end follow up has higher hazard of mortality than Glasgow Coma Scale at admission < 9 was 129 (50.4%). Mechanically ventilated patients with abnormal RBS at baseline had a 32% higher mortality hazard than those with normal RBS (AHR = 0.68, 95%: 0.4, 0.93). The hazard of mortality in patients with a normal serum

albumin level was 34% less likely than in patients whose serum albumin level was not measured (AHR = 0.66, 95% CI: 0.46, 0.96). Furthermore, upon admission of mechanically ventilated patients to the ICU, a one-unit increase in the patients' creatinine level increased the mortality hazard of patients by 17% (AHR = 1.17, 95% CI: 1.12, 1.35) (Table 8).

Table 8: Multivariable Cox regression analysis for mortality predictors among Mechanical ventilated patients admitted to the ICU, Addis Ababa

Variables	Category	Outcome of patients		CHR(95% CI)	AHR(95%CI)	P-value
		Death, n (%)	Censored, n (%)			
Age group	≤40	98(38.3)	71(56.3)	1		
	40-60	91(35.5)	36(28.6)	1.46(1.09, 1.94)	1.11(0.80, 1.55)	0.533
	>60	67(26.2)	19(15.1)	1.11(0.81, 1.52)	0.83(0.58, 1.18)	0.298
Systolic at baseline	<120 (normal)	168(65.6)	74(58.7)	1		
	120-139 (Prehypertension)	51(19.9)	21(16.7)	0.78(0.57, 1.07)	0.57(0.38, 0.85)	0.007
	≥140(High blood pressure)	37(14.5)	31(24.6)	0.55(0.38, 0.78)	0.61(0.36, 1.06)	0.078
Diastolic at baseline	<80(Normal)	189(73.8)	79(62.7)	1		
	80-89(Prehypertension)	34(13.3)	19(15.1)	0.87(0.60, 1.27)	1.09(0.68, 1.73)	0.719
	≥ 90(High blood pressure)	33(12.9)	28(22.2)	0.63(0.43, 0.91)	1.28(0.72, 2.28)	0.394
Pulse rate at baseline	Normal	93(36.3)	54(42.9)	1		
	Abnormal	163(63.7)	72(57.1)	1.30(1.00, 1.69)	1.17(0.83, 1.65)	0.37
Respiratory rate at baseline	Normal	53(20.7)	38(30.2)	1		
	Abnormal	203(79.3)	88(69.8)	1.27(0.93, 1.72)	0.94(0.65, 1.35)	0.729
Systolic at end follow-up	<120 (normal)	210(82.0)	67(53.2)	1		
	120-139(prehypertension)	29(11.3)	39(31.0)	0.59(0.40, 0.87)	2.11(1.23, 3.61)	0.007
	≥140(High blood pressure)	17(6.7)	20(15.9)	0.42(0.25, 0.70)	1.20(0.58, 2.48)	0.631
	<80(Normal)	229(89.5)	77(61.1)	1		
	80-89(Prehypertension)	13(5.1)	33(26.2)	0.39(0.22, 0.69)	0.25(0.12, 0.53)	<0.001

Diastolic at end follow-up	≥90(High blood pressure)	14(5.5)	16(12.7)	0.40(0.23, 0.69)	0.66(0.30, 1.44)	0.297
SPO2 at end follow-up	<90	160(62.5)	12(9.5)	2.27(1.76, 2.93)	0.92(0.68, 1.26)	0.619
	≥90	96(37.5)	114(90.5)	1		
Pulse rate at end follow-up	Normal	61(23.8)	72(57.1)	1		
	Abnormal	195(76.2)	54(42.9)	1.71(1.28, 2.28)	1.10(0.77, 1.57)	0.585
Neurologic disease	Yes	48(18.8)	23(18.3)	0.71(0.51, 0.98)	0.84(0.57, 1.25)	0.396
	No	208(81.3)	103(81.7)	1		
Renal failure	Yes	60(23.4)	10(7.9)	1.64(1.23, 2.19)	1.11(0.69, 1.78)	0.67
	No	196(76.6)	116(92.1)	1		
Cardiovascular	Yes	75(29.3)	34(27.0)	0.78(0.59, 1.02)	1.10(0.78, 1.56)	0.584
	No	181(70.7)	92(73.0)	1		
HIV infection	Yes	20(7.8)	7(5.6)	2.42(1.52, 3.86)	2.81(1.62, 4.88)	<0.001
	No	236(92.2)	119(94.4)	1		
Neuromuscular disease	Yes	4(1.6)	6(4.8)	0.37(0.14, 0.99)	0.62(0.20, 1.96)	0.42
	No	252(98.4)	120(95.2)	1		
	Yes	131(51.2)	21(16.7)	1.83(1.43, 2.34)	0.96(0.69, 1.34)	0.801
	No	125(48.8)	105(83.3)	1		
Glasgow Coma Scale at	<9	226 (88.3)	79(62.7)	3.43 (2.3, 5.15)	2.14 (1.32,	0.836
	≥ 9	30 (11.7)	47 (37.3)	1		
Glasgow Coma Scale at end	≤12	247(97.2)	13 (10.3)	36.52(16.11,	39.65(16.09,	<0.001
	>12	7(2.8)	113(89.7)	1		
RBS at baseline	Normal	76(29.7)	42(33.3)	1		
	Abnormal	180(70.3)	84(66.7)	0.77(0.59, 1.02)	0.68(0.49, 0.93)	0.015
WBC at baseline	Normal	148(57.8)	84(67.2)	1		
	Abnormal	108(42.2)	41(32.8)	1.37(1.07, 1.76)	1.09(0.80, 1.47)	0.594
	Normal	130(50.8)	95(75.4)	1		

WBC at end	Abnormal	126(49.2)	31(24.6)	1.81(1.41, 2.32)	1.19(0.87, 1.63)	0.281
Creatinine at	Mean± SD	1.35±1.58	0.81±0.80	1.10(1.02, 1.18)	1.17(1.02, 1.35)	0.03
Creatinine at end follow-up	Mean± SD	1.78±1.98	0.86±0.80	1.10(1.04, 1.16)	0.91(0.80, 1.03)	0.138
Serum albumin level	Not done	151(59.0)	71(56.3)	1		
	Normal	51(19.9)	29(23.0)	0.68(0.50, 0.94)	0.66(0.46, 0.96)	0.028
	Hypoalbuminemia	46(18.0)	25(19.8)	0.79(0.57, 1.11)	0.80(0.56, 1.16)	0.243
	Hyper albuminemia	8(3.1)	1(0.8)	1.24(0.61, 2.52)	1.07(0.37, 3.09)	0.902
FIO2 at end of follow-up	Percentage(95%CI)	85.23(80.16,92.80)	46.98(41.24,55.61)	1.00(1.00, 1.01)	1.00(1.00, 1.00)	0.2
Vasopressor used	Yes	139(54.3)	20(15.9)	1.75(1.36, 2.24)	0.93(0.67, 1.29)	0.655
	No	117(45.7)	106(84.1)	1		

1 indicates reference category

6. Discussion

The primary focus of this study was to determine the time to death and predictors of mortality among mechanically ventilated patients admitted to the intensive care units of four selected public hospitals in Addis Ababa. My study evaluated the patients' sociodemographic, clinical related, treatment-related, MV-related, and morbidity characteristics from their medical record data using a survival analysis model.

The incidence of death among patients in the ICU was found to be 9.23 cases (95% CI, 8.14–10.46) per 100 person-days of observation. The cumulative probability of failure on the first day of admission to the ICU was 6.23%; on the tenth day, it was 68.28%; on the twentieth day, it was 80.65%; on the thirty-first day, it was 88.30%; and at the end of the follow-up, it was 98.54%. The median survival time was found to be 6 days.

This study's findings indicated that the overall mortality rate among mechanically ventilated patients in the ICU of four hospitals in Addis Ababa was found to be 67.0%. This finding is consistent with the findings of studies done in Colombia(16), South India(20), Nigeria (21), and Egypt (9). However, this study finding was higher than the study results of studies done in high-income countries like the USA (10) and Germany (23). Similarly, it is higher than studies conducted in middle-income countries like Saudi Arabia(19), Brazil (25), and low-income countries like Kenya (22). In addition, it is higher than the study result of findings obtained from Ethiopia: Southern Ethiopia(13), St. Paul's Hospital Millennium Medical College (24) and Tikur Anbessa (8). The discrepancy might arise because of sample size, or a shortage of essential medications and equipment.

This study's finding indicates that mechanically ventilated patients with high systolic blood pressure were shown to have an elevated mortality risk. This result is similar to a study conducted in Israel, which demonstrated that patients with high SBP levels were associated with higher in-hospital mortality(30).

This study indicated that the study participants with prehypertension systolic blood pressure condition at baseline had lower mortality risk in the ICU. This study result is supported by a study done in USA that declares as mortality is no longer increased for patients with prehypertension (31)

This study result also demonstrated that the hazard of death for mechanically ventilated patients in the ICU who had HIV infection was higher. This study's finding is supported by evidence from a clinical review that showed mechanically ventilated HIV patients are twice as likely to die in the ICU compared to non-HIV patients(32).

The level of the Glasgow Coma Scale at the end of follow-up for mechanically ventilated patients was shown to have a high mortality risk. This study result is supported by studies conducted in Ethiopia, such as in Dessie Hospital(27), Ambo University Referral Hospital(33), Tikur Anbessa Specialized Hospital (8) and Southern Ethiopia (13), which showed that the Glasgow coma scale < 9 was statistically significant with mortality. The change in mental state may be a sign of a serious illness or a main neurological condition (8). Neurological abnormalities, severe decompensated disease, cerebral hypo perfusion brought on by sepsis, blood loss, and drunkenness are just a few of the factors that might contribute to this level of awareness disturbance. Furthermore, individuals with unstable mental states may be unable to protect their airway, which increases the risk of contracting viral and respiratory infections.(34)

Mechanically ventilated patients who had a normal serum albumin level were less likely to have a risk of mortality as compared to patients whose serum albumin level was not measured. In line with this study, a study conducted in China demonstrated that a decreased serum albumin level is associated with an increased risk of death (35). This may arise from the fact that an increase in serum albumin concentration is associated with prediabetes development and progression to overt diabetes independently of the metabolic syndrome(26). Also the bulk of our patient group is undernourished due to poor socioeconomic status and subsequently experiences a catabolic sickness condition since they do not have access to nutritionists or standardized nutritional therapy. Parenteral nutrition is not offered, and enteral feeding is not tailored to the patients' caloric requirements (8).

Our study also revealed that creatinine level increments would affect mechanically ventilated patients' survival in the ICU. This study's finding was supported by multicenter evidence from Addis Ababa (7). The cause could be that an elevated creatinine level signals kidney damage those results in loss of function, which severely affects metabolism and causes electrolyte imbalance and metabolic acidosis, both of which have a significant negative impact on mortality (36).

7. Limitation of the study:

- Some important variables that might have significant predictors, such as malnutrition, body mass index, smoking habit, marital status, occupation, and education level, were unavailable in the chart.
- Furthermore, some clinical interventions like ABG analysis, Etco2 monitoring to determine acidosis and/or alkalosis, and dialysis for renal failure were not obtained, which could have influenced mortality. Also, mechanical ventilator monitoring parameters like PEEP, PIP, I: E ratio, etc.
- There are no common formats between hospitals to document mechanical ventilator outcome parameters.
- The nature of the retrospective study itself was a limitation.

8. Conclusion:

In this retrospective cohort study, we found that the overall mortality among mechanically ventilated patients admitted to the ICUs of four public hospitals in Addis Ababa was high. Systolic blood pressure at baseline, systolic blood pressure at end follow-up, diastolic blood pressure at end follow-up, HIV infection, GCS at end follow-up, RBS at baseline, creatinine at baseline, and serum albumin level were identified as significant predictors for mortality in the ICU.

9. Recommendation

To federal ministry of health

- Could be use the study findings as an input to improve quality of care

To hospital management:

- The hospital management should avail of an ABG machine and Etco2 monitoring for early detection of complications and better management of mechanically ventilated patients.
- Supplementary information's time to death and mortality predictors related to mechanical ventilation and make prompt measures

To ICU Directors and ICU staffs:

- As a result of this study it is better to emphasize do (routine tests, early detection of cases and frequent monitoring of vital signs, RBS, creatinine level, and serum albumin), and there should also be prepare a common template or format for documenting mechanical ventilator outcome parameters.

To Researchers:

- Further prospective study in the future is needed, with the inclusion of other important predictive variables like malnutrition, body mass index, smoking habit and others, is advocated for better result.

10.Reference

1. Feleke BE, Feleke TE, Damtie M, Achenefe D, Biadglegne F. Survival of patients in the intensive care units of referral hospitals in Amhara Region: A prospective cohort study. *Ethiop J Heal Dev.* 2020;34(1):30–4.
2. Krishnamoorthy V, Vavilala MS, Mock CN. The need for ventilators in the developing world: An opportunity to improve care and save lives. *J Glob Health.* 2014;4(1):1–4.
3. Series I. Mechanical Ventilation. 2020;196(April).
4. Nega G, Sibhat M. Survival status and predictors of mortality among mechanically ventilated COVID-19 patients in Addis Ababa COVID-19 Care Centers , Ethiopia : A survival analysis [version 1 ; peer review : awaiting peer review]. 2022;1–14.
5. Alemayehu M, Azazh A, Hussien H, Baru A. Characteristics and Outcomes of Mechanically Ventilated Patients at Adult ICU of Selected Public Hospitals in Addis Ababa, Ethiopia. *Open Access Emerg Med.* 2022;14(July):395–404.
6. RF 32 Mechanical Ventilation Facts and Statistics (2023).
7. Endeshaw AS, Fekede MS, Gesso AS, Aligaz EM, Aweke S. Survival status and predictors of mortality among patients admitted to surgical intensive care units of Addis Ababa governmental hospitals , Ethiopia : A multicenter retrospective cohort study. 2023;(February):1–8.
8. Debebe F, Gof A, Haile T, Alferid F, Estifanos H, Adhikari NKJ. Predictors of ICU Mortality among Mechanically Ventilated Patients : An Inception Cohort Study from a Tertiary Care Center in Addis Ababa , Ethiopia. 2022;2022.
9. Nassar Y, Magdy M, Hamed L, Algohary T. A 5-year registry of mechanically

ventilated patients comprising epidemiology, initial settings, and clinical outcome. Egypt J Chest Dis Tuberc. 2018;67(3):250.

10. Auld S, Caridi-Scheible M, Blum JM, Robichaux CJ, Kraft CS, Jacob JT, et al. ICU and ventilator mortality among critically ill adults with COVID-19. medRxiv Prepr Serv Heal Sci [Internet]. 2020;1–12. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32511599><http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC7276026>
11. Frutos-vivar F, Ferna C, Anzueto A, Epstein SK, Nin N, Raymondos K, et al. Characteristics and Outcomes of Ventilated Patients According to Time to Liberation from Mechanical Ventilation.
12. Auld SC, Caridi-scheible M, Blum JM, Robichaux C, Kraft C, Jacob JT, et al. Ill Adults With Coronavirus Disease 2019 *. 2020;799–804.
13. Abate SM, Assen S, Yinges M, Basu B. Survival and predictors of mortality among patients admitted to the intensive care units in southern Ethiopia: A multi-center cohort study. Ann Med Surg [Internet]. 2021;65(April):102318. Available from: <https://doi.org/10.1016/j.amsu.2021.102318>
14. Endeshaw AS, Tarekegn F, Bayu HT, Ayalew SB, Gete BC. The magnitude of mortality and its determinants in Ethiopian adult intensive care units: A systematic review and meta-analysis. Ann Med Surg [Internet]. 2022;84(July):104810. Available from: <https://doi.org/10.1016/j.amsu.2022.104810>
15. Clark PA, Lettieri CJ. Clinical model for predicting prolonged mechanical ventilation. J Crit Care [Internet]. 2013;28(5):880.e1-880.e7. Available from: <http://dx.doi.org/10.1016/j.jcrc.2013.03.013>
16. Enrique J, Alba M, Felipe A, Valencia U, Sánchez N, Fernando L, et al. Factors Associated with Survival in Patients Undergoing Invasive Mechanical Ventilation in an Intensive Care Unit in Colombia , 2017 – 2018 : A Retrospective Cohort Study.

Drugs - Real World Outcomes [Internet]. 2021;8(3):417–25. Available from: <https://doi.org/10.1007/s40801-021-00241-y>

17. Anzueto A, Frutos F, Brochard L, Stewart TE, Benito S, Epstein SK, et al. Characteristics and Outcomes in Adult Patients Receiving Mechanical Ventilation. 2002;287(3):345–55.
18. Sison SM, Sivakumar GK, Cau C, Greenough WB, Oh ES, Galiatsatos P. Heliyon Mortality outcomes of patients on chronic mechanical ventilation in different care settings : A systematic review. 2021;7(February).
19. Ismaeil T, Almutairi J, Alshaikh R, Althobaiti Z, Ismaiel Y, Othman F. Survival of mechanically ventilated patients admitted to intensive care units results from a tertiary care center between 2016-2018. Saudi Med J. 2019;40(8):781–8.
20. Sudarsanam TD, Jeyaseelan L, Thomas K, John G. Predictors of mortality in mechanically ventilated patients. Postgrad Med J. 2005;81(962):780–3.
21. Ku T, It E, Ochukpe C. Journal of Anesthesia & Clinical Mechanical Ventilation in the Intensive Care Unit : A Prospective Study of Indications and Factors that Affect Outcome in a Tertiary Hospital in Nigeria. 2017;8(4):8–11.
22. Lalani HS, Waweru-Siika W, Mwogi T, Kituyi P, Egger JR, Park LP, et al. Intensive care outcomes and mortality prediction at a National Referral Hospital in Western Kenya. Ann Am Thorac Soc. 2018;15(11):1336–43.
23. Roedl K, Jarczak D, Bachmann M, Schulte F, Weber CF, Weerth A De, et al. Australian Critical Care Mechanical ventilation and mortality among 223 critically ill patients with coronavirus disease 2019 : A multicentric study in Germany. 2021;34.
24. Hunegnaw W, Bayisa T. Outcome of mechanical ventilator use and associated factors at Saint Paul ' s Hospital Millennium Medical College Medical Intensive Care Unit. 2022;1(2).
25. Bonfada D, Lima KC. Survival analysis of elderly patients in Intensive Care Units

197. 1981;

26. Jun JE, Lee SE, Lee Y Bin, Jee JH, Bae JC, Jin SM, et al. Increase in serum albumin concentration is associated with prediabetes development and progression to overt diabetes independently of metabolic syndrome. *PLoS One*. 2017;12(4):1–13.
27. Tilahun L, Molla A, Ayele FY, Nega A, Dagnaw K. Time to recovery and its predictors among critically ill patients on mechanical ventilation from intensive care unit in Ethiopia: a retrospective follow up study. *BMC Emerg Med* [Internet]. 2022;22(1):1–11. Available from: <https://doi.org/10.1186/s12873-022-00689-3>
28. Wotiye AB, Shimber ET, Ayele BA. Factors Associated with ICU Mortality at Hawassa University Comprehensive Specialized Hospital (HUCSH). 2022;(1):3–10.
29. Tsedalu A, Dagget T, Seid A, Alene T, Amara T, Misganew W, et al. African Journal of Emergency Medicine Survival status and predictors of mortality among traumatic brain injury patients in an Ethiopian hospital : A retrospective cohort study. *African J Emerg Med* [Internet]. 2021;11(4):396–403. Available from: <https://doi.org/10.1016/j.afjem.2021.06.003>
30. Klang E, Soffer S, Shimon Shahar M, Barash Y, Apter S, Konen E, et al. Association of normal systolic blood pressure in the emergency department with higher in-hospital mortality among hypertensive patients. *J Clin Hypertens*. 2019;21(12):1841–8.
31. Mainous AG, Everett CJ, Liska H, King DE, Egan BM. Prehypertension and mortality in a nationally representative cohort. *Am J Cardiol*. 2004;94(12):1496–500.
32. Sarkar P, Rasheed HF. Clinical review: Respiratory failure in HIV-infected patients - a changing picture. *Crit Care*. 2013;17(3):1–11.
33. Bacha AJ. Survival Status and its predictors among Patients Admitted to Pediatric Intensive Care Unit at Selected Tertiary Care Hospitals in Ethiopia : A Prospective Observational Study. 2022;
34. Bekele Z, Jisha H, Haile M. Outcomes and Associated Factors Among Adult Patients

Admitted to Adult Intensive Care Unit, Retrospective Cohort Study. *Int J Surg Oncol.* 2022;7(1):20–9.

35. Jin X, Li J, Sun L, Zhang J, Gao Y, Li R, et al. Prognostic Value of Serum Albumin Level in Critically Ill Patients: Observational Data From Large Intensive Care Unit Databases. *Front Nutr.* 2022;9(June):1–10.
36. Honore PM, Jacobs R, Joannes-Boyau O, De Regt J, Boer W, De Waele E, et al. Septic AKI in ICU patients. diagnosis, pathophysiology, and treatment type, dosing, and timing: a comprehensive review of recent and future developments. *Ann Intensive Care.* 2011;1(1):32.

ASSURANCE OF PRINCIPAL INVESTIGATOR

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I was providing timely progress report to my advisor and seek the necessary advice and approval from my primary and co advisors in the course of the research.

Name of the student: Tadele Zenebe

Signature: _____

Date: _____

Approval of the Primary Advisor

Name of the primary advisor: Rahel Mezemer

Signature: _____

Date: _____

Approval of the Co-Advisor

Name of Co-Advisor: Solomon Oljira

Signature: _____

Date: _____

Approval of the Examiner

Name of Examine: Zebenay Workneh

Signature: _____

Date: _____

11. ANNEXES

Annex I: Data Extraction checklist from different literature of variables

Name of Facility_____		Patient card number_____	
Date of data collection _____(D/M/Y)			
Annex I: Data Extraction checklist from different literature of variables			
Part I: Questions to Assess socio-demographic data			
S.No	Question	Response	
1	Age	_____ (in years)	
2	Sex	1. Male 2. Female	
3	Date of admission	_____ (D/M/Y)	
Part II: Questions to Assess the clinical parameter and morbidity related predictors of the study			
S.No	Question	Response	
4	Systolic Blood Pressure at mechanical ventilation initiation	_____/_____(mmHg)	
5	diastolic Blood Pressure at mechanical ventilation initiation	_____/_____(mmHg)	
6	SPO2 at mechanical ventilation initiation	_____(in)%	
7	Pulse Rate at mechanical ventilation initiation	_____(beats/min),	
8	Respiration Rate at mechanical ventilation initiation	_____(breaths/min)	
9	Temperature at mechanical ventilation initiation	_____(in _°C)	
10	Systolic Blood Pressure at end of follow-up at (discharge)	_____/_____(mmHg)	
11	diastolic Blood Pressure at end of follow-up at (discharge)	_____/_____(mmHg)	
12	SPO2 at end of follow-up	_____(in %)	
13	Pulse Rate at end of follow-up	_____(beats/min)	
14	Respiration Rate at end of follow-up	_____(breaths/min)	
15	Temperature at end of follow-up	_____(in °C)	
16	Diagnosis at admission	_____	

17	Was there any Neurologic disease?	1. Yes
		2. No
18	if yes question number 17 (circle on all existed)	1. Parkinson's disease
		2. epilepsy and seizures
		3. stroke
		4. meningitis
		5. other (specify) _____
19	Was there Renal failure?	1. Yes
		2. No
20	if yes question number 19 (circle on all existed)	1. Acute Kidney Injury (AKI)
		2. Chronic Kidney Disease(CKD)
21	If there is renal failure was dialysis done?	1. Yes
		2. No
22	Was there any Respiratory disease?	1. Yes
		2. No
23	if yes question number 22 (circle on all existed)	1. aspiration Pneumonia
		2. ARDS
		3. Asthma
		4. SCAP
		5. COVID-19 infection
		6. Other (specify)_____
24	Cause of initiation of mechanical Ventilation	1. Type -1 respiratory failure
		2. Type -2 respiratory failure
		3. Coma
25	was there any cardiovascular	1. Yes
		2. No
26	if yes question number 25 (multiple response is possible)	1. Acute MI
		2. HTN
		3. CHF
		4. Cardiogenic shock,
		5. post cardiac arrest
		6. other(specify)_____
27	Was there DM?	1. Yes
		2. No
28	Was there anemia?	Yes
		No
29	Was there HIV infection?	Yes
		No

		30		Stage I Stage II Stage III
			If yes Q number 29 (circle on existed)	
Part III: Questions to Assess Mechanical ventilator related variables				Stage IV
		31		1. Yes
	Questions		Was there Neuromuscular disease?	Responses 2. No
48	Date of mechanical ventilation intubation		If yes question number 31(circle on existed) _____ (D/M/Y)	1. GBS
49	Ways of ventilation	32	Endotracheal Tube (ETT)	2. Myasthenia gravis
		33	Was there Shock?	1. Yes
50	Mode of mechanical ventilation		1. PRVC	2. No
		34	if yes question number 33 (circle on all existed)	Sepsis/septic shock
			2. A/C PC	Cardiogenic shock
			3. A/C VC	Hypovolemic shock
		35	Any complications after intubation?	1. Yes
			4. SIMV	No
			5. CPAP	1. HAI/Sepsis
			Other _____	2. Pneumothorax
51	FIO2 at mechanical ventilation initiation	36	_____ (%)	3. VAP
52	FIO2 at end of follow-up		_____ (%)	4. Pulm.Edema
53	Date of mechanical ventilation extubation		_____ (D/M/Y)	5. Atelectasis
			if yes question number 35 (Circle on all existed)	6. Others (specify) _____
54	Total Length of stay On mechanical ventilator	37	_____ (in days)	1. Yes
Part IV: Questions to Assess Management/Medication related variables				2. No
		38	Total Length of stay in ICU	_____ days ICU
	Questions	39	Glasgow Comma Scale at admission	Responses _____ in number
55	Was Vasopressor use?	40	Glasgow Comma Scale at (discharge/death)	1. Yes _____ in number
		41	RBS at baseline	2. No _____ (mg/dL)
56	Was Steroids use?	42	WBC at admission	1. Yes _____ (cells/ μ L)
		43	WBC at end of follow-up (discharge)	2. No _____ (cells/ μ L)
57	Was there any chest tube inserted?	44	Creatinine at admission	1. Yes _____ (mg/dL)
		45	Creatinine at end of follow-up (discharge)	2. No _____ (mg/dL)
58	If yes for Q 59, Reason for chest tube insertion?	46	RBS at end of follow-up (discharge)	1. Pneumothorax _____ (mg/dL)
			2. Haemothorax	Not done
59	What was outcome of patient?	47	Serum albumin level	Normal
			1. Died	hypoalbuminemia
			2. Recovered (weaned off from MV or discharged)	Hyper albuminemia
			3. discharge against medical advice	
60	Date of (Discharge, died, against medical advice,...)		_____ (D/M/Y)	