# ADDIS ABABA UNIVERSITY

# COLLEGE OF HEALTH SCIENCES

# DEPARTMENT OF EMERGENCY MEDICINE


## CHARACTERISTIC AND OUTCOMES OF MECHANICALLY VENTILATED PATIENTS AT ADULT ICU OF SELECTED PUBLIC HOSPITALS IN ADDIS ABABA, ETHIOPIA 2020.

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**RESEARCH THESIS TO BE SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, DEPARTMENT OF EMERGENCY MEDICINE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR MASTERS OF SCIENCE DEGREE IN EMERGENCY MEDICINE AND CRITICAL CARE NURSING.**

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**ADDIS ABABA, ETHIOPIA**

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## ABBREVIATIONS AND ACRONYMS

**A/C –** Assist Control

**ARDS** - Acute respiratory distress syndrome

**CPAP** - Continuous positive airway pressure

**DVT** - Deep vein thrombosis

**ETT** - Endotracheal tube

**FIO2** - Fraction of inspired oxygen

**GCS** - Glasgow coma score

**ICU** - Intensive care unit

**MODS** - Multiple organ dysfunction syndromes

**MV** -Mechanical ventilation

**PEEP** - Peak end-expiratory pressure

**PCV** - Pressure controlled ventilation

**PSV** - Pressure support ventilation

**SIMV** - Synchronized intermittent mandatory ventilation

**SPSS** - Statistical package for social sciences

**VAP** - Ventilator-associated pneumonia

**VCV** - volume-controlled ventilation

## Abstract

**Introduction:** Mechanical ventilation is the primary method of supporting organ function in patients treated in intensive care units. The information on the characteristics and outcomes of patients requiring mechanical ventilation is critical for the understanding of reasons for mortality. However, there is a scarce of literature in developing countries, including Ethiopia.

**Objective:** The objective of this study is to assess the characteristics and outcomes of mechanically ventilated adult ICU patients in selected public hospitals, Addis Ababa, Ethiopia, from 2019 to 2020.

**Method:** An institutional-based quantitative cross-sectional study design was employed. All Adult patients who were mechanically ventilated in adult ICU for at least 24 hours were included and the collected data was evaluated with Statistical Package for the Social Sciences version 25 software.

**Result**: Of 181 mechanically ventilated patients, 98(54.4%) were male. The main reason for ventilation was respiratory failure. Volume-controlled ventilation was the preferred initial ventilation mode followed by pressure-controlled ventilation. The main weaning technique employed for the survived patients was CPAP followed by a T-tube trial. The mean duration of stay in the ventilator was 7.09± 6.06, and the length of stay in ICU was 10.04 ± 10.242 days. The mortality rate in mechanically ventilated patients was 41.7%. The mortality rate was higher in patients with cardiac diseases. Inotropic use, sedation use, and length of stay on mechanical ventilator independently associated with mortality.

**Conclusion and recommendation:** The mortality rate of mechanically ventilated patients in the selected public hospitals was high. It is better to use a Customized severity score while admitting patients to ICU and implement different quality improvement projects.

**Keywords**: Mechanical Ventilation, Characteristics, Outcome

# 1. Introduction

## 1.1 Background

The number of patients requiring intensive care is increasing worldwide. Many of these patients need mechanical ventilation. (1). Mechanical ventilation is the essential strategy of supporting organ function in patients treated in intensive care units (ICUs) and has become emblematic of the ICU since its use has resulted in the development of intensive care units and the establishment of intensive therapy as a separate medical area (1).

Positive pressure mechanical ventilation proved to save lives during poliomyelitis epidemics of the 1950s. Since that time, there has been a growing increase in the use of ventilatory support, and it is closely associated with the development of critical care medicine. Early mechanical ventilators were used in conjunction with neuromuscular blocking agents to provide controlled ventilation. Today, most machines are triggered by the patient, and there is a growing awareness of the complexity of patient-ventilator interaction(2–4).

The Fundamental objectives of mechanical ventilation are to improve pulmonary gas exchange and relieve respiratory distress, thus facilitating lung and airway healing while at the same time lessening the risk for iatrogenic complications (5).

The reasons for putting patients on mechanical ventilation are varied and have traditionally been grouped into hypoxic and ventilatory respiratory failures. Some conditions predisposing to respiratory failure include respiratory distress, airway obstruction, reduced respiratory drive, abnormal chest wall, and respiratory muscle fatigue. However, the primary indication for ventilatory support should be reversible to enable early weaning of the ventilator (6).

The cause of respiratory failure, the goal of ventilation, and the patient's comorbidities should be taken into consideration when a ventilator is initially set. In general, ventilation is manipulated by changes in tidal volume and respiratory rate. To improve oxygenation, a fraction of inspired oxygen and/or Positive end-expiratory pressure can be increased. Positive end-expiratory pressure improves oxygenation by recruiting collapsed alveoli and decreasing intrapulmonary shunt (7).

Despite its importance, patients who put on ventilators are prone to preventable complications like ventilator-associated pneumonia, pneumothorax, pulmonary embolism, and atelectasis.. (8)

Sedation and analgesia are vital elements of care for many mechanically ventilated patients in the intensive care unit (ICU). Various prophylaxis measures also have been shown to effectively reduce the incidence of certain complications. This is particularly true for the prevention of Stress ulcers and deep vein thrombosis (DVT), where prophylaxis for critically ill patients to patients in the ICU is considered routine care (9,10).

Liberation from the ventilator is the ultimate purpose of mechanical ventilatory assistance. This is a simple procedure for the majority of patients. Initiating a test of unassisted spontaneous breathing in the form of either a T-piece test, a continuous positive airway pressure test, or a pressure supported ventilation (PSV) test is a simple and straightforward method of testing readiness for release from mechanical ventilation(11).

The outcome of mechanical ventilated patients has been studied previously. Esteban and colleagues reported the characteristics and outcomes of adult patients who were mechanically ventilated. They observed that 33% of patients admitted to the ICU were mechanically ventilated and “survival depended on both factors present at the start of mechanical ventilation and patient management in the intensive care unit” (12)

## 1.2. Statement of the problem

Mechanical ventilation is a cornerstone in critical care management, which is subjected to heterogeneous groups of patients with different diseases and is associated with various complications and mortality (13). Though there is no known data about specific death related to mechanical ventilators, according to the world health organization's recommendation, the total mortality rate in ICU for developing countries is between 30% up to 35 percent (14).

Mechanical ventilator predisposes patients to numerous complications, such as ventilator-induced lung injury, ventilator-associated pneumonia, and other nosocomial infections, venothrombotic events, pressure ulceration, gastritis, and increased length of stay. The probability of developing these complications increases with longer durations of Mechanical Ventilator support in a nearly linear relationship (15).

A chart review study from western India found that the prevalence of death among patients on mechanical ventilators in ICU was 67.21%. According to the study, patient management and pre-MechanicaVentilation factors were independently associated with increased mortality (16). Similarly, the study from Egypt shows that the prevalence of death among mechanically ventilated patients was 64% while 30.8% of mechanically ventilated patients developed Mechanical Ventilator-associated complications (13).

Most studies on the characteristics and outcome of ventilatory support were usually carried out in high-income countries and very little contemporary data from emerging countries are available(17–19) As a result, to the best of the investigator's knowledge, literature is scarce in developing countries including Ethiopia.

To my knowledge, this is the first study to describe the characteristics and outcome of adult patients on a Mechanically ventilated patient in ICU of selected public hospitals in Addis Ababa.

Therefore, this study aimed at assessing the reasons for using MV, clinical characteristics of the patients, different modes of ventilation, complications rate, outcomes, and associated factors of mortality of mechanically ventilated patients at adult ICU of selected public hospitals Addis Ababa.

## 1.3 Significance of the Study

The primary intent of this study is to assess the clinical characteristics and outcomes of mechanically ventilated adult ICU patients in selected public hospitals in Addis Ababa. Since mechanical ventilation is the most important intervention in ICU, it is crucial to assess its outcome and find the associated factors to increase the quality of care.

The information on incidence, patient characteristics, and outcomes of patients requiring mechanical ventilation is critical in understanding the reasons for mortality in patients. It will also help for better use of resources and making critical clinical decisions (20). There are few studies focused on the characteristics and outcome of mechanically ventilated patients in Ethiopia.

Therefore, the outcome of the study will hopefully provide input for policymakers, public hospitals that have mechanical ventilators, and ICU professionals to contribute to the improvement of quality of care. Furthermore, the study finding may also be used as baseline data for researchers who want to research on the same inquiry.

## 2: Literature review

Understanding of the characteristics of the mechanically ventilated patient such as the indication for mechanical ventilation, the ventilator management strategy, techniques used to identify patients capable of ventilator discontinuation, management of the interaction between weaning and sedation, and the outcome of the patient may help minimize both complications and resource consumption during mechanical ventilation. (21)

## 2.1 Characteristics of mechanically ventilated adult ICU patients

A retrospective study was done in the western India Intensive Care Unit shows 122 (22.4%) patients received MV for a mean duration of 4 days. The mean age of the ventilated patient was 58.80 and 46.7 % of them were females. 54.1% of them admitted from the emergency department while 45.90 from different wards. Acute respiratory failure 86.07%, Coma 9.02%, Acute respiratory failure on chronic pulmonary disease 4.09% Neuromuscular disease 0.82% were found to be the reason for the initiation of mechanical ventilation in the study. Regarding Risk factors for Acute Respiratory Failure in the last 48 h before start Mechanical ventilation 35% had a decreased level of consciousness due to disease or trauma, 30% sepsis, 16% heart failure 7% aspiration, and 6% pneumonia. The most commonly used initial ventilator mode was 66% Assist/Control Pressure Controlled Ventilation and 34% Assist/Control Volume Controlled Ventilation. Trials of weaning were performed with a T-piece trial in 89.6% of patients and continuous positive airway pressure was used in 10.4% of patients(16).

A study conducted on 138 patients in Maharashtra, India revealed that the most common etiology for MV was poisoning (53.6%). The mean age of patients was 43.22 years, ranging from 14 to 75 years with male predominance (73.91%). The average length of stay in ICU before MV, on MV, and the cumulative length of stay in ICU were 0.78, 5.9, and 6.4 days in non-survivors. (22),

A Prospective cohort study in the intensive care unit (ICU) of a general university hospital in southern Brazil between March 2004 and April 2007 reported that from 2,430 patients admitted to the ICU during the study period 1,115 (46%) of them were included in the study. The median age of the ventilated patient was 57.2 and 52 % of them were males. The sources of admission were the Hospital ward (56%) Emergency department (25%) and Other hospitals (19%). Reason for the initiation of mechanical ventilation were Sepsis (41.8%) Shock (37.8%) Pneumonia

(37%) ALI (15%) (ALI without ARDS (3.6%) ARDS (11.4%) Neurological condition Stroke (7.1%) Neuromuscular disease (1.3%) Other neurological condition (3%) COPD (5.4%) Cardiac arrest (6.0%) Asthma (1.6%). The most commonly used initial ventilator modes were 73 % A/C PCV and 20% PSV, 2.5% AC/VCV. The mean stay of the patient in mechanical ventilator, ICU, and hospital were 9.3, 14.6, and 24.7 respectively. Additionally,70.1% needed vasopressors (23).

A multi-center prospective cohort conducted in 19 intensive care units from 9 Chilean cities revealed that among 588 patients admitted, 156 (26.5%) received MV (57% males). Mean age 54.6+/-18 years. The most common indications for MV were an acute respiratory failure (71.1%) and coma (22.4%). Assist-control mode (71.6%) and synchronized intermittent mandatory ventilation (SIMV) (14.2%) were the most frequently used. T-tube was the main weaning strategy. The mean duration of MV and length of stay in ICU were 7.8+/-8.7 and 11.1+/- 14 days respectively (19).

A retrospective cohort study performed at the critical care department of Cairo University showed that 1081 patients were mechanically ventilated. The duration of ventilation was 6±10 days, and the length of ICU stay was 13±15 days. The most commonly used mode was VCV (61.8%), followed by Non-Invasive Continuous Positive Airway Pressure (15.4%), positive crankcase ventilation (PCV) (14.7%). The most common weaning method used was Pressure Support – Continuous Positive Airway Pressure (PS-CPAP) followed by unplanned extubation. The diagnosis that was the cause for a longer duration of ventilation was respiratory diseases (11.3±15.7 days) followed by CNS diseases (5.95±7.38), sepsis and septic shock (5.14±6.03), and cardiac diseases (3.84±6.75). Many complications from mechanical ventilation were found in this study group: 14.8% of patients developed VAP, 6.1% of patients developed pneumothorax, of which 1% cases developed tension pneumothorax. and, 2.8% Cardiopulmonary arrest (13).

A single-center study conducted in a rural hospital of India prevailed that 505 patients were admitted to ICU within 2 years. Out of admitted patients, 161(31.88%) were received mechanical ventilation. The main reason for ventilation was Acute kidney injury (36.6%), Sepsis (31.28%), neurological (26.34%), cardiac (16.23%), and respiratory (14. 46%). Comorbidities were seen in 76.4% of patients. Chronic kidney disease (CKD) (17.23%) and coronary artery disease (CAD)

(14.65%) were commonest comorbidities followed by hypertension (12.27%) and diabetes (11.68%). (24)

A Prospective Study conducted in the Intensive Care Unit of the University of Benin Teaching Hospital, Nigeria, showed that a total of 128 patients were admitted to the ICU over six months, and 44 (34.4%) were mechanically ventilated. The mean age of ventilated patients was 37.7 ± 21.10 years with a male to female ratio of 1:1.2. Respiratory distress and airway protection were the main indications for mechanical ventilation in this study, representing 38.6% and 27.3% respectively. Other indications included deteriorating Glasgow coma score (GCS) and hyperventilation, 20.5% and 13.6% respectively. Patients were ventilated for a variable number of days ranging from1-36 days. The mean duration of ventilation was 12.30 ± 10.10 days with most patients ventilated for 1-7 days (38. 6%). The ventilation duration had a significant effect on liberating patients from a mechanical ventilator. 68.2% were successfully weaned off the ventilator while the rest of the patients were ventilator-dependent during the period of the study. The preferred initial mode of ventilation was Synchronized intermittent mandatory ventilation (SIMV) (52.3%). Assist control mode (A/C) employed in 47.7% of patients in the units. Those needing ionotropic supports being about five times less likely to be weaned off ventilator compared with those not on inotropes (25).

A prospective observational study conducted at Ayder comprehensive specialized hospital adult ICU in Ethiopia showed a total of 105 (36.7%) patients received invasive MV. The median age of the sampled patients was 32 years, and 16.2% were above the age of 60 years. The main reason to put on a ventilator was an acute respiratory failure (50.5%) and followed by coma (35.2%). The median duration of stay on Mechanical Ventilator was 8 days and, 11.4% of them had prolonged MV use, and 21% had no DVT prophylaxis despite no contraindications. Complications were observed in 63.8% including, stress-related gastric bleeding (28.6%), VAP (27.6%), AKI (22.9%) and new septic shock development (20%), and so on(26)

## 2.2 Outcome of mechanically ventilated adult ICU patients

Mechanical ventilation is a cornerstone of care in current intensive care units. Even though Mechanical Ventilation is not therapeutic—it is only a support technology, which is designed to assist gas exchange while avoiding harm. Consequently, one of the overarching goals of MV is to liberate as quickly as possible from the machine. (27).

A retrospective study done in an Indian Intensive Care Unit showed overall mortality for the unselected general ICU patients on MV was 67.21% while that for ARDS patients was 76.1%. The main factors independently associated with increased mortality were pre-MV factors: age, heart failure, patient management factors: positive end-expiratory pressure, and Factors occurring throughout MV development of renal failure and hepatic failure after initiation of MV (16).

The study conducted in central India reported that the mortality rate of patients on mechanical ventilation was 42.1%. 35 patients required inotropes support with a mortality of 62.8 %. Coronary artery disease, hypertension (mortality- 56%) and CKD (mortality-80%) showed significant association with outcome(24).

A multicenter, prospective cohort study done in Brazil prevailed that the overall ICU and hospital mortality rates were 34%. In the multivariate analysis, age, comorbidities, associated organ failures, moderate to severe ARDS were independently associated with hospital mortality (28).

A retrospective cohort study conducted at the critical care department of Cairo University, Egypt, showed Mortality rate in mechanically ventilated patients was 64%. The mortality rate was higher in patients with cardiac diseases followed by respiratory disease, central nervous system diseases, and septic shock. The mortality rate was 60.4% in patients ventilated for less than a week, 79.2% in patients who stayed for two weeks on mechanical ventilation, 81.8% for patients ventilated for three weeks, and 71.2% for patients who were on mechanical ventilation for more than three weeks ($P$=0.0001). There was a significant association between mortality and comorbidities, as the highest mortality was seen in patients with six (76.4%) comorbidities and lowest in patients with only two (47.7%) comorbidities ($P$=0.0001) (13).

A retrospective Descriptive Study conducted in the Intensive Care Unit of Ugandan Regional Referral Hospital indicates that the mortality rate among ventilated patients was 73.5 % (29).

A prospective study conducted at Ayder comprehensive specialized hospital adult ICU in Ethiopia showed that the overall ICU mortality rate for patients under invasive MV was 28.6%. Age above 60 years old and new septic shock development was associated with a substantially increased risk of mortality (26).

# 3: Objectives

## 3.1 General Objective

The objective of this study is to assess the characteristics and outcomes of mechanically ventilated adult ICU patients in selected public hospitals, Addis Ababa, Ethiopia, from 2019 to 2020.

## 3.2 Specific Objectives

- To assess the clinical characteristics of mechanically ventilated adult ICU patients in selected public hospitals in Addis Ababa, Ethiopia.
- To determine the outcomes of mechanically ventilated adult ICU patients in selected public hospitals in Addis Ababa, Ethiopia.
- To identify factors, which are, associated with poor outcome of mechanically ventilated adult ICU patients in selected public hospitals, Addis Ababa, Ethiopia.

# 4: Methodology

## 4.1 Study Area and period

Addis Ababa is the capital city of Ethiopia, and the seat of the African Union and Economic Commission for Africa is situated at the heartland of Ethiopia, with a total population of 4,793,699 in an area of 540 square kilometers. The city encompasses 11 sub-cities, and 116 woredas also hold 40 private hospitals, 86 health centers, and 14 public hospitals. Among 14 public Hospitals, 6 Hospitals are administrated under Addis Ababa Health Bureau, five hospitals are administrated under the Federal Ministry of health, 1 hospital is administrated under Addis Ababa University the remaining two hospitals are under self-administration. (30) Among those 14 hospitals, Torhayiloch and Police force hospitals were excluded due to ethical issues, Ammanuel mental health hospital was excluded due to lack of service, and Alert hospital was excluded due to lack of cooperation from the hospital. The study was conducted in three selected public hospitals in Addis Ababa. These are Menilik II Hospital, Yekatit 12 Hospital, and St. Paul Hospital, where they provide Mechanical ventilation for critically ill patients.

The study was undertaken in selected three public Hospitals from February 27 to March 27, 2021.

## 4.2 Study Design:

An institutional-based cross-sectional study was employed through a review of patient's medical cards, which were admitted from July 2019 to July 2020.

## 4.3 Source Population:

All patients who were admitted to Adult ICU in selected public hospitals on the stated period

## 4.4 Study population

The study population was a randomly selected Mechanically ventilated adult patient from July 7, 2019, to July 8, 2020. in selected public hospitals.

## 4.5 Inclusion and exclusion criteria

### 4.5.1 Inclusion criteria

All Adult patients who were mechanically ventilated in ICU for at least 24 hours from July 7, 2019, to July 8, 2020.

### 4.5.2 Exclusion criteria

Those patients with incomplete recording, lost charts, and charts with poor handwriting (difficult to read).

## 4.6 Variables

### 4.6.1 Dependent variables

The outcome of mechanical ventilated adult patients

### 4.6.2 Independent variables:

Socio-demographic factors (sex, age), indication for initiation of MV, Length of stay (in hospital, ICU, on MV), mechanical ventilator mode, complications, Admission diagnosis, comorbidities, mode of weaning, sepsis, ARDS, MODS, organ failed in ICU, sedation used, Readmission status, CPR done, reintubation.

## 4.7 Operational definition

**Outcome** – in this study outcome is interpreted as a patient after mechanical ventilation whether they were survived or not survived.

**Characteristics** – what was male to female ratio, the age of mechanically ventilated patients, how (in what mode), what was their initial diagnosis while admission to ICU, what was their main indication, what access to the airway was employed, type of sedation used and for how long adult patients used the mechanical ventilator and what was the main complications they developed and also the method of weaning from a mechanical ventilator. And also did the patient develop ARDS, sepsis, and MODS during the mechanical ventilation period.

**MODS**: Failure of 2 or more organs in ICU. And also ODINS criteria was used to differentiate each organ failed (31).

## 4.8 Sample size determination

For the first and the second objectives, a single population proportion formula used to calculate the sample size by considering the following statistical assumptions;

$$n = [(z\ \alpha/2)^2 * p\ (1-P)]\ /d^2 \text{ where;}$$

- 'n' is the required sample size
- 'P' the proportion of ICU mortality rate for patients under mechanical ventilation taken as 28.6%, from study on Ayder comprehensive specialized hospital adult intensive care unit, Mekelle, Ethiopia.2017
- 'Z' is the standard score corresponding to a 95% confidence level
- 'd' is the margin of error of 5%

$$N_0 = \frac{[(1.96)^2 * (0.28 * 0.72)\ ]}{(0.05)^2} = 310$$

The total number of mechanically ventilated patient in selcted hospital were 450. Since this sample is taken from a relatively small population (less than 10,000) the sample size has been adjusted as

$$N = n_o/1 + n_0/N$$
$$310/1 + 310/450 = 184$$

Then we take 10% of 184 as a contingency value as missing data finally a total number of a sample size of the study is 202

Therefore, the sample size calculated is 202

## 4.9 Sampling technique and procedure

The Three public hospitals (Yekatiti 12 hospital, Minilik II hospital, and Saint Paul Hospital) were selected by simple random sampling. Then to select the study participants from each hospital, the proportional allocation formula was used based on caseloads. There about 450 mechanically ventilated adult patients (154 from Yekatiti 12 hospital, 120 from Minilik II hospital, and 176 from Saint Paul Hospital) from July 8, 2019, to July 7, 2020. After that, medical records of mechanically ventilated adult patients were taken from the identified cards in each hospital, simple random sampling technique was applied to select the study participants.

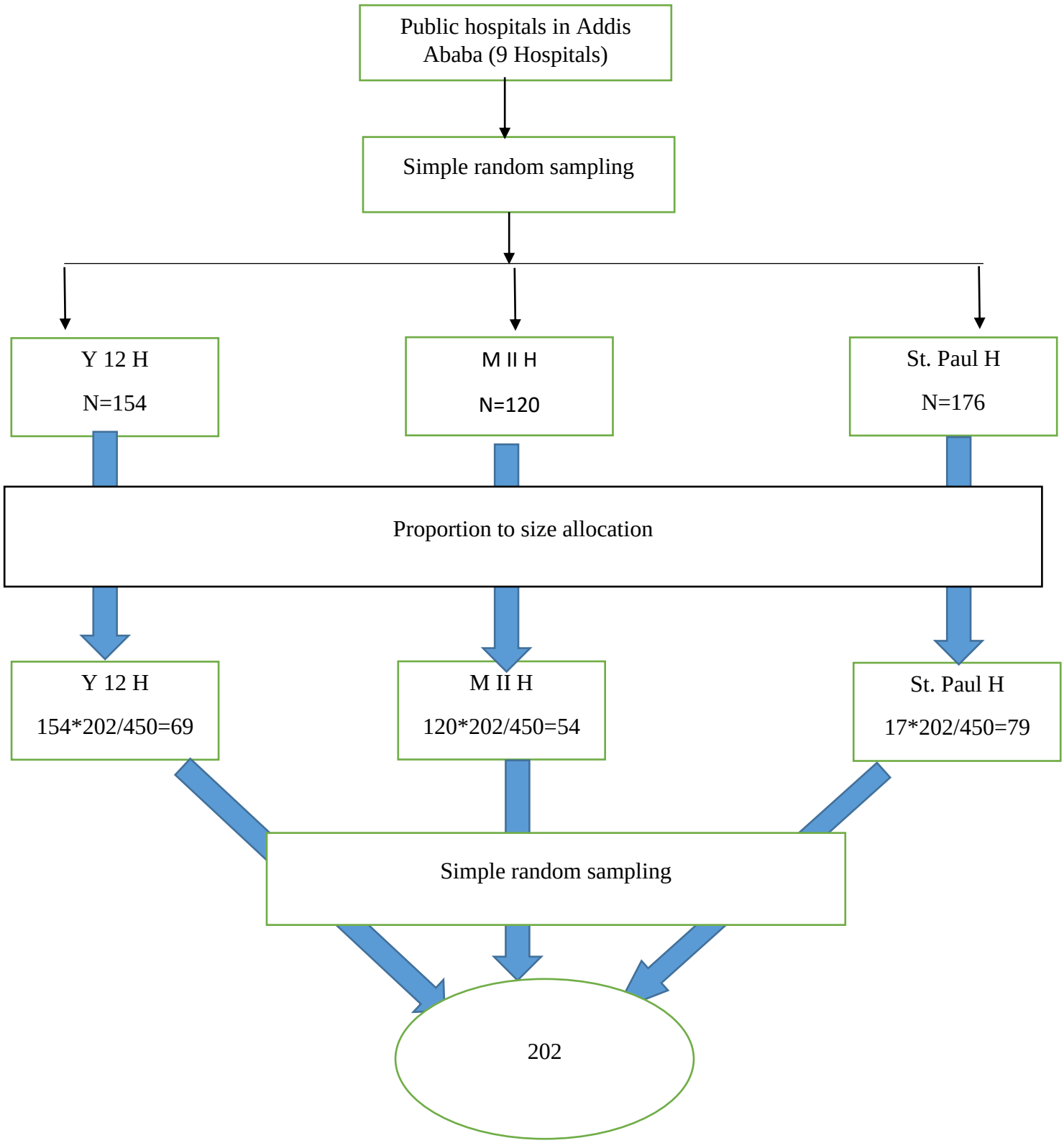


**Figure 1: A schematic representation of sampling method**

## 4.10 Data Collection tools and materials

Data was collected from the study population using a structured data abstraction tool adapted from different works of literature ((16),(32)(26) ) based on the elements intended to study.

## 4.11 Data quality assurance

A properly designed and structured data abstraction tool was used. Data collectors were given 2 days of training and closely supervised during data collection and entry. The data collectors were composed of health professionals (BSC ECC nurses, MSC EMCC nurses) for better understanding and interpretation of the patients' medical charts. The pre-test was carried out using ten patient cards of ICU admitted patients in Tirunesh Beijing general hospital to check the completeness and clarity of the tool. And some parts of the collection tool were revised and adjusted.

## 4.12 Data analysis

Clean up and cross-checking of data was done before analysis. Data was checked for completeness and coded manually and entered into SPSS version 26 for analysis. Both descriptive and analytical statistical procedures were utilized. Descriptive statistics like percentage, mean, median, standard deviation were used for the presentation of characteristics of mechanically ventilated patients. Tables and graphs were used for data presentation. Binary logistic regression was used to identify factors associated with outcomes of the ventilated patient. A multivariable logistic regression model was fitted to control the possible effect of confounders. Finally, the variables which have an independent association with poor outcomes were identified based on OR, with 95%CI and p-value less than 0.05.

## 4.13. Dissemination of the result

The result of this study was submitted to Addis Ababa University College of Health Sciences Department of Emergency medicine. The copies of this result will also be given to the federal ministry of health, Addis Ababa city administration health bureau, and hospital management, so they can use the findings for planning and implementation of intervention program, attempt to present in the different workshop, and publish my work in scientific journals, will be made.

## 4.14 Ethical consideration

The ethical clearance was obtained from Addis Ababa University College of health sciences department of emergency medicine and Addis Ababa Public Health and Emergency Management Directorate. Additionally, the confidentiality of all the data to be gained was respected. Confidentiality was ensured by not mentioning patient's names in the questioner and unauthorized individuals will not be allowed to access the data which was collected by using a password-protected computer.

# 5: Results

## 5.1 socio-demographic characteristics of ventilated adult patients

From 202 randomly selected mechanically ventilated patients, admitted from July 2019 to July 2020, Twenty-two patients had incomplete data on the charts and their charts could not be located. So that, 180 (89.1%) patients were included in this study. The majority 107(59.4%) of the participants were between 18-40 years. The mean and standard deviation age of respondents was 42.2±18.1 years with a minimum of 18 years and a maximum of 92 years old. More than half of the patients were male 98(54.4%).

**Table 1: Socio-demographic characteristics of mechanically ventilated adult patients in selected public hospital ICU (n=180) 2021.**

| variable | | Frequency (N) | Percent (%) |
|---|---|---|---|
| Age | 18-40 | 107 | 59.4 |
| | 41-70 | 56 | 31.1 |
| | >70 | 17 | 9,4 |
| Sex | Male | 98 | 54.4 |
| | Female | 82 | 45.6 |

## 5.2 Characteristics mechanically ventilated patients

### 5.2.1 Categories and source of admission to ICU

From the total of 180 ventilated patients' majority of them were medical diagnosis patients 123(68.3 %) followed by 42(23.3%) surgical diagnosis patients. Regarding the Source of ICU admission majority were from Emergency 94(52.2%), followed by inpatient Wards 57(37.1), Operation room 23 (12.1), and six (3.3%) were from other hospitals. Regarding the reason for admission (31.1%) had respiratory problems, followed by Neurologic (18.4%), and cardiac (11%). The readmission rate was 8.3%. For the admission, diagnoses see Table 2.

**Table 2: Reasons of admission for patients in MV, of selected public hospitals, 2021**

| Variable | Sub variable | Frequency(N) | Percent(%) |
|---|---|---|---|
| Neurological | TBI | 5 | 2.8 |
| (33, 18.4%) | Meningitis | 6 | 3.3 |
| | Stroke | 7 | 3.9 |
| | Subdural Hematoma | 4 | 2.2 |
| | Others | 11 | 6.2 |
| Respiratory | Bronchial Asthma | 6 | 3.3 |
| (56, 31.1%) | ARDS | 10 | 5.5 |
| | Pneumonia | 26 | 14.4 |
| | Pulmonary Trumbo Embolism | 6 | 3.3 |
| | upper airway obstruction | 3 | 1.7 |
| | Others | 5 | 2.8 |
| Cardiovascular | Congestive Heart Failure | 5 | 2.8 |
| (20, 11%) | Myocardial infarction | 6 | 3.3 |
| | Cardiogenic shock | 3 | 1.7 |
| | Peripheral artery disease | 3 | 1.7 |
| | Post cardiac arrest | 3 | 1.7 |
| Surgical (Post OP) (13, 7.3%) | Acute Abdomen | 14 | 7.8 |
| Sepsis (9, 5%) | | 9 | 5 |
| Renal (3, 1.7%) | Renal disease | 3 | 1.7 |
| Gastrointestinal | Upper GI bleeding | 3 | 1.7 |
| (10, 5.6%) | Liver disease | 3 | 1.7 |
| | Others | 4 | 2.2 |
| Endocrine | DKA | 3 | 1.8 |
| (7, 4.2%) | HHS | 1 | .6 |

| | | | |
|---|---|---|---|
| | Thyroid storm | 3 | 1.8 |
| Toxicology (9, 5%) | Poisoning | 9 | 5 |
| Others | Malignancy | 7 | 4 |
| (19, 10.7%) | PPH | 2 | 1.1 |
| | Burn | 1 | .6 |
| | Poly-trauma | 4 | 2.2 |
| | Tetanus | 4 | 2.2 |
| | Relapsing Fever | 1 | .6 |

TBI: Traumatic brain injury, HHS: hyperosmolar hyperglycemic state, DKA: diabetic ketone Acidosis, ARDS: acute respiratory distress syndrome, CHF: cardiac heart failure, PPH: postpartum hemorrhage RTA: road traffic accident

### 5.2.2 Risk factors for ARF in last 48 h before starting Mechanical Ventilation

The majority 163(90.6%) of the mechanically ventilated patient had the risk factor for acute respiratory failure 48 h before starting Mechanical Ventilation. Among this 141(78.3%) had Decreased level of consciousness due to disease or trauma, followed by sepsis 39(21.7%), postoperative state 38(21.1%), and pneumonia 36(20%) were the major risk factors.

**Table 3: Risk factors for ARF in last 48 h before starting Mechanical Ventilation, of selected public hospitals, 2021**

| Risk factors for ARF 48hr before starting MV | Frequency (N) | Percentage (%) |
|---|---|---|
| Decreased GSC due to disease or trauma | 141 | 78.3 |
| Sepsis | 39 | 21.7 |
| Postoperative state | 38 | 21.1 |
| Pneumonia | 36 | 20.0 |
| Aspiration | 31 | 17.2 |
| Heart failure | 15 | 8.3 |
| Severe trauma or burn injury | 9 | 5.0 |
| Pancreatitis | 2 | 1.1 |

### 5.2.3 Indication and Initial Mode of Mechanical ventilation

Respiratory failure and Airway protection were the major indications for mechanical ventilation in this study representing 47.8% and 41.7% respectively. Other indications included cardiovascular failure (shock) and neuromuscular disease, 9.4%, and 1.1% respectively. Access to the airway used was ETT 179(98.9%) and tracheostomy 2(1.1%). Various modes of ventilation strategy used in ICU and the frequency of each mode are as follows: The most commonly utilized initial ventilator modes were (92)51.1 % A/C VCV, followed by (42) 23.3% A/C PCV, (35)19.4 % SIMV, and (9) 5% CPAP.

### 5.2.4 Length of stay

The mean and standard deviation length of stay of respondents in the hospital was 16.85± 19.737, in ICU 10.04 ±10.242 and on Mechanical ventilator was 7.09±6.06. The majority of the patients stay in hospital (75 %,) and ICU (50%) for more than 7 days. On the other hand, majority of the patients stay on a mechanical ventilator for 3-7 days. In our study, those with Neuromuscular cases as a reason of ventilation had a significantly longer duration on ventilator (13.50 ± 2.121) followed by toxicology cases (11.13 ± 10.934) sepsis (8.56 ± 5.175) GI diseases (8.44 ± 7.418), and neurologic disease (7.87 ± 6.224).

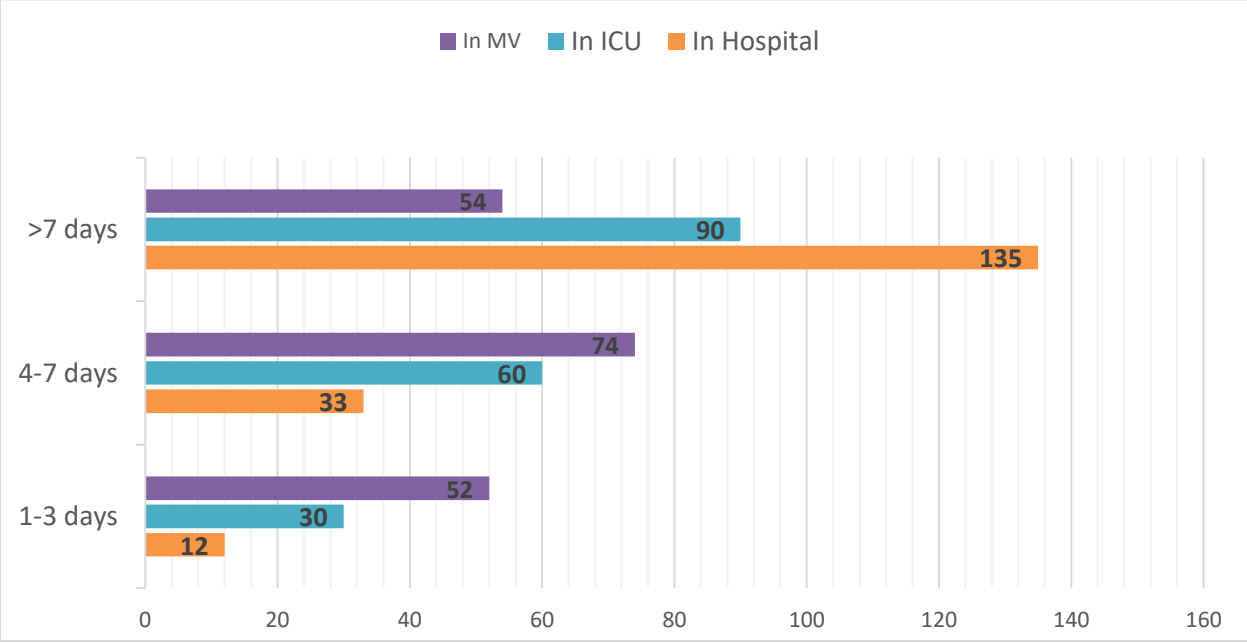


**Figure 2: length of stay in the hospital, ICU, and on mechanical ventilator of ventilated adult patients in selected public hospitals, ICU, Addis Ababa Ethiopia, 2021.**

### 5.2.5 Comorbidity and GCS at admission

From the total study population, 78(43.3%) patients had comorbidity, Hypertension 26(14.4%) and Diabetes mellitus 18(10 %) was the most common comorbidity followed by HIV/AIDS 14(7.8%), Tuberculosis 6(3.3%), CHF 9 (5%), stroke 5(2.8%) and others 7(5.6%). From the physical examination, the GCS of patients at admission was ≤ 8 in 68 (37.8%), 9-12 in 48 (26.7%) and the remaining 64(35.6%) patients GCS was from 13-15.

### 5.2.6 The sedation used and Complication

Of 180 patients who were connected to MV 150 (83.3%) used sedatives drugs. Of which more than half (53.8%) were sedated using Diazepam followed by ketamine (25.3%), Morphine (12.8), Propofol (9.1%), and thiopental 4(1.6%). 40 (22.2%) of mechanically ventilated patient develop mechanical ventilation related Complications of which ventilator-associated pneumonia developed in 27(15%) patients; pneumothorax in 6(3 %) patients, emphysema and post-extubation stridor each account for 3(1.7%) patients and other complications account for 7(3.8%)

### 5.2.7 Organ failure and other characteristics

From the total of 180 ventilated patients more than half 122(67.8 %) developed at least one organ failure. 49 (27.2%) developed multi organ dysfunction syndrome. Of this 59(32.8%) developed cardiac, 48(26.7%) renal 51(28.3%) Neurological, 15(8.3%) Hematologic and 13(7.2%) Hepatic failure. The weaning methods used for the improved patients were CPAP 54 (51%), T-tube trial 23(22%), PS with CPAP 24(23%), and accidental extubation 4(4%). Acute respiratory distress syndrome was seen in 24(13.3%) of the patients. Regarding inotropic drugs use, 74(41.1%) of patients used inotropic drugs, Ulcer and DVT prophylaxis were used by 118(65.6%), and 136(75.6%) of them respectively. For 13(7.2%) patients cardiopulmonary resuscitation procedures were performed before they were admitted to the intensive care unit.

## 5.3 Outcome

Among the total study participants, 105(58.3 %) survived, and 75(41.7%) dead. Sepsis was the leading cause of death 35(46.67). The mortality rate was higher in patients with cardiac diseases (59%), followed by respiratory disease (48 %). The mortality rate was 57.7% in patients ventilated for 1-3 days, 44 % in patients who stayed for more than 7 days on mechanical ventilation, 28.37% for patients ventilated for 4-7days.

## 5.4 Factors associated with the outcome of ventilated patients admitted at ICU

In bivariate regression analysis age, GCS level, readmission status, Risk for ARF,(sepsis, postoperative state, cardiovascular), length of stay in hospital in days, length of stay in ICU, Length of stay in MV, MV related complication, CPR before admission, inotropic use, DVT prophylaxis multi-organ dysfunction syndrome (MODS) and sedation used were statistically associated with mortality at a p-value of less than 0.25.

In multivariable regression analysis length of stay on MV, Inotropic use, and sedation used were statistically positively associated with mortality at a p-value of less than 0.05 but the other variables were not found statistically significant. The probability of mortality for those who stay in mechanical ventilator more than 7 day is greater than by 19.2 %( OR, 0.192; 95% CI, 0.040-0.926) as compared to those who stays for 4-7 days. The odds of mortality for those who were not taken sedation is higher by 3.951 times (OR, 3.951; 95% CI, 1.035 - 15.089) as compared to those who have taken sedatives. The odds of those who taken inotropes mortality is higher by 17.5 times (OR, 17.5; 95% CI, 4.652-65.959) than those who have not taken inotropes

**Table 4: Logistic regression analysis of associated factors with the outcome of mechanically ventilated patients among adult ICU of selected hospitals, Addis Ababa, Ethiopia, 2021**

| Variables | | Final Outcome | | COR(95%CI) | AOR(95%CI) | P Value |
|---|---|---|---|---|---|---|
| | | survived | Dead | | | |
| Age | <40 | 34 | 22 | 0.470 (0.166-1.331) | 1.136 (0.187-6.895) | 0.890 |
| | 40-70 | 64 | 43 | 0.453 (0.150-1.367) | 0.390 (0.062-2.461) | 0.316 |
| | >70 | 7 | 10 | 1.00 | 1.00 | |
| GCS category | 3-8 | 27 | 41 | 2.899 (1.427-5.888) | 0.846(0.151-4.757) | 0.850 |
| | 9-12 | 36 | 12 | 0.636 (0.277-1.463) | 0.383(0.102-1.442) | 0.156 |
| | 13-15 | 42 | 22 | 1.00 | 1.00 | |
| Risk for ARF | Yes | 91 | 72 | 3.692(1.022- 13.342) | 1.810(0.186- 17.640) | 0.610 |
| | No | 14 | 3 | 1.00 | 1.00 | |
| Risk for ARF: Sepsis | Yes | 10 | 29 | 5.989 (2.690-13.334) | 1.938 (0.517-7.262) | 0.326 |
| | No | 95 | 46 | 1.00 | 1.00 | |
| Risk for ARF: Aspiration | Yes | 23 | 8 | 0.426 (0.179-1.013) | 0.482 (0.111-2.104) | 0.332 |
| | No | 82 | 67 | 1.00 | 1.00 | |
| Risk for ARF: Postoperative state | Yes | 17 | 21 | 2.013 (0.976-4.151) | 1.056 (0. 315-3.542) | 0.930 |
| | No | 88 | 54 | 1.00 | 1.00 | |
| Length of stay in ICU) | 1-3 | 8 | 22 | 5.500 (2.191-13.805) | 8.554(0.946-77.342) | 0.056 |
| | 4-7 | 37 | 23 | 1.243 (0.630-2.455) | 1.995(0.471-8.444) | 0.348 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | >7 | 60 | 30 | 1.00 | 1.00 | |
| Length of stay in MV | 1-3 | 22 | 30 | 1.705 (0.790-3.676) | 0.452(0.068-3.018) | 0.412 |
| | 4-7 | 53 | 21 | 0.495 (0.237-1.035) | 0.192(0.040-0.926) | 0.040** |
| | >7 | 30 | 24 | 1.00 | 1.00 | |
| Readmission | yes | 5 | 10 | 3.077 (1.006-9.412) | 2.459(0.532-11.359) | 0.249 |
| | No | 100 | 65 | 1.00 | 1.00 | |
| MV complication | yes | 20 | 22 | 1.545 (0.762-3.133) | 1.924 (0.556-6.649) | 0.301 |
| | No | 85 | 55 | 1.00 | 1.00 | |
| Organ failure | yes | 59 | 63 | 4.093 (1.977-8.475) | 0.502 (0.102-2.388) | 0.386 |
| | No | 46 | 12 | 1.00 | 1.00 | |
| Cardiovascular(OF) | yes | 20 | 39 | 4.604 (2.367- 8.954) | 1.040(0.217-4.996) | 0.961 |
| | No | 85 | 36 | 1.00 | 1.00 | |
| | yes | 23 | 25 | 1.783 (0.915- 3.472) | 1.313(0.255-6.769) | 0.745 |
| Renal(OF) | No | 82 | 50 | 1.00 | 1.00 | |
| Neurological(OF) | yes | 16 | 35 | 4.867 (2.419- 9.795) | 6.470 (0.947-44.214) | .057 |
| | No | 89 | 40 | 1.00 | 1.00 | |
| MODS | yes | 15 | 34 | 4.976 (2.444-10.130) | 0.772 (0.238-4.309) | 0.768 |
| | No | 90 | 41 | 1.00 | 1.00 | |
| CPR before Admission | yes | 1 | 12 | 19.810 (2.515-156.025) | 3.086(0.186-51.189) | 0.432 |
| | No | 104 | 63 | 1.00 | 1.00 | |
| Inotropic use | yes | 16 | 58 | 18.978 (8.888-40.523) | 17.517(4.652-65.959) | 0.000** |
| | No | 89 | 17 | 1.00 | 1.00 | |
| DVT prophylaxis | yes | 74 | 44 | 1.00 | 1.00 | |
| | No | 31 | 31 | 1.682 (0.903-3.133) | 0.815 (0.219-3.036) | 0.760 |
| GI prophylaxis | yes | 85 | 51 | 1.00 | 1.00 | |
| | No | 20 | 24 | 2.000 (1.006-3.977) | 0.623(0.144-2.685) | 0.525 |
| Sedation used | yes | 93 | 57 | 1.00 | 1.00 | |
| | No | 12 | 18 | 2.447 (1.098-5.454) | 3.951 (1.035 - 15.089) | 0.044** |
| Presence of ARDS | yes | 11 | 13 | 1.792 (0.755-4.254) | 2.320(0.503-10.710) | 0.281 |
| | No | 94 | 62 | 1.00 | 1.00 | |

NB *=p<0.05, and 1.00=reference

## 6. DISCUSSION

The use of a mechanical ventilator in patients admitted to ICU has been increasing. The data regarding the characteristics and outcome of the ventilated patient is vital since it allows better conveying the outcome to the patient's family(33). This study assessed the characteristics and outcomes of mechanically ventilated adult patients admitted in ICU of selected public hospitals in Addis Ababa.

The Mean age of the mechanically ventilated patient in this study was 42.2±18.1 years and 54.4% of them were males. (52%). This finding was similar with a study conducted in Maharashtra, India (43.22 years) and lesser than studies done in western India (58.80 years) and chili (54.6 years) (16,19,22). This may be due to the lower mean age of the Ethiopian population. The preponderance of male sex (54.4% was similar to a study done in Brazil(23).

In this study, Sources of admission of mechanically ventilated patients were from Emergency (52.2%), inpatient Wards (37.1), Operation room (12.1), and (3.3%) were from other hospitals. The study conducted in India shows 54.1% of patients admitted from the emergency department while 45.90 from different wards which are in line with our study(16). However, the 4-year prospective study in southern Brazil shows the sources of admission to ICU were from the Hospital ward (56%), Emergency Department (25%), and Other hospitals (19%) which is different from our study(23).

Respiratory failure was the main indication for mechanical ventilation in this study representing 47.8%. Other published studies in India, chili, Nigeria, and Ethiopia also show that respiratory failure is the main indication for putting a patient on Mechanical Ventilator which ranged from 38.6-86.07% (6,16,19,26). Nevertheless, the study conducted in Cairo prevails cardiac disease as the predominant indication of mechanical ventilation. This discrepancy in indication might be due to the type of intensive care unit and the difference in the category of diseases in the setting.

The most commonly utilized initial ventilator modes in this study were (92)51.1 % A/C VCV, followed by (42) 23.3% A/C PCV, (35)19.4 % SIMV, and (9) 5% CPAP. Similarly, Tobi et al. found that volume-controlled ventilation (VCV) was the main initial ventilation strategy (61.8%) employed among other modes (13). On the other hand, the study conducted in India and Brazil indicates the predominant mode of initial ventilation (66% & 73%) was the PCV, and in Benin

teaching hospital, Nigeria the preferred mode of ventilation was SIMV (52.3%) which is different from our study(16,23,25). The selection of initial ventilation strategy can be varying based on the individual preference and need but the function of mode is the same.

In this study, the mean duration of patient stayed on mechanical ventilator, ICU, and the hospital was 7.09± 6.06, 10.04 ± 10.242, and 16.85± 19.737 respectively. Likewise, a multicenter study conducted in 19 Chilean ICU showed that the Mean duration of MV and length of stay in ICU were 7.8±8.7 and 11.1± 14 days respectively (19). The report from Nassar et al. also showed that the duration of mechanical ventilation was 6±10 days which is slightly similar to our study(13). However, the study conducted in southern Brazil and Nigeria showed a higher mean duration of stay on mechanical ventilation which is 9.3 days and 12.3 days respectively(23,25). The discrepancy in ventilator stay among the other studies might be due to late admission of patients because of shortage of beds and other facilities in our hospital. In our study, those with Neuromuscular cases had a significantly longer duration of ventilation (13.50 ± 2.121) followed by toxicology cases (11.13 ± 10.934) this finding differ from the study conducted in Egypt which shows respiratory diseases (11.3±15.7 days) and CNS diseases (5.95±7.38) had a longer stays in mechanical ventilator(13).

The majority 163(90.6%) of the mechanically ventilated patient had the risk factor for acute respiratory failure. Among these Decreased level of consciousness due to disease or trauma (78.3%) and sepsis (21.7%) were the major risk factors in this study. The major risks factors are in line with a study of Kathib et al. but the decreased level of consciousness was higher and sepsis was lesser in our study as compared to the report by Kathib et al. which is 35% had a decreased level of consciousness due to disease or trauma and 30% had sepsis before initiation of mechanical ventilation (16) this might be due to difference in the category of diseases in the settings.

From the ventilated patients more than half (67.8 %) developed at least one organ failure. Of this (32.8%) developed cardiac, (26.7%) renal (28.3%) Neurological, 15(8.3%) Hematologic and 13(7.2%) Hepatic failure. And (27.2%) developed multi-organ dysfunction syndrome. Our result differs from the study conducted in southern Brazil which shows higher multi-organ dysfunction (45%) and the organ failing were renal (26%), cardiovascular (20.4%), coagulopathy (18%),

neurological (10%), and hepatic (7.7%). This might be due to the diagnostic capability and specialization of the ICU.

In this study, (22.2%) of the events developed mechanical ventilation-related complications. The main complications were ventilator-associated pneumonia (15%) and pneumothorax (3 %). This finding slightly similar to the finding by Nassar et al. in which 14.8% of patients developed VAP, 6.1% of patients developed pneumothorax as major complications(13). However, the report from Berhe et al. shows a higher VAP (27.6%) rate than our study(26).This might be due to the better care.

Weaning from Ventilator is the main issue in ICUs. The main weaning technique employed for the survived patients in this study was CPAP 54 (51%) followed by T-tube trial 23(22%). Our finding is different from the study conducted in chili and in Egypt in those studies the preferred method of weaning were T-tube and PS-CPAP respectively(13,19). The difference might be due to the preference of the physicians and the patient's tolerance for both methods.

In the present study, the overall mortality rate as an outcome in the patients requiring invasive mechanical ventilation support was 41.7**%.** The report from different published study shows in Brazil 34%, in central India 42.1, western India 67.21, Nigeria 31.8% , Egypt 64%, Uganda 73.5% and in Ayder hospital Ethiopia 28.6% (6,13,16,23,24,26,29). Our findings were almost the same as the study conducted by Chiwhane and Diwan, which reported 42.1%. the mortality in our study was higher than the studies conducted in Brazil (34%), Nigeria (31.8%), and Ayder hospital Ethiopia (28.6%). The highest mortality in our study might be due to delayed admission to intensive care due to delayed professional decision, lack of bed and an inadequate number of a ventilator, late referral, admission problem (admitting unsalvageable Patients, lack of standardized illness severity scoring strategies). In this study mortality rate was higher in patients with cardiac diseases (59%). similarly, Nassar et al reported that the mortality rate was higher in patients with cardiac diseases.

Sepsis is the leading cause of death in our study, which is a preventable and potentially curable disease. This may implicate there might be a gap in infection prevention methods. The gap could be minimized by improving our diagnostic capabilities, strictly following standard infection prevention protocols, and giving proper training on the care of mechanically ventilated patients for those professionals working in ICU.

The main factors independently associated with mortality in this study were the length of stay on the Mechanical Ventilator, Inotropic use, and sedation use. Our findings are different from a study conducted in southern Brazil, Maharashtra India, and Ayder which reported that age, organ failures, ARDS, comorbidity, sepsis, length of stay on mechanical ventilation, ICU stay that were significant associated with mortality(23,24,26). This difference might be due to the study design, sample size, and setup of the hospital.

## 7: Limitation and strength

The findings in this study are subjected to some limitations. Since the nature of the study was retrospective, no direct intervention or direct observation of patients was done. The limited number of patients also another limitation.

Despite the limitations, this study has strengths. It is the first multicenter study on characteristics and outcomes of mechanically ventilated patients in adult ICU of Addis Ababa, possibly in Ethiopia. It also tried to incorporate most of the pertinent characteristics of mechanically ventilated patients.

## 8. Conclusion

The mortality rate of mechanically ventilated patients in the selected public hospitals was high (41.7%). The main reason for admission was respiratory causes. Respiratory failure was the main indication for the initiation of mechanical ventilation. The main factors independently associated with mortality in this study were the length of stay on the Mechanical Ventilator, Inotropic use, and sedation use.

## 9: Recommendation

For Federal ministry of health

- It is better if there are customized scores and other predictors for predicting the outcome as they allow judicious use of resources.
- It would be better if there is an infection prevention protocol for intensive care units.

For Addis Ababa of health bureau

- To arrange different training on a mechanical ventilator and patient care for ICU professional
- To increase the number of beds and mechanical ventilators in AICU.

For respective Hospitals

- To conduct quality improvement projects
- To improve the patient record keeping.

For researchers:

- It is better to conduct more such studies prospectively in different regions of Ethiopia, as this is from selected public hospitals of Addis Ababa.

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## Annex 1 Data abstraction tool

| | | | | |
|---|---|---|---|---|
| Age | | | | |
| Sex | Male | | Female | |
| Source of admission | Emergency ward | | Elective OR | |
| | Ward | | | |
| | Other hospitals | | | |
| Readmission | Yes | | No | |
| Admission Diagnosis | Respiratory | | Renal | |
| | Cardiovascular | | Other | |
| | Surgical | | | |
| | Neurological | | | |
| | Trauma | | | |
| | Obstetric | | | |
| Disease character | Medical | | Surgical | |
| | Obstetric | | Trauma | |
| Indication for MV | Neurological (coma) (Safe airways) | | | |
| | Respiratory failure | | | |
| | Cardiovascular failure( shock | | | |
| Access to airway | ET Tube | | Tracheostomy | |
| Initial Mode of mechanical ventilation | | | | |
| Risk factors for ARF in the last 48 h before start MV | Heart failure | | Sepsis | |
| | Decreased level of consciousness due to disease or trauma | | Massive transfusion (>8 units of packed red blood cells/12 h) | |
| | Postoperative state | | Pancreatitis | |
| | Pneumonia | | Severe trauma or burn injury | |
| | Aspiration | | | |
| Pre-existing comorbidities | | | | |
| Length of stay | In hospital | | On Mechanical ventilator | |
| | In ICU | | | |
| Complication | Yes | | VAP | |

| | | | | |
|---|---|---|---|---|
| | | | Pneumothorax | |
| | | | Atelectasis | |
| | | | Post extubation strider | |
| | | | Other | |
| | No | | | |
| ARDS | Yes | | No | |
| GCS | | | | |
| Weaning method | PS with CPAP | | T-TUBE | |
| | CPAP alone | | Accidental extubation | |
| Organs failing in ICU | Renal | | Hematologic | |
| | CNS | | Hepatic | |
| | Cardiac | | | |
| Sedation used | Diazepam | | Morphine | |
| | Ketamine | | Thiopental | |
| | Propofol | | | |
| Inotropes Use | Yes | | No | |
| CPR within 24 hours before ICU admission | Yes | | No | |
| Outcome | Death | | Transfer to the inpatient ward | |
| | Discharge | | Referred | |
| | LAMA | | | |
| Cause of death | | | | |

## Annex 2: ODINS criteria

| Organ system dysfunction | Criteria |
|---|---|
| Respiratory | Pao2 < 60 Torr (FIO2 =0.2) or need for ventilatory support |
| Cardiovascular | SBP < 90 mmHG with signs of peripheral hypoperfusion, continuous infusion of vasopressor or inotrope agent to maintain > 90 mmHg SBP. |
| Renal | Serum creatinine >300 µmol/L or urine output < 500ml/24h or <180 ml/8h or need for hemodialysis or peritoneal dialysis |
| Neurologic | GCS < 6(in the absence of sedation at any time in the day) or sudden onset of confusion or psychosis |
| Hepatic | Serum bilirubin > 100 µmol/L or alkaline phosphatase > 3 times from the normal value |
| Hematologic | Hematocrit < 20% or TLC <2000/mm3 or platelet count < 40000/mm3 |
| Infectious | 2 positive blood cultures or presence of gross pus in a closed space or source of infection determined during hospitalization or at autopsy in case of death within 24 hour |