



ST. PAUL HOSPITAL MILLENNIUM MEDICAL COLLEGE

Incidence of extubation failure and its predictors among adult mechanically ventilated patients in selected public hospitals intensive care unit, Addis Ababa city administration, Ethiopia.

Dr. OFFIFEN TAMENE (ECCM RESIDENT)

A research thesis submitted to department of emergency and critical care medicine, in partial fulfillment of the specialty in emergency and critical care medicine.

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Investigator address	Dr. Offifen Tamene (MD, Resident) :Phone Number: +251-9-35-93-24-27 E-Mail: offifen@gmail.com
Name of advisors	Dr Sisay Hailu (Assistant professor of ECCM): Phone No: 09-13-81-41-72 Dr Hana Ketema (Assistant professor of ECCM): Phone No: 09-13-78-25-54

SAINT PAUL HOSPITAL MELLINIUM MEDICAL COLLEGE

DEPARTMENT OF EMERGENCY AND CRITICAL CARE MEDICINE

Incidence of extubation failure and its predictors among adult mechanically ventilated patients in selected public hospital intensive care units, Addis Ababa city administration, Ethiopia.

Investigator name: Dr. Offifen Tamene (ECCM final year resident)

Name of advisors: Dr Sisay Hailu (Assistant professor of ECCM)

Dr.Hana Ketema (Assistant professor of ECCM)

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Acronyms

AaBET	Addis Ababa Burn, Emergency and Trauma
ALERT	All African Leprosy Rehabilitation and Training Center Hospital
ECCM	Emergency and Critical Care Medicine
ICU	Intensive Care Unit
ER	Emergency Room
MV	Mechanical Ventilator
EF	Extubation Failure
ETT	Endotracheal Tube
SPHMMC	St. Paul Hospital Millennium Medical College
AOR	Adjusted Odds Ratio
VAP	Ventilator Associated Pneumonia
APACHE	Acute Physiology and Chronic Health Evaluation
FIO2	Fraction of Inspired Oxygen
PI	Principal Investigator
DC	Data Collector

Abstract

Background: Extubation failure is a common complication in critically ill adult patients who require mechanical ventilation. It occurs when a patient cannot be successfully weaned from the ventilator and requires reintubation. This can lead to significant morbidity and mortality, as well as increased healthcare costs. Identifying and addressing risk factors can help improve outcomes for critically ill adult patients. Despite, the rising number of patients on mechanically ventilated in Ethiopia, there is limited data on the incidence of extubation failure and its predictors in mechanically ventilated patients.

Objective: To assess Incidence of extubation failure and its predictors among adults mechanically ventilated patients at selected public hospitals ICU in Addis Ababa, Ethiopia, 2023.

Methods: An institution based cohort study was conducted. A total of 202 adults mechanically ventilated patients were selected using a simple sampling technique. All adult mechanically ventilated patients at the selected public hospital from September 1, 2022, to August 31, 2023, were included whereas patients who had incomplete charts which missed the outcome variable were excluded. The data were collected by reviewing their medical records from September 1, 2022, to August 31, 2023. Variables having a p-value < 0.05 in the multivariate analysis was considered as statistically significant. The strength of association will be summarized by using an adjusted Odds ratio with corresponding 95% confidence interval.

Results: Out of the 202 ICU patients, 45.54% [95%CI 0.387- 0.52] developed Extubation Failure. Medical complication on MV Like AKI, AOR: 0.05 [95%CI: 0.003-0.60] prolonged duration on MV > 10 days AOR: 5.3 [95%CI: 1.01-27.7], GCS < 10, AOR: 5.9 [95%CI: 1.39-25.15], Increased endotracheal secretion: AOR: 19.07 [95%CI: 0.9-28.29] and greater than 2 times SBTs, AOR: 9.37 [95%CI: 1.38-63.48] were significantly associated with the extubation failure.

Conclusion

The incidence of extubation failure was one out of five in our study area. Medical complication on MV, Duration on MV $\geq$ 10 days, GCS < 10, Copious tracheal secretions and Frequency of SBTs > 2 times are independent variables those significantly predict the extubation failure.

Keywords: Extubation Failure, Extubation and Ethiopia.

1. Introduction

1.1. Background

Extubation failure is defined as the need for reinstitution of ventilatory support within 24 to 72 hours of planned endotracheal tube removal (1). A systematic review of weaning and extubation readiness among in ICU patients defined early EF as occurring within 6 hours of extubation, intermediate EF occurring at 6 to 24 hours post-extubation and late EF between 24 and 48 hours post-extubation(2). This is a common problem in intensive care units and can lead to prolonged mechanical ventilation, increased morbidity and mortality. In order to determine whether a patient is ready to be taken off the ventilator in the intensive care unit (ICU), spontaneous breathing trials (SBTs) are performed (3) and extubation is deemed successful if mechanical assistance is not needed for 48 hours after removal of the endotracheal tube (4). Extubation failure rates in the intensive care unit (ICU) range from 5 to 30%; these failures are typically due to respiratory failure, airway obstruction, excessive secretions, and difficulty protecting the airway and up to 50% of these cases required reintubation within 72 hrs (1, 5-8). Early identification of patients at risk, proper management of airway secretions, and appropriate use of non-invasive ventilation can reduce the incidence of extubation failure. However, further research is needed to better understand the incidence and risk factors of extubation failure in resource limited ICU setups.

Many studies suggest that extubation failure increases the mortality rate, length of hospital stays, healthcare expenditures, and ventilator-associated pneumonia(9, 10). As a result, ICU practitioners are interested to understand more about the determinants of extubation failure (EF). The possible factors associated with failed extubation includes; advanced age, aspiration or increased secretion, low GCS, positive fluid balance, prolonged mechanical ventilation, inadequate respiratory muscle strength, unstable hemodynamic status of the patients and high APACHE scores are some of the contributing factors for extubation failure (9-12).

Mechanical ventilator (MV) is an automated device that provides all or part of the work of breathing for patients with impaired respiratory or neurologic function. Mechanical ventilation plays a big role in critical care in adult ICUs. Nearly 50% of people who were mechanically ventilated had respiratory disorders as their primary diagnoses, and 30% had cardiovascular

diseases(13).Mechanical ventilation with positive pressure is a technique that has been employed in the intensive care units with increasing frequency.

Endotracheal tube (ETT) is a conduit for mechanical ventilation and provides airway support for individuals with upper airway abnormalities(14). According to a 1-day point prevalence study conducted in 412 medical-surgical ICUs in North America, South America, Spain, and Portugal; acute respiratory failure was the cause of mechanical ventilation in 66% of ventilated patients(15). Of these patients, 75% were ventilated via endotracheal tube(16). Thus, management of the endotracheal tube is a vital part of critical care.

Despite the efforts in western nations, its incidence, predictors, and effects are still unknown in sub-Saharan nations where predicting the outcome of an extubation is more difficult. To our knowledge, little is known about the relationship between extubation predictors and situations with limited resources for ICUs. As a result, the aim of this study is to examine incidence and the factors that predict EF in adult patients receiving mechanical ventilation in intensive care units. Therefore, early EF predictor identification helps in extubation from MV decision-making.

1.2. Statement of the problem

Globally, Extubation failure has been discovered to be significantly related to an increase in mortality rate (17-19). It also causes significant physical and psychological morbidity, disability, and premature mortality among those affected patients and imposes a heavy financial burden on health services(20, 21). According to review study in India shows. EF incidence reported in different ICUs ranged from 6% to 47% (22). Growing rates of extubation failure are associated with the development of extubation complications as a cause of early death and disability. Furthermore, it also asserted that this has an impact on the economy that results in a public health challenge for various countries (1, 6, 21). Studies have been conducted worldwide to identify the incidence and factors that influence extubation failure, but there are few studies on the extubation failure and its predictors in Ethiopia which is conducted in single center study. So, understanding the factors that contribute to extubation failure is essential to improve the quality of life patients. Therefore, the goal of this study is to assess the incidence of Extubation failure and predicting factors among adults mechanically ventilated patients in Addis Ababa at multiple centers.

1.3. Significance of the study

The findings from this study will benefit patients by providing the most relevant information and it gives evidence-based data on incidence and its predictors among mechanically ventilated patients in ICU for physicians and healthcare providers which create awareness on early prevention and control of the factors that cause intubation related complication and particularly, the development of extubation failure. The results of this study could also have important implications for clinical practice by improving the accuracy of extubation decisions and reducing the incidence of extubation failure, ultimately improving patient outcomes and reducing healthcare costs.

The results will provide insight for local health institutions, educational centers, policymakers, and governments to see the level of the problem and set appropriate interventions. This study will also deliver information on the contributing factors to the development of extubation failure and enable the Addis Ababa health bureau, the Ethiopian Ministry of Health, nurse administrators, and health institution managers to recognize and act on factors related to extubation failure. Additionally, this study could be used as a reference for further research in the future.

2. Literature Review

2.1. Incidence of Extubation failure

According to an observational study conducted in American college of surgeons level I trauma center over 3 years, overall rate of extubation failure was 5.7%(23).

In a multi-center cohort study of hospitalized COVID-19 patients done in OUWB school of Medicine, Royal Oak, MI, USA, up to 1 in 3 critically ill COVID-19 patients required reintubation (24). In a cohort study of 2,007 endotracheally intubated subjects who required ICU admission at a tertiary care center, Harborview Medical Center, USA, 19% were required reintubation(25).

In cross-sectional study of intubated adult subjects receiving mechanical ventilation for > 24 h conducted shows us, 21.3% were failed extubation(26).

In a cohort study that included patients admitted to the intensive care unit of a tertiary hospital in southern Brazil, extubation failure was observed in 28.7% patients (27). In secondary analysis of two previous prospective studies University of Poitiers, France, 16% experienced extubation failure (28).

In observational study done in a medical ICU of teaching hospital at Universite de Poitiers, France, among patients who experienced a planned extubation attempt 14% required reintubation within the 7 days following extubation(29).

In a cohort study done in departments of Critical Care Medicine, Landseed International Hospital, Taoyuan, Taiwan, the rate of extubation failure was 15% (30). In a cross sectional study done in ICU of First Hospital of Qinhuangdao, China extubation failure was observed in 18.1% of patients (31).

In an observational study with medical records of intubated patients with severe pneumonia in intensive care unit of West China School of Medicine and West China Hospital, 34.4% of patients had extubation failure (32).

In an observational study done in Addis Ababa from December 1, 2020 to November 30, 2021 EF was 34.15% (33).

2.2. Predictors of Extubation failure

2.2.1. Sociodemographic and baseline characteristics factors of extubation failure

Age: Many studies show that advanced age is associated with higher risk of extubation failure (14, 33, 34).

In a cross sectional study done in ICU of First Hospital of Qinhuangdao, China showed that age $\geq$ 75 years old [AOR = 3.099, (95%CI [1.003-9.57](35). The study conducted in Thailand shows advanced age [Adjusted OR 1.02 95% CI [1.01-1.04] was the significant risk factor for extubation failure(36). The study conducted in Addis Ababa also shows age $>$ 60 years of age ([AOR: 4.2 95% CI 1.38–12.48] was significantly associated with extubation failure(33).

Sex: In the study conducted in Montpellier University Hospital, Montpellier, France shows female gender (AOR :2.024 95% CI (1.187–3.450), $P = 0.010$) was significantly associated with the extubation failure(37). However, males were found to have greater risk of extubation failure than females in Randolph's study of one hundred and eighty two patients across ten North American ICUs(38).

Comorbidities: The study conducted in Thailand shows patients who had comorbidities like congestive heart failure (AOR:2.65, 95% CI = 1.31-5.40) was the significant risk factor for extubation failure(36). According to meta-analysis and systematic review done in France shows patients who experience comorbidities like chronic obstructive respiratory disease, history of chronic cardiac or respiratory disease were associated with a higher risk of extubation failure (39).

2.2.2. Clinical and laboratory profile before the last spontaneous breathing trial between extubation success and extubation failure.

Duration on mechanical ventilation: In a Brazilian prospective cohort study of $n=124$ mechanically ventilated patients established prolonged ventilatory support (mechanical ventilation for more than 15 days) to be associated with EF(40). A study conducted in Kenya also found that duration of mechanical ventilation was independently associated with extubation failure. Successful extubation was associated with significantly shorter duration on mechanical ventilation(38). In the study conducted in Montpellier University Hospital, Montpellier, France

shows length of ventilation > 8 days (AOR 1.956 (1.087–3.518), $P = 0.025$ was significantly associated with the extubation failure(37). The study conducted in Addis Ababa also shows prolonged duration of MV ≥ 10 days ([AOR]: 4.77 [95% CI 1.55–14.66] was significantly associated with extubation failure(33).

Hemodynamic stability: The Difficult airway society extubation guidelines consider hemodynamic instability as a risk factor for extubation failure, and recommend normalisation of cardiovascular parameters prior to attempting extubation(41). Another similar study found that patients who received inotropes dopamine and dobutamine (AOR = 3.71; 95% CI [1.08–12.78]) were at higher risk for extubation failure(40). The study conducted in Addis Ababa also shows Moderate to copious endotracheal secretions [AOR: 3.483 [95% CI 1.10–11.4] was best predictor of extubation failure(33).

Neurological status of patients: The patient's level of consciousness is a variable of interest with higher levels of sedation being shown to increase the risk of extubation failure (38). A cohort study sought to measure the incidence and outcomes of failed extubation in Dr George Mukhari Academic Hospital intensive care unit (ICU), in South African found that a low GCS < 10 independently predict the extubation failure [AOR :5.1 (CI 1.8 - 14.8)](34). The observational cohort study was carried out at Northwestern Memorial Hospital in Chicago shows, low GCS <10 [AOR:13 (CI 2- 72) was a significant associated factors of extubation failure(42).

Hemoglobin level and history of blood transfusion: Several studies indicate that anemia increase the risk of extubation failure [AOR], 3.69; 95% CI, 1.22–11.15] (43, 44).

Acute disease severity and characteristics at time of extubation: A systematic review and meta-analysis study conducted in France show that patients who failed extubation also had more severe acute illnesses than those who succeeded, as evidenced by the SAPS II and APACHE II scores being higher in the unsuccessful patients' group. A higher likelihood of extubation failure was strongly related with acute heart failure, COPD flare-ups, and pneumonia as causes for intubation(45).

2.2.3. Pre and peri-extubation factors.

Uses of steroids: Recent literature has demonstrated that use of steroids in planned extubations is beneficial in preventing laryngeal edema and reintubations. Various doses, type and regimes of steroids are used with variable frequencies for prevention of post extubation laryngeal edema(46). An RCT study done in Pakistan reveals that dexamethasone injection 24 hours prior to extubation decreased reintubation significantly ($P=0.001$) and post-extubation stridor was 54.6% significantly lower in the dexamethasone group than in placebo group (6/46 versus 15/46, $P=0.025$)(47).

Adrenaline nebulization following extubation: Following extubation, laryngeal edema is a frequent source of upper airway obstruction and, if severe, might require re-intubation. Nebulized adrenaline lessens edema in the airway(48, 49). A study conducted in India shown us Aerosolized adrenaline has been demonstrated to be superior to aerosolized budesonide in the treatment of post-extubation stridor due to its longer-lasting effects(48).

2.3. Conceptual framework

The conceptual framework was developed from different literature reviews (24, 25, 33, 50-53). This framework shows the relationship between Extubation failure with patient-related factors, clinical factors and drugs given modalities. Patient-related factors have both direct and indirect effects on Extubation failure.

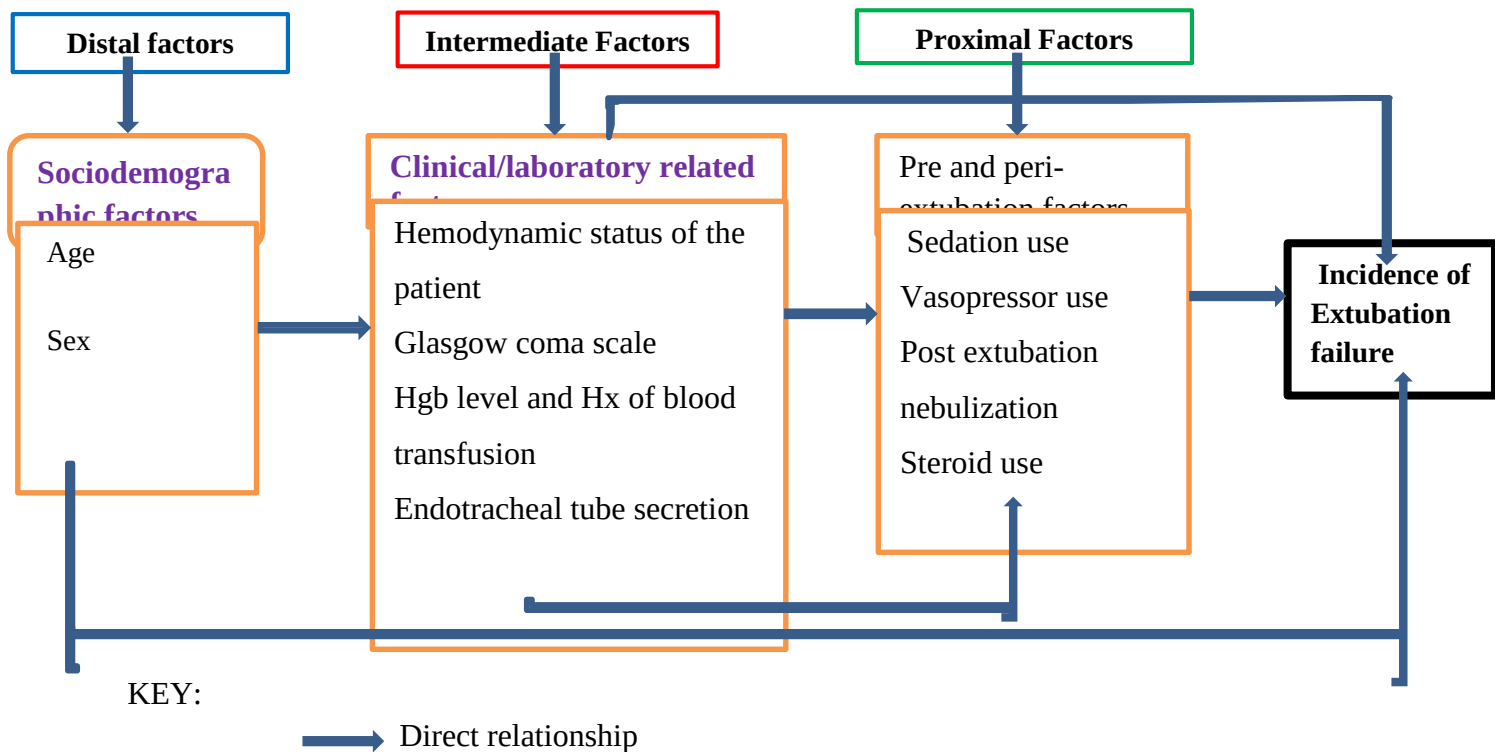


Figure 1. A conceptual framework for the study on incidence of extubation failure and its predictors among mechanically ventilated patients in selected public ICU hospitals, in Addis Ababa City Administration, Ethiopia in 2023.

3. Objectives

3.1 General Objective

To assess the incidence of extubation failure and associated factors among mechanically ventilated patients in selected public ICU hospitals from September 1, 2022 to August 31, 2023, in Addis Ababa City Administration, Ethiopia.

3.2 Specific Objectives

- 1) To determine the incidence of extubation failure among mechanically ventilated patients.
- 2) To identify predictors of extubation failure among mechanically ventilated patients.

4. Methodology

4.1. Study Setting and Period

The study was conducted in two selected public hospitals in Addis Ababa city administration (AaBET and St Paul hospital). The city has more than 55 hospitals of which 15 are public. There are 15 government-run hospitals in the city. The Addis Ababa Health Bureau runs seven hospitals, whereas the Federal Ministry of Health operates Five, the Ministry of Education (AAU) one, and the Addis Ababa City Health Bureau's defense force two. Public hospitals in Addis Ababa are TASH, SPHMMC, Zewditu Memorial Hospital, ALERT Hospital, Yekatit12 Hospital, Ras Desta Damtew Memorial Hospital, St. Peters Specialized Hospital, Menelik II Hospital, Tirunesh Beijing Hospital, Armed Force specialized hospital, Federal police hospital, Amanuel Hospital, Gandhi Hospital, Eka General Hospital, and Abebech Gobena Memorial Hospital. AaBET Hospital located in Addis Ababa, Ethiopia is an emergency and trauma center that provides emergency medical services and critical care to patients. The hospital has a dedicated critical care unit that provides specialized care to critically ill patients. In addition to emergency and critical care, the hospital also provides a range of other medical services, including surgical services, diagnostic services, and outpatient services. Overall, AaBET Hospital plays a critical role in providing medical care to the people of Addis Ababa and the surrounding areas.

SPHMMC is one of the rapidly growing tertiary care centers in Addis Ababa, Ethiopia. Almost all specialty programs are given and one of them is Emergency and Critical care medicine specialty programs. Each unit is equipped with 12-beds to provide critical care for critically ill patients. AaBET ICU gives critical care service for both adult and pediatric patients of which majority of them are trauma patients.

Cases admitted to the ICU are prioritized per the institution's protocol. The standard monitoring includes non-invasive blood pressure, pulse oximetry (oxygen saturation), and electrocardiogram (ECG).The units provide critical care for adult and pediatric patients who require invasive mechanical ventilation, hemodynamic support and close monitoring. This study was conducted for 12 months period (from September 1, 2022 to August 31, 2023)

4.2. Study Design: The institution-based cohort study design was conducted.

4.3. Source Population: All patients who were intubated and were on MV at St. Paul and AaBET hospitals ICU in the study period.

4.4. Study Population: All extubated patients and who are on MV from September 1, 2022 to August 31, 2023

4.5. Inclusion and Exclusion criteria

Inclusion criteria

- All patients admitted to at St. Paul and AaBET hospitals ICU in a study period and >18 years of age and were on mechanical ventilator

Exclusion criteria

- Death before extubation
- ≤ 18 years old
- Tracheostomy insertion prior to extubation have been made or initially have tracheostomy at admission
- Patients extubated and re-intubated due to a blocked or incorrectly placed endotracheal tube
- Brain dead patients
- Self extubated patients
- Those patients who left against medical advice

4.6. Sample size determination

Sample-size of this study was determined by using $p=34.15\%$, from a study conducted in SPHMMC (33) and sample size was calculated to be 212 with the following formula

$$N = (Z \alpha/2)^2 p (1-p) / d^2$$

Where n = the minimum sample size

Z = the standard normal deviate

P = Incidence of the previous study characteristic

95% confidence interval

d = degree of precision or accuracy

5% degree of precision

α = significance level

5% Significance level

$$n = (1.96)^2 (0.3415 * 0.6585) / (0.05)^2$$

$$n = 346$$

Small sample correction

$$n = n_0 / (1 + (n_0 - 1) / N) \quad n = 346 / (1 + (346 - 1) / N)$$

$$n = 223$$

n = corrected sample size

$$n_0 = 346$$

N = source population (ave 630 pts)

Thus n= 223.

4.7. Sampling method and sampling procedure

A multistage sampling technique was used. First, two public hospitals were chosen by simple random sampling among 15 public hospitals. The selected hospitals were (AaBET and St Paul). For record reviews, 12 consecutive months; September, October, November, December, January, February, March, April, May, June, July and August was chosen deliberately because they are months included in the study period. Starting from the September forward, based on the sequence of their card number, a sample random sampling procedure was used to select an adequate number of samples (patient charts) until the required sample size will be obtained. During the 12 months, the total number of newly adults ICU patient's admissions on average 630. After constructing the sample frame using the patient's medical registration number, samples were selected by a simple random sampling technique. Second, eligible mechanically ventilated patients will be considered for each hospitals. So, using the following formula, the required sample size from each hospital is allocated proportionally to two hospitals based on their monthly report figures

The sample size for each facility = no of respondent from each facility x final sample size

Total number of source of population

$n_i = N_i x n / N$ The final sample required number of individually enrolled in the study using simple random sampling.

Table 1: Proportional allocation of each mechanically ventilated patients towards Incidence and its predictors at selected public ICU hospitals in Addis Ababa city administration, Ethiopia, 2023.

Name of Selected Hospital	Total Mechanically ventilated patients in each hospital(Ni)	Proportional allocation of each participant in each hospital by the formula ; $ni = (n * Ni) / N$	Total participants from each hospital
ST. PAUL	350	$ni = 223 * 350 / 630$	123
AaBET	280	$ni = 223 * 280 / 630$	100
Total	N= 630		223

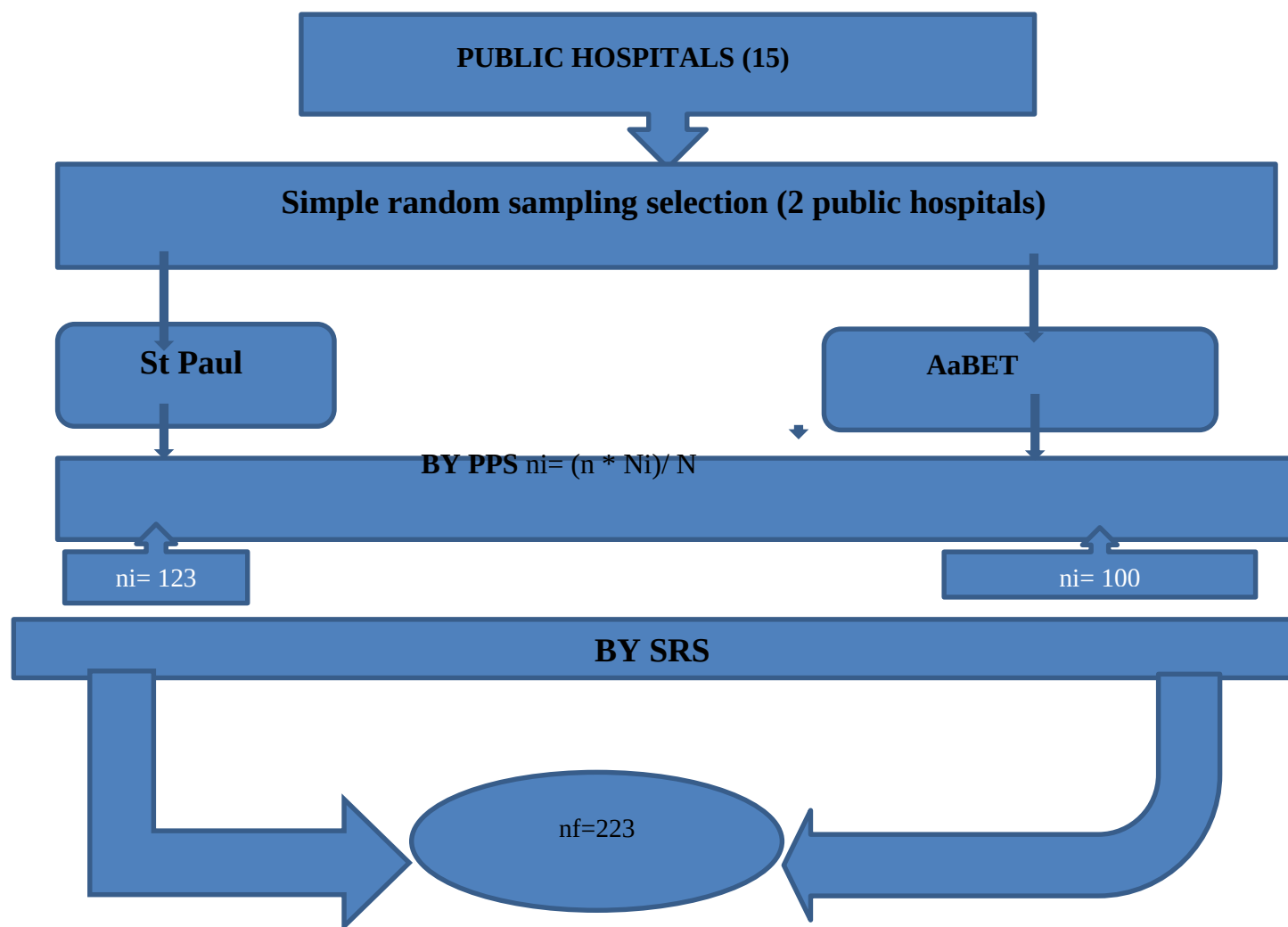


Figure 2 : Schematic presentation of sampling technique to determine Incidence and its predictors at selected public ICU hospitals in Addis Ababa city administration, Ethiopia, 2023

KEY: AA=Addis Ababa, AaBET = Addis Ababa Burn, Emergency and Trauma, PPS= probability proportion to size, SRS= Simple random sampling.

4.8 Variables

4.8.1. Dependent variable

Incidence of extubation failure

4.8.2. Independent Variable

- Socio demographic factors – Age ,sex

- Length of stay on MV
- Sedation use
- Vasopressor use
- Post extubation nebulization
- Steroid use
- Hemodynamic status of the patient
- Glasgow coma scale
- Endotracheal tube secretion

4.9. Data collection methods & techniques

Data were collected using a checklist prepared based on previous works of literature and data were extracted through a structured data extraction checklist from the patient's registration book and select medical records of patients who were intubated for at least 48 hours. Then the chart of the selected patients were reviewed in detail. The extraction checklists were contain socio-demographic characteristics, Clinically, Pre and peri extubation drugs used and laboratory profile before and after the last SBT. The data were extracted by two trained health professional and was being supervised by the principal investigator. And the principal investigator double checked the data entry for maximizing accuracy.

4.10. Data quality assurance

Pretest was done on (12) 5% of the study samples in Tikur Anbesa Hospital, Addis Ababa which was assumed to have similar characteristics to the study area, after the pretest necessary corrections were done on the checklist to improve the quality. Before the data collection period, one-day training were given for data collectors. Onsite supervision was given to solve any doubt with data collection tools and techniques. The collected information were checked for its consistency & completeness by the principal investigator on a daily basis. Data cleaning were checked by the codebook for any missing values and data errors.

4.11. Data process and analysis

Data were cleaned, entered into Kobo-collect version: 2023.2.4, and then exported to SPSS Version 26 for analysis. First, descriptive statistics of the study variables were done. Patient cohort characteristics for continuous data were described in terms of central tendency (mean or median as

appropriate) and dispersion (standard deviation or inter-quartile range) and in frequency and percentage for categorical variables after normality of distribution checked and for those non-normally distributed population median and inter-quartile ranges were reported. Shapiro-Wilk test of normality was used to check the normality of distributions for continuous independent variables. The Incidence density rate (IDR) was calculated for the entire study period and reported per 100 patients per days. Bivariate logistic regression was first fitted and those independent variables which became significant on the bivariate regression having p-value ≤ 0.25 level of significance were included in the multivariable analysis. Variables having a p-value <0.25 in the bivariate analysis were a candidate for the final multivariate regression analysis. An adjusted odds ratio (AOR) with 95% confidence intervals (CIs) were reported to measure the strength of association. Variables having a p-value <0.05 was considered statistically significant. Multicollinearity was assessed by variance inflation factor and variable with VIF >10 were removed. Goodness of fit of the final model was checked using Hosmer and Lemeshow test considering good fit at P-value > 0.05 . Finally, the results of the study were presented with text, graph, and table.

4.12. Dissemination plan

After completion, the result of this study will be disseminated to the SPHMMC Department of Emergency and Critical Care medicine as partial fulfillment of the certificate in the postgraduate course and will be presented to the university community as part of the research thesis defense and disseminated to the SPHMMC, FMOH, and stakeholders.

4.13. Ethical consideration

Ethical clearance was obtained from the research directorate of SPHMMC, institutional review board (SPHMMC-IRB) before the start of the study and also from SPHMMC ethical review committee. During data collection, the names of study participants were not included and confidentiality was reassured through code numbers.

4.14. Operational definition

Intensive care unit: A special area in a hospital where critically ill patients or highly dependent patients who need close and frequent observation can be cared for by qualified and special trained staff working under the best possible condition.

Adult: a patient above age 18.

Extubation: removal of endotracheal tube from the trachea.

Failed extubation: is considered to have occurred when reintubation or respiratory assistance is needed within 48 hours of a scheduled extubation(45).

Successful extubation: patient able to maintain spontaneous breathing without features of respiratory distress or free from mechanical ventilation for more than 48 hours after extubation(45).

Weaning: the process of decreasing the degree of ventilator support and allowing the patient to assume a greater proportion of their own ventilation.

Spontaneous breathing trial: is a test used to determine the patient's ability to breathe without the support of a mechanical ventilator.

Amount of tracheal secretion: evaluates the airway secretions of a patient provided with a score depending on the amount of suctioning needed per hour(54).

Minimal secretions- Suctioning is required every 2–4 h

Moderate secretions- Suctioning required every 1–2 h

Copious secretions- Suctioning is required several times per hour

5. Results

5.1. Sociodemographic characteristic of participants

Out of newly admitted ICU patients, who were enrolled in care from the 1st of September, 2022 to the 31st of August, 2023, 202 medical records were reviewed. Twelve charts were incomplete. Among patients included in the final analysis, more than half 125 (61.9%) of the study participants were male and the mean age of the cohort on MV was 41.5 years with SD $\pm$ 17 years. More than half 112 (55.4%) of the study participants were under 40 years. About 59(29.2) of participants had recorded baseline comorbidity and also more than half 109(54%) of participants have not developed complication on MV. Majority of patients included in this study 108(53.5%) stayed on mechanical ventilation less than 6 days.

Table 2: Baseline sociodemographic characteristics of participants to assess the Incidence and Predictors of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September 1, 2022 to August 31, 2023 (n=202).

Variables	Category	Extubation status		Total, n (%)
		EF, n (%)	ES, n (%)	
Age	< 40	37(34.21)	75(65.79)	112(55.4)
	40-60	26(53.06)	23(46.94)	49(24.2)
	60	27(69.23)	12(30.77)	29(14.35)
Sex	Male	56(44.80)	69(55.20)	125(61.9)
	Female	36(46.75)	41(53.25)	77(38.1)

Comorbidities	No comorbidities	46(46.46)	13(53.54)	59(29.2)
	HTN	11(57.89)	8(42.11)	19(9.4)
	DM	4(36.36)	7(63.64)	11(5.4)
	Heart disease	5(33.33)	10(66.67)	15(7.4)
	Pulmonary disease	5(41.67)	7(58.37)	11(5.4)
	CKD	4(66.67)	2(33.33)	6(2.97)
	Liver disease	5(83.33)	1(16.67)	6(2.97)
	Stroke	3(27.27)	8(72.73)	11(5.4)
	Others	9(39.13)	14(60.87)	23(11.38)
Complication recorded during MV	No complication	17(15.60)	92(84.40)	109(54)
	VAP	50(94.34)	3(5.66)	53(26.2)
	Sepsis	16(94.12)	1(5.88)	17(8.4)
	Shock	5(100.00)	0(0.00)	5(2.4)
	AKI	4(22.22)	14(77.78)	18(8.9)
Duration on MV in days	<= 6 days	12(11.11)	96(88.89)	108(53.5)
	7-10 days	43(82.69)	9(17.31)	52(25.7)
	>= 10 days	37(88.10)	5(11.90)	42(20.8)

5.2. Clinical profiles before the last spontaneous breathing trial between extubation success and extubation failure groups.

For patients who had extubation failure, about more than three-fourth 38(80.85%) had < 10 GCS and about more than half 101(65.16%) of patients extubation success in this study had $\geq$ 10 GCS. From EF of study participants, almost half 87(47.03 %) had positive fluid balance and three-fourth 50(72.46%) had WBC count > 12,000 / μ L.

Table 3: Clinical profiles before the last spontaneous breathing trial between extubation success and extubation failure groups to assess the Incidence and Predictors of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September 1, 2022 to August 31, 2023 (n=202).

Variables	Extubation status		Total, n (%)
	EF, n (%)	ES, n (%)	
GCS			
$\geq$ 10	54(34.84)	101(65.16)	155(76.7)
< 10	38(80.85)	9(19.15)	47(23.3)
Fluid balance			
Positive fluid balance	87(47.03)	98(52.97)	185(91.6)
Negative fluid balance	5(29.41)	12(70.59)	17(8.4)
Amount of Endotracheal secretion			
Minimal secretions	10(11.49)	77(88.51)	87(43.06)
Moderate secretions	73(69.52)	32(30.48)	105(52)
Copious secretions-	9(90.08)	1(10.00)	10(5)
Laboratory results			

WBC count $\leq$ 12,000 / μ L	42(31.58)	91(68.47)	133(65.8)
WBC count $>$ 12,000 / μ L	50(72.46)	19(27.54)	69(34.2)
Hemoglobin $\geq$ 10 g/dL	64(40.76)	93(59.24)	157(77.7)
Hemoglobin $<$ 10 g/dL	28(62.22)	17(37.78)	45(22.3)

5.3. Characteristics during the last spontaneous breathing trial between extubation success and extubation failure groups.

Concerning about characteristics during the last spontaneous breathing trial between extubation success and extubation failure groups, in this study about 56(96.55%) of extubation failure patients had attempts $>$ 2 times of frequency of prior SBTs.

Table 4: Characteristics during the last spontaneous breathing trial between extubation success and extubation failure groups to assess the Incidence and Predictors of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September 1, 2022 to August 31, 2023 (n=202).

Variables	Extubation status	
	EF, n (%)	ES, n (%)
Frequency of prior SBTs		
$\leq$ 2 times	36(25.00)	108(75.00)
$>$ 2 times	56(96.55)	2(3.45)
Tidal volume, mL	397.8 $\pm$ 39.12	384.2 $\pm$ 36.6
Respiratory rate, breath/ minute	17.2 $\pm$ 3.18	16.2 $\pm$ 3.3
RSBI, RR/TV	47.94 $\pm$ 10.2	43.5 $\pm$ 8.4
Minute ventilation, L/min	6.95 $\pm$ 1.07	5.8 $\pm$ 1.2

PEEP, cm H ₂ O	5.3±0	5±0
FIO ₂	86.41±682.2	84.3±678.6
SpO ₂ , %	96.9± 4.16	93.7± 4.17
Heart rate, beats/min (mean ± SD)	94.5±16.2	92.3±14.2
Systolic BP, mm Hg (mean ± SD)	120.2±12.69	116.2±9.47
Diastolic BP, mm Hg (mean ± SD)	71.1± 7.6	67.1± 6.9

FIO₂; the fraction of inspired oxygen, RSBI; rapid shallow breathing index, RR; respiratory rate, TV; tidal volume, PEEP; positive endexpiratory pressure, BP; blood pressure, SD; standard deviation.

5.4. Steroids and post-extubation nebulization used

Although steroids were administered in 133 of extubation attempts 65.8%, only 64.85 % of the extubation attempts met the full criterion, having at least 2 doses of steroids administered with Steroids administered ≥ 6hrs pre-extubation.

Majority of the patients were hemodynamically stable at the time of extubation. 181(89.6%) patients had not been on inotropic support for at least 24 hours prior to extubation.

Adrenaline nebulization was carried out in 173(85.6%) of the extubated patients.

Table 5: Steroids and post-extubation nebulization used to assess the Incidence and Predictors of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September 1, 2022 to August 31, 2023 (n=202).

Variables	Extubation status		Total, n (%)
	EF, n (%)	ES, n (%)	
Number of steroids used prior to extubation			
Not administered	0(0.00)	1(100)	1(0.4)
One dose	8(11.43)	62(88.57)	70(34.65)
Two dose	84(64.12)	47(35.88)	131(64.85)
Steroids administered $\geq$ 6hrs pre-extubation			
Yes	84(63.16)	49(36.84)	133(65.8)
No	8(11.59)	61(88.41)	69(34.2)
Vasoactive drugs used for at least 24 hrs prior to extubation			
Used	16(76.19)	5(23.81)	21(10.4)
Not used	76(41.99)	105(58.01)	181(89.6)
Adrenaline nebulization post-extubation			
Done	91(52.60)	82(47.40)	173(85.6)
Not done	1(3.45)	28(96.55)	29(14.4)

5.5. Incidence of extubation failure

Overall, the extubation failure (EF) rate in our patients was 45.54% [95%CI 0.387- 0.52].

Incidence of extubation failure among adults mechanically ventilated at selected public ICU hospitals in Addis Ababa City Administration in 2023.

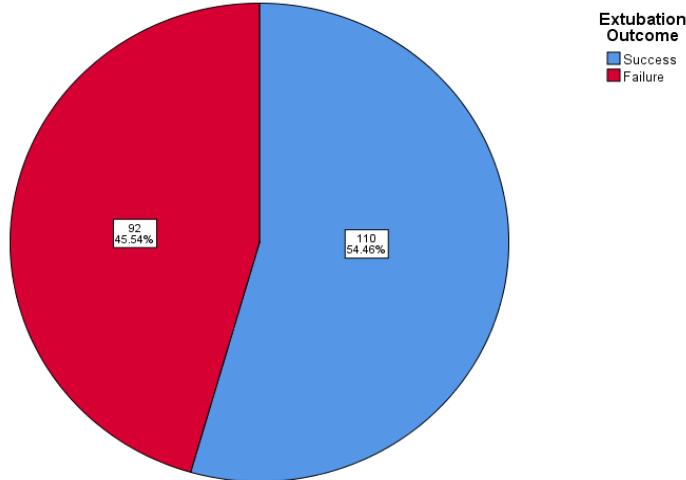


Figure 3: Incidence of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September1, 2022 to August 31, 2023(n=202).

5.6. Predictors of extubation failure

Bivariate and multivariate analysis was carried out using logistic regression between dependent and independent variables. At bivariate analysis, the extubation failure was significantly associated with advanced age(> 60 years)[COR:4.33[95%CI,1.98-9.46],medical complication on MV, VAP, Sepsis and Shock[COR:90.2 95%CI,25.2-32.7],COR:86.6[95%CI,10.8-26.9],COR:1.06[95%,4.5-15.26] respectively. It has also significant association with prolonged duration on mechanical ventilation COR: 59.2[95%CI, 19.5-79.6], GCS < 10 COR: 7.89[95%CI, 3.5-17.54], Increased endotracheal secretion COR: 69.3[95%CI, 7.9-36.02]. Table: 6

At multivariate analysis, extubation failure was significantly associated with Medical complication on MV Like AKI,AOR:0.05[95%CI:0.003-0.60] prolonged duration on MV > 10 days AOR: 5.3[95%CI:1.01-27.7],GCS<10,AOR:5.9[95%CI:1.39-25.15],Increased endotracheal secretion: AOR: 19.07[95%CI:0.9-28.29]and greater than 2 times SBTs, AOR: 9.37[95%CI:1.38-63.48].

The risk of extubation failure was 5.3 times higher in patients who are more than 10 days on mechanical ventilated as compared to patients who are mechanically ventilated less than 10 days.

Table 6: Bivariate and multivariate analysis to assess the Incidence and Predictors of EF at selected public ICU hospitals, in Addis Ababa city administration, Ethiopia, from September 1, 2022 to August 31, 2023 (n=202).

Variables	Extubation status		COR(95% CI)	P-value	AOR(95% CI)	P-value
	EF, n (%)	ES, n (%)				
Age						
< 40	37(34.21)	75(65.79)	1		1	
40-60	26(53.06)	23(46.94)	2.17[1.09-4.29]	0.026	1.9[0.48-8.2]	0.337
60	27(69.23)	12(30.77)	4.33[1.98-9.46]	0.000	1.5[0.19-12.01]	0.682
Complication on MV						
No complication	17(15.60)	92(84.40)	1		1	
VAP	50(94.34)	3(5.66)	90.2[25.2-32.7]	0.000	2.45[0.36-16.4]	0.356
Sepsis	16(94.12)	1(5.88)	86.6[10.8-26.9]	0.000	2.5[0.15-40.04]	0.518
Shock	5(100.00)	0(0.00)	1.06[4.5-15.26]	0.000	1.4[0.6-4.3]	0.41
AKI	4(22.22)	14(77.78)	1.6[11.01-23.9]	0.486	0.05[0.003-0.60]	0.023**
Duration on MV						
<= 6 days	12(11.11)	96(88.89)	1		1	
7-10 days	43(82.69)	9(17.31)	38.2[15-97.4]	0.000	5.8[0.7-48.7]	0.103
>= 10 days	37(88.10)	5(11.90)	59.2[19.5-79.6]	0.000	5.3[1.01-27.7]	0.048**

GCS						
≥ 10	54(34.84)	101(65.2)	1		1	
< 10	38(80.85)	9(19.15)	7.89[3.5-17.54]	0.000	5.9[1.39-25.15]	0.016**
Endotrachealsecretion						
Minimal secretions	10(11.49)	77(88.51)	1	0.000	1	
Moderate secretions	73(69.52)	32(30.48)	17.6[8.06-38.3]	0.000	6.15[1.35-27.88]	0.055
Copious secretions	9(90.08)	1(10.00)	69.3[7.9-36.02]		19.07[0.9-28.29]	0.018**
WBC ≤ 12,000 /μL	42(31.58)	91(68.47)	1		1	
WBC > 12,000 /μL	50(72.46)	19(27.54)	5.7[2.9-10.83]	0.000	2.3[0.58-9.2]	0.232
Hemoglobin ≥ 10 g/dL	64(40.76)	93(59.24)	1		1	
Hemoglobin < 10 g/dL	28(62.22)	17(37.78)	2.39[1.2-4.73]	0.012	2.07[0.44-9.6]	0.354
FrequencyofpriorSBT						
≤ 2 times	36(25.00)	108(75.0)	1		1	
> 2 times	56(96.55)	2(3.45)	84[19.5-61.7]	0.000	9.37[1.38-63.48]	0.022**
Steroids used prior to extubation						
Not administered	0(0.00)	1(100)	1		1	
One dose	8(11.43)	62(88.57)	0.07[0.03-0.16]	0.000	2.5[0.4-10.4]	0.996
Two dose	84(64.12)	47(35.88)	1.5[1.25-2.55]	0.001	4.3[0.10-9.6]	0.766
Steroids administered ≥ 6hrs pre-extubation						

Yes	84(63.16)	49(36.84)	13.07[5.7-29.6]	0.000	3.2[0.01-0.46]	0.996
No	8(11.59)	61(88.41)	1		1	
Vaso active drugs used for<24hrspriortoextub ation						
Used	16(76.19)	5(23.81)	4.4[1.55-12.59]	0.005	3.8[0.49-29]	0.199
Not used	76(41.99)	105(58.0)	1		1	
Adrenalinenebulizatio n post-extubation						
Done	91(52.60)	82(47.40)	31.1[4.13-33.5]	0.001	1.49[0.138-10.01]	0.741
Not done	1(3.45)	28(96.55)	1		1	

6. DISCUSSION

This study was conducted to assess the Incidence and Predictors of EF at selected public Hospital ICUs, in Addis Ababa city administration, Ethiopia, from September1, 2022 to August 31, 2023. This study revealed that Overall extubation failure (EF) rate in our patients was 45.54% [95%CI 0.387- 0.52]. This study was in line with study done in France,38%[95% CI:0.39- 0.81](55).

Our study was higher than study done in France,16%(35),in Taiwan,15%(56),in China,18.1%(56). This difference might be due to study design, sample size variation and study area. Medical complication on MV, Prolonged duration on MV ≥ 10 days, GCS < 10 , Endotracheal secretion, patients with copious airway secretions and Frequency of SBTs > 2 times are independent variables which Significantly predict the extubation failure among our study participants.

Duration of mechanical ventilation > 10 days is an independent predictor of extubation failure according to this study. Several studies have investigated the association between the duration of mechanical ventilation and extubation failure, consistently demonstrating that a prolonged duration of mechanical ventilation (>10 days) is a significant predictor of extubation failure.

Prolonged mechanical ventilation can lead to respiratory muscle weakness, impaired airway clearance, and reduced respiratory drive, all of which can increase the risk of extubation failure(57-60).

Low GCS has been found to be an independent predictor of extubation failure. Patients with low GCS scores are more likely to have compromised airway protection, impaired cough reflex, and inadequate respiratory drive, all of which can increase the risk of extubation failure. This study is supported with study (56, 63, 64).

According to our research, airway secretions have a strong correlation with extubation failure. Compared to patients with little to no airway secretions, individuals with moderate to copious airway secretions had a > 19.7 -fold increased risk of experiencing an extubation failure. It was supported by study (25, 56, 64), patients who failed an SBT more than twice had a significantly higher rate of extubation failure compared to those who passed the SBT on the first or second attempt. This suggests that repeated failure of SBTs may indicate underlying respiratory muscle weakness, inadequate pulmonary function, or other factors that impair the patient's ability to sustain spontaneous breathing after extubation(65).

Overall, the findings of this research underscore the multifactorial nature of extubation failure and emphasize the importance of a holistic approach to patient assessment and management before extubation. Addressing these identified factors through targeted interventions, such as neurological assessment, secretion management, weaning optimization, and individualized weaning protocols, may help mitigate the risk of extubation failure and improve patient outcomes in critical care settings. Further research and clinical interventions aimed at addressing these factors are warranted to enhance extubation success rates and overall patient care in intensive care units.

6.1. Strength and limitation of the study

6.1.1. Strength of the study

The cohort was selected to only ICU patients. The sample was relatively homogenous.

Additionally, we used multicenter nature of the study to conduct the study.

Use of kobo-collect for data collection which may minimizes missing data and potential error.

6.1.2. Limitation of the study

Despite having its strength, this study also has some limitations. First, because of the retrospective nature of the study, the data were collected from medical records which are prone to incompleteness and we couldn't draw causal inferences between observed associated factors with extubation failure.

The variations in the standard of clinical setup and observational nature of study design resulted in selection bias, in turn; some important predictors like APACHE score, arterial blood gas analysis, cuff leak test, and analgesic/sedative agents that may affect the extubation outcomes were not included in this study.

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

The incidence of extubation failure among patients on MV was one out of five in our study area. Medical complication on MV, Prolonged duration on MV ≥ 10 days, GCS < 10 , copious endotracheal secretions and Frequency of SBTs > 2 times are independent variables those significantly predict the extubation failure among our study participants.

These results underscore the importance of closely monitoring and addressing these factors when considering extubation in critically ill patients. Identifying and managing these risk factors may help reduce the incidence of extubation failure and improve patient outcomes in intensive care settings. Further research and clinical interventions aimed at addressing these factors could potentially lead to improved extubation success rates and overall patient care in critical care settings.

7.2. Recommendation

Based on our study findings, we recommend that patients with the identified predictors should be considered in the decision making process of weaning from the mechanical ventilator.

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9. ANNEXES

Annex 9.1: Information Sheet and Informed Voluntary Consent Form for Head of Public Hospitals.

My name is **Dr. OFFIFEN TAMENE (ECCM RESIDENT)**. I am conducting a study on the Incidence and Predictors of extubation failure among adults mechanically ventilated patients in AaBET and St Paul ICU Hospitals from September 1, 2022 to August 31, 2023, in Addis Ababa City Administration, Ethiopia at St. Paul Hospital Millennium Medical College. I kindly request you to lend me your attention to explain to you the study and study participants.

The study title: Incidence and Predictors of extubation failure among adults mechanically ventilated patients in selected public hospitals from September 1, 2022 to August 31, 2023, in Addis Ababa City Administration, Ethiopia.

Purpose of the study: The main aim of this study is to write a thesis as a partial requirement for the fulfillment of Emergency and critical care medicine specialist for the principal investigator. Moreover, the result of the study will be used as evidence and input to planning for patients with diabetic nephropathy by any concerning body and its predictors among mechanical ventilator patients.

Procedure and duration: I will collect the data by using a card review of patients selected systematically. The checklist contains four parts and 34 questions.

Risks and benefits: The risk of participating in this study is very minimal. The findings from this research will reveal important information for St Paul and AaBET hospitals and local health planners. This study will provide appropriate counseling and early treatment before the patients reach irreversible complications and death.

Confidentiality: The information that we will be provided will be kept confidential. There will be no information that will identify the participant in particular. The findings of the study will be general for the study community and will not reflect anything, particularly of an individual person. The questionnaire will be coded to exclude showing names. No reference in oral or written reports that could link participants to research.

Rights: The information needed for the study is collected from the recorded patients' cards and electronic databases in the selected hospitals. The hospital has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the hospital.

Contact address: If there are any questions or enquires any time about the study or procedures, please contact in this address.

Principal investigator: Dr. Offifen Tamene (MD, Resident): Phone: +251-9-35-93-24-27

E-Mail: offifen@gmail.com

Declaration of informed voluntary consent:

I have read the participant information sheet. I have clearly understood the purpose of research, the procedures, the risks and benefits, issues of confidentiality, the rights of participants and the contact address for any queries. I have the opportunity to ask questions for things that may have been unclear. I am also informed that the hospitals administration has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the institution. Therefore, I declare my voluntary consent on the behalf of _____ hospital management to allow this study to be conducted in the hospital with my initials (signature).

Name and signature of Head of institution _____ Date _____

Name and signature of Principal investigator _____ Date _____

N.B: This is signed face to face in the presence of the principal investigator. Please provide a copy of this signed consent to responsible head.

Thank you for your cooperation!!

Annex 7.2: English Version Questionnaire.

Topic: Incidence of extubation failure and Predictors of among adults mechanically ventilated patients at selected public hospitals from September 1, 2022 to August 31, 2023, in Addis Ababa City Administration, Ethiopia.

Instruction: Dear data collector this is a data abstraction form designed to collect data of patients started the treatment in selected public health facilities at Intensive care Unit. Please try to fill all the requested fields that are prepared in the section of the data abstraction form.

The form has four Part:

Part I: General information

Part II: The socio-demographic characteristics of the patient

Part III: The clinical and laboratory characteristics of the patient

Part IV: Steroids and post-extubation nebulization used and Out-come of patients

Part I : General Information			
Question	Response	Code	Skip to
Name of health facility	ST PAUL	1	
	AaBET	2	
Name of data collector			
Date of data collection			
Starting time			
Finishing time			

Part II. Socio-demographic and baseline Characteristics of between extubation success and failure groups.

No	Question	Responses	Code	Skip To
101	Sex	Male	1	
		Female	2	
102	Age	_____years		
103	History of comorbidity condition	No comorbidities	1	
		HTN	2	
		DM	3	
		Heart disease	4	
		Pulmonary disease	5	
		CKD	6	
		Liver disease	7	
		Stroke	8	
		Others	9	
104	Complication recorded during MV	Ventilator-associated pneumonia	1	
		Sepsis	2	
		Shock	3	
		Acute kidney injury	4	
		Others	5	
105	Mechanical ventilation duration in days	_____ day/s		

Part II: Clinical profiles before the last spontaneous breathing trial between extubation success and extubation failure groups

No.	Question	Response	Code	Skip to
201	Glasgow coma score	-----		
202	Fluid balance	Negative fluid balance	1	
		Positive fluid balance	2	
203	Endotracheal secretions	No suctioning was required	1	
		Suctioning is required every 2–4 h	2	
		Suctioning required every 1–2 h	3	
		Suctioning is required several times per hour	4	
204	WBC count	-----(/ μ l)		
205	Albumin	----- (mg/ml)		
206	Hemoglobin	----- (mg/dl)		
207	BUN	----- (mmol/L)		
208	Creatinine (mmol/L)	----- (mmol/L)		
		Not done in the 24 hrs prior to extubation	1	

209	Blood gas analysis	Normal	2	
		Abnormal	3	
210	PH	-----		
211	PCO ₂	-----		
213	HCO ₃	-----		

Part III: Characteristics during spontaneous breathing trials between extubation success and extubation failure groups				
No.	Question	Response	Code	Skip to
301	Frequency of prior SBTs	≤ 2 times	1	
		> 2 times	2	
302	Tidal volume	-----, mL		
303	Respiratory rate	-----breath/minute		
304	Rapid shallow breath in index(RSBI)	-----		

305	Minute ventilation	----- L/minute		
306	Positive End Expiratory Pressure (PEEP)	-----cm H ₂ O		
307	Fraction of inspired oxygen(FIO ₂)	-----		
308	SpO ₂ pre extubation	-----%		
309	Heart Rate	----- beats/minute		
310	Systolic Blood pressure	----- mm Hg		
311	Diastolic Blood Pressure	----- mm Hg		

Part IV: Steroids and post-extubation nebulization used and Out-come of patients				
No.	Question	Response	Code	Skip to
		Not administered	1	

401	Number of steroids administered doses at least 6hrs prior to extubation	One dose	2	
		Two doses	3	
402	Steroids administered $\geq$ 6hrs pre-extubation	No	1	
		Yes	2	
403	Vasoactive drugs used for at least 24 hrs prior to extubation	No used		
		Used	2	
404	Adrenaline/Nor-adrenaline nebulization post-extubation	Not done	1	
		Done	2	
405	Extubation outcome	Failure	1	
		Success	0	

Thank you