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Prevalence And Associated Factors Of Ventilator-Associated Pneumonia Among Intubated Adult Patients Admitted In Tibebe Ghion Specialized Hospital,

Koyachew, Bazezew

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BAHIR DAR UNIVERSITY
COLLEGE OF MEDICINE AND HEALTH SCIENCE
DEPARTMENT OF INTERNAL MEDICINE.

**PREVALENCE AND ASSOCIATED FACTORS OF
VENTILATOR-ASSOCIATED PNEUMONIA AMONG
INTUBATED ADULT PATIENTS ADMITTED IN TIBEBE
GHION SPECIALIZED HOSPITAL,
BAHIR DAR, NORTHWEST ETHIOPIA.**

**A RESEARCH THESIS REPORT TO BE SUBMITTED TO
DEPARTMENT OF INTERNAL MEDICINE IN THE PARTIAL
FULFILMENT OF THE REQUIRMENTS FOR THE
SPECIALITY TRAINING PROGRAM OF INTERNAL
MEDICINE AT BAHIR DAR UNIVERSITY COLLEGE OF
MEDICINE AND HEALTH SCEINCE.**

**PRINCIPAL INVESTIGATOR: DR. Bazezew Koyachew, (FINAL YEAR
RESIDENT)**

Investigator	BazezewKoyachew (MD, Final Year Medical Resident) Department of Internal Medicine College of Medicine and Health Sciences Bahir Dar University Email: degagegn@gmail.com Cell phone: +251-918437339
Advisors	DrYilkalAbie (MD, Internist) Department of Internal Medicine College of Medicine and Health Sciences Bahir Dar University. Email:yilkala7@gmail.com Cell phone: +251-918750340 Mr.MekonnenMelkie, (Lecture at Bahir Dar University.) Department of Public Health College of Medicine and Health Sciences Bahir Dar University. Email Cell phone: +251-9 30525010
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Project Area	TibebeGhion Specialized Hospital, Bahir Dar, Ethiopia

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ACRONYMS

AICU.....	adult intensive care unit
AOR.....	adjusted odds ratio
ARDS.....	acute respiratory distress
syndromeATS.....	American Thorax Society
BDUCMSH.....	Bahir Dar University college of medicine and health science
COR.....	crude odds ratio
ICU.....	intensive care unit

IDSА.....Infectious Diseases Society of America
MDR.....multi drug resistance
MV.....mechanical ventilator
TGSH.....TibebeGhion Specialized Hospital
UNESCO.....United Nations Educational, Scientific and Cultural
Organization
VAP.....ventilator associated pneumonia

Abstract

Background: Ventilator-associated pneumonia (VAP) is defined as pneumonia occurring more than 48 hours after the initiation of endotracheal intubation and mechanical ventilation. It is the most common nosocomial infection among intubated patients.

Objectives: This study aimed to determine the prevalence of ventilator-associated pneumonia and identify associated factors among intubated adult patients admitted to TibebeGhion Specialized Hospital, Ethiopia, from Jan2023 to Dec2025..

Methods:An institution-based cross-sectional study was conducted in TGSH, among 314 adult patients who were mechanically ventilated for more than 48 hours. Data were collected through structured medical chart review using a standardized data extraction checklist. Data cleaning done and were entered and analyzed using SPSS software. Bivariable logistic regression was performed to identify candidate variables, and those with a p-value <0.25 were entered into a multivariable logistic regression model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were used to identify independent predictors of VAP. A p-value <0.05 was considered statistically significant.

Results:The prevalence of ventilator-associated pneumonia (VAP) was **18.2%** (95% CI: 13.9–22.4%).In multivariable logistic regression analysis, sedation (AOR = 2.83; 95% CI: 1.26–6.35; $p = 0.012$), prolonged mechanical ventilation (≥ 7 days) (AOR = 7.27; 95% CI: 3.39–15.57; $p < 0.001$), diabetes mellitus (AOR = 3.23; 95% CI: 1.14–9.09; $p = 0.027$), tracheostomy (AOR = 7.12; 95% CI: 1.92–26.39; $p = 0.003$), sepsis (AOR = 7.47; 95% CI: 2.52–22.13; $p = 0.002$), and prior antibiotic use (AOR = 4.14; 95% CI: 1.69–10.16; $p = 0.002$) were independently associated with ventilator-associated pneumonia.

Conclusion and recommendations:The prevalence of ventilator-associated pneumonia (VAP) was 18.2% (95% CI: 13.9–22.4%) which is lower than the previous study finding.

Sedation, prolonged mechanical ventilation, prior antibiotic use, diabetes mellitus, tracheostomy, and sepsis are independent predictors of ventilator-associated pneumonia. Sedation minimization and daily interruption protocols, early weaning and spontaneous breathing trials, strict tracheostomy care and suctioning protocols, antimicrobial stewardship and culture-guided therapy, glycemic control for diabetic patients and early recognition and management of sepsis are recommended.

Key Words: magnitude, Ventilator associated pneumonia, intubated, adults, Tibebe Ghion Hospital, Bahir Dar, Ethiopia.

1. INTRODUCTION

1.1. Background

Ventilator-associated pneumonia (VAP) is defined as pneumonia occurring more than 48 hours after the initiation of endotracheal intubation and mechanical ventilation (MV) (1, 2). It is a subset of hospital acquired pneumonia that results from the microbial invasion of the normally sterile lower respiratory tract, which subsequently can overpower the host's defense and establish the infection of the lung(3).

Based on the onset it is classified as early-onset and late-onset. Early-onset VAP occurred in ventilated patients within the first four days (<4 days) of mechanical ventilation which is usually caused by antibiotic-sensitive bacteria. Late-onset VAP refers to VAP that developed in mechanically ventilated patients from the fifth day (≥ 5 days) of mechanical ventilation and it is caused by multidrug-resistant (MDR) pathogens(2).

Ventilator-associated pneumonia is diagnosed when there is **a new or changing lung infiltrates on chest x-ray** and at least two of the following clinical feature: fever ($\geq 38^{\circ}\text{C}$), increased white blood cell count ($\geq 12 \times 10^3 \text{ WBC/ml}$), and purulent tracheobronchial secretions(4).

Clinical criteria, used in combination, may be helpful in diagnosing VAP, however, the considerable inter-observer variability and the moderate performance should be taken in account. Bacteriologic data do not increase the accuracy of diagnosis as compared to clinical diagnosis(5). The Presence of VAP was associated with increased risk of hospital morbidity and it remains the most frequent infection among patients hospitalized in the Intensive Care Unit (ICU). It is associated with high economic costs, longer attributable lengths of stay in the hospital, and high mortality, especially when lung infection is caused by high-risk pathogens, such as MethicillinResistant Staphylococcus aureus (MRSA), Extended Spectrum β -lactamase (ESBL)-producing Gram-negative bacteria, and Multiple Drug Resistance (MDR). The presence of specific host, environmental or pharmacological factors may enhance the propensity of patients to develop VAP(6, 7, 8).

Prevention measures should be applied to reduce VAP. The important components of prevention protocols are meticulous hand hygiene, head elevation, avoid over use of antibiotics and suction when necessary(8).

1.2 Statement of the problem

VAP is the most common nosocomial infection among intubated patients.

Globally the prevalence of VAP is around 15.6%.(9) , and the cumulative **incidence** of VAP in different countries ranges from 13.5% in USA to 57.5% in Egypt(7, 9, 10, 11, 12). The crude mortality rate of ventilator-associated pneumonia ranged from 16% to 94% compared to 0.2% to 51% in non-VAP patients and ICU length of stay in VAP patients ranged from 8 to 24 days compared to 2.5 to 13 days in non-VAP patients in developing countries(13, 14). In Ethiopia, there is a retrospective study conducted at FHCSH and TGSH, the incidence was around 27.9%(4).

Patients With ventilator-associated pneumonia develop many complications like severe sepsis/septic shock, acute respiratory distress syndrome (ARDS), atelectasis, and infection with MDR organisms which in turn increases cost and morbidity and mortality(15). In studies assessing economic impact of ventilator associated pneumonia in America found that Patients with VAP had higher mean costs especially from pharmacy, MV, respiratory therapy and chest X ray all of which were at least 40% higher. In developing countries the total cost for VAP patients was about 3 fold higher than for non-VAP patients in which this cost was probably associated with prolonged hospitalization of VAP patients(16, 17).

VAP is an important nosocomial infection among the critically ill patients, requires purposeful study to reduce mortality. Good knowledge of VAP incidence and its predictors is an important way to decrease its consequence and to implement more effective preventive measures of VAP(10).

1. 3. Literature review

Prevalence of ventilator-associated pneumonia

The overall prevalence of VAP globally is around 15.6%(9). A study done in India the prevalence of VAP is around 27.21% from this most cases are late onset VAP that MDR pathogens are high incidence in this group(18). According to Meta analyses and systematic review done in china the cumulative prevalence of VAP was 23.8%(11). Older age (≥ 60 years), coma, re-intubation, tracheotomy and prolonged ventilation were the factors significantly associated with the occurrence of VAP(11).

A retrospective study done in Ethiopia Bahir Dar the incidence of VAP was 27.9%.The risk factors identified with the development of VAP were ventilation duration, blood transfusion, corticosteroid use, supine head position and low Glasgow coma scale(4).

Risk factors of ventilator-associated pneumonia

There are various risk factors for the development of VAP. These factors include patient characteristics, prolonged MV time and length of ICU stays, decrease level of consciousness, comorbidities, prior antibiotics use, invasive operations, nasogastric feeding, continuous use of intravenous sedatives, stress ulcer prophylaxes and position(19, 20, 21).

Socio-demographic risks of ventilator-associated pneumonia

Older age (>60) and male sex are independent risk factor for susceptibility to VAP(11, 20, 21). The risk of VAP increased by more than 1.15-fold as age increased by 1 year and elderly people were prone to chronic diseases like chronic heart failure, potential respiratory diseases, chronic renal failure, diabetes, hypertension, and more non-metastatic cancers(20). On the other hand there a different study which shows no statistically significant difference between VAP and non VAP groups regarding age and sex, (22, 23).

Intervention related risk factors of ventilator- associated pneumonia

The duration of mechanical ventilation, the length of ICU stay, use of H₂ blockers, supine position of patients, re intubated patients, on MV for more than two weeks and tracheostomy were independent risk factors for development of ventilator associated pneumonia,(11, 22, 24, 25). MV is an effective intervention in critically ill patient in ICUs to save life. But prolonged ventilation can lead to increase risk of infection and various complications. . The artificial airway established by mechanical ventilation changes the mucosal defense function of the normal airway. It weakens the ability of swallowing and the scavenging capacity of cilia to mucus. Bacteria directly enter the lower respiratory tract or pass through the gap between the tracheal tube wall and the airway leading to infection(20). Positioning of mechanical ventilated patients may affect the prevalence of VAP. Supine positioning is an independent risk factors associated with the development of VAP especially when it combined with enteral feeding(25, 26).

According to a Meta analyses done in Greece Patients positioned semi recumbently 45° have significantly lower incidence of clinically diagnosed VAP compared to patients positioned supinely. On the other hand, the incidence of clinically diagnosed VAP among patients positioned pronely does not differ significantly from the incidence of clinically diagnosed VAP among patients positioned supinely(27).

Stress ulcer prophylaxis medications that alter the gastric pH, like H₂ antagonists and antacids, result in colonization of gastric by potentially pathogenic organisms and increase the risk for ventilator-associated pneumonia, during aspiration of gastric secretions. Therefore sucralfate should be used instead of H₂ antagonists for stress ulcer prophylaxis in gastro-esophageal bleeding risk patients(28, 29).

Tracheostomy is typically performed in acute respiratory failure, wherein there is a need for prolonged mechanical ventilation, or in those who cannot protect the airway because of facial injuries or an altered level of consciousness. In patients who required prolonged mechanical ventilation, there was significant decreased incidence of VAP, less ventilator time, and lower ICU LOS when tracheostomy was performed within 7 days after admission. In this study, the incidence of VAP was significantly higher in the late tracheostomy group (42.3% vs. 27.2% early tracheostomy group)(19, 25, 30).

Prior antibiotic exposure has been identified as a risk factor for VAP occurrence, making it a growing concern among clinical trials.(31, 32)

Frequent reintubation is found to be a risk factor for VAP. The main cause for pneumonia associated with frequent reintubation is the aspiration of gastric contents(19).

Admission diagnosis related risk factors of ventilator- associated pneumonia

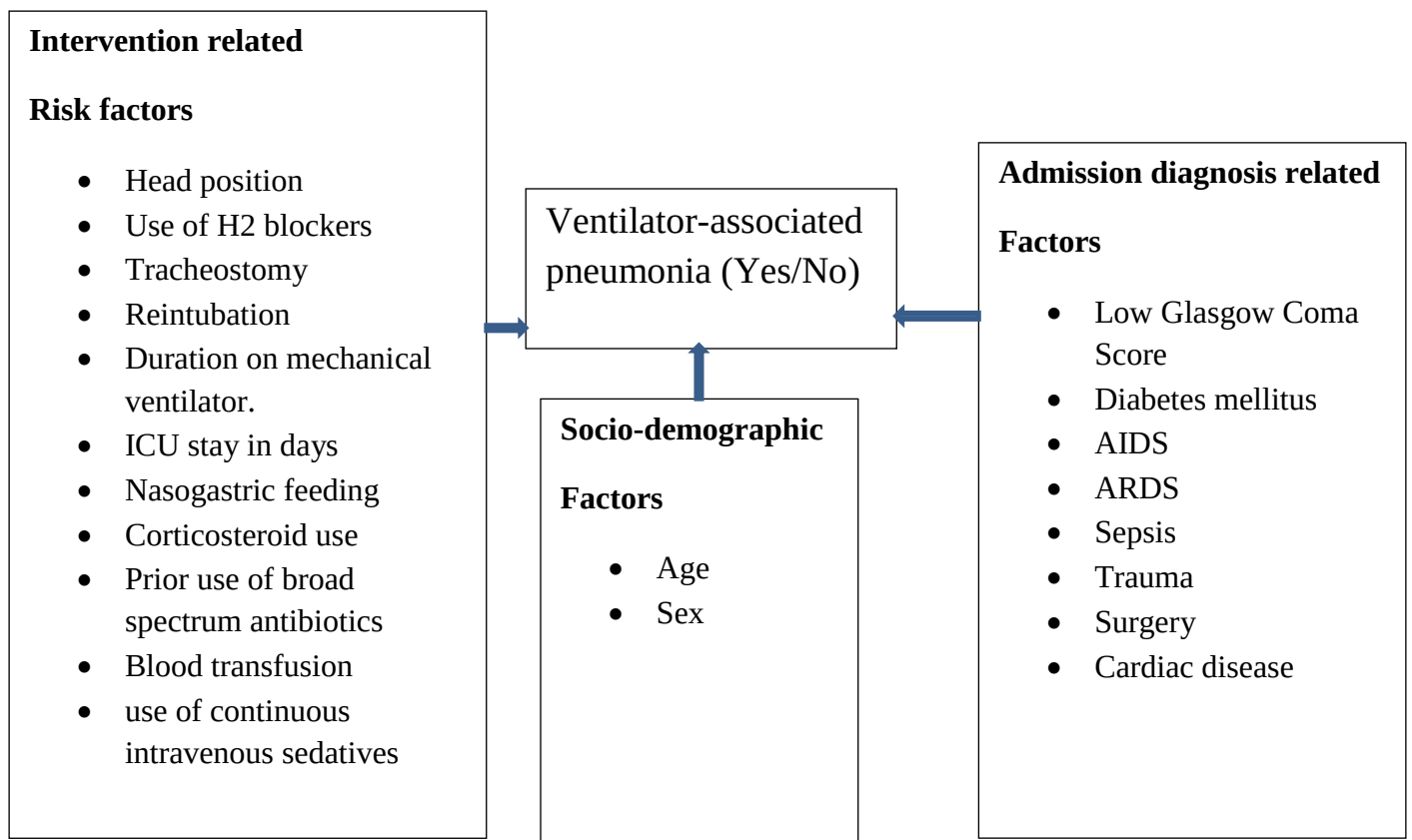
The risk of ventilator-associated pneumonia is significantly higher among patients with a primary admitting diagnosis of burn, trauma, central nervous system disease, respiratory disease, and cardiac diseases(12). On the other hand, there was no statistically significant difference between VAP and non-VAP groups regarding underlying co-morbidities like Diabetes, Chronic Obstructive pulmonary diseases, and Congestive Heart Failure(15, 25).

Because phagocytic functions of alveolar macrophages are impaired in ARDS, it is independently associated with late-onset VAP. Besides this in ARDS most patients initially receive antibiotics and due to longer duration of intubation late onset VAP and MDR pathogens common(33, 34).

Level of consciousness has a significant impact on the incidence of VAP. It was found in a study in India that the incidence of VAP in stuporous (62.5%) and comatose (50%) patients is significantly higher ($P=0.0023$) than that in conscious (35.75%) and drowsy (18.42%) patients. This may be due to the higher chances of aspiration in comatose patients(7, 25).

Patients who had low Glasgow coma scale during admission had higher risk for ventilator associated pneumonia than in patients with higher Glasgow coma scale(35).

1.4 Conceptual frame work



Keywords: AIDS, ARDS, ICU, H2 blockers, VAP

1.5. Significant of the study

Although multiple studies on ventilator-associated pneumonia (VAP) have been conducted worldwide, including in Ethiopia, there is limited research specifically addressing its prevalence and risk factors.

Most studies agree on the major factors influencing VAP; however, some inconsistencies remain, particularly regarding the impact of primary admission diagnosis and socio-demographic characteristics.

This study provides valuable information on the prevalence and determinants of VAP, as well as trends of the disease in Ethiopia, particularly at **TibebeGhion Specialized Hospital (TGSH)**.

In addition, it offers insights into potential strategies for prevention and management of VAP.

VAP remains a common cause of mechanically ventilated-associated nosocomial infections and represents a significant, preventable source of morbidity and mortality, underscoring the need for continuous surveillance.

2. Objectives

2.1. General objective:

To assess the prevalence and associated factors of VAP among intubated patients at TGSH, AICU 2023 to 2025.

2.2. Specific objectives:

To assess prevalence of VAP among intubated patents at AICU Jan.2023 to Dec.2025.

To identify associated factors of VAP among intubated patients at AICU Jan.2023 to Dec.2025.

3. Methods and Materials

3.1 study area

Bahir Dar is situated on the southern shore of Lake Tana, the source of the Blue Nile (locally called Abay). The city is recognized as one of the ten most beautiful cities in Africa and was awarded the UNESCO Learning City Award in 2015.

It is located approximately 578 km (360 miles) north-northwest of Addis Ababa, at an elevation of 1,840 meters (6,036 feet) above sea level.

Tibebe Ghion Specialized Hospital (TGSH) is located about 10 km south of the city center, approximately 7 km from the new bus station ('Addisu Meneharia') on the way to Adet District, and about 23 km from the Blue Nile Falls (locally called *Tis Abay*, meaning "Smoke of Fire"). TGSH is a tertiary university teaching hospital with a total bed capacity of 450, of which 72 beds are designated for adult medical patients.

The hospital serves as a referral center for patients from across the Amhara region and provides both outpatient and inpatient services across all major departments. The present study will be conducted at TGSH.

The Adult Intensive Care Unit (AICU) is one of the eight wards at TGSH, providing intensive and critical care for patients requiring specialized monitoring and treatment. The AICU has 10 beds, each equipped with a mechanical ventilator and a patient monitor.

3.2 Study design

Institution-based cross-sectional study was used.

3.3 Study period

Study was conducted from Oct to Dec 2025.

3.4 Population

Source population: All patients admitted to adult ICU and on intubation.

Study population: All patients who were on mechanical ventilator for more than 48hrs

3.5 inclusion and exclusion criteria

Inclusion criteria:

*All patients from the age of 18yrs and above and who are on MV for more than 48 hours in Jan.2023 to 2025 Dec.

Exclusion criteria:

Incomplete charts.

3.6 Sample size determination

The sample size of the study was determined based on the following assumptions according to the study done at FHCSH and TGSB 2019-2021

,with prevalence of 27.9%(4), sample size level, of confidence interval 95%, estimated error and below, ($z_{\alpha/2}=1.96$) .Then using formula estimate of single population proportion the sample size would be calculated.

$$N = (Z_{\alpha/2})^2 p (1-p) / d^2$$

$$N=(1.96)^2 (0.279 * 0.721) / (0.05)^2=310$$

And 10 percent nonresponse rate resulted 340 of the data size.

3.7 Sampling procedure

There were 365 intubated patients and 45 of them incomplete charts and 6 of them charts lost, all complete charts were included.

3.8.Variables of the study

Dependent variables: Ventilator-associated pneumonia

Independent variables:

Socio-demographic: age, sex.

Admission diagnosis-related factors: low Glasgow coma scale, ARDS, Cardiac diseases, Diabetes mellitus, AIDS, and Sepsis, trauma.

Intervention-related factors: duration on mechanical ventilator support, duration on intensive care unit stay, tracheostomy, re-intubation, Tube, Nasogastric feeding, use of corticosteroid, supine head position, use of histamine blockers, blood transfusion, use of continuous intravenous sedatives, surgical intervention and prior use of broad-spectrum antibiotics.

3.9 Operational definitions

Ventilator-associated pneumonia is diagnosed with:

The Presence of a new or progressive chest x-ray infiltrate plus at least two of the following clinical symptoms:

- Fever > 38°C with **no other recognized causes**
- Leukocytosis(>12000) or leucopenia(<4000)
- New-onset purulent tracheal secretion during suction.
- Increased oxygen requirement.

Prior antibiotic administration: intravenous antibiotic administration for longer than **24hours** during any portion of the patient's hospitalization before and including mechanical ventilation

Corticosteroid use: use of corticosteroid drugs like, hydrocortisone, prednisolone, and dexamethasone for greater than **2 days** during intubation.

Patient use of continuous intravenous sedations: administration of continuous infusions of sedatives drugs like diazepam, propofol, and ketamine as a continuous infusion for **≥24 hours** during mechanical ventilation.

Depressed consciousness, **GCS less than 9(4).**

3.9.1 Methods of data collection

Trained data collectors was assigned at AICU. First data extractors selected records of patients who were intubated for more than 48 hours.

The data was collected by detail chart review using a structured data extraction checklist.

Confidentiality of participants was kept by not mentioning their name on the checklist.

3.9.2 Data quality assurance

Special training was given for selected data collectors. The questioner was pretested for clarity. The collected data checked by the investigator carefully for completeness, accuracy and clarity before data entry. The principal investigator monitored overall data collection and entry.

3.9.3 Data entry and analysis

Data were coded and entered into SPSS latest version software for analysis. Association of independent variables with VAP were done individually using binary logistic regression. Collinearity among independent variables were assessed using a Pearson correlation matrix.

Variables with correlation coefficients greater than 0.7 were considered collinear. HosmerLemeshow fit model was used and maximum VIF WAS 3.25.

To identify predictor variables for VAP, multivariate logistic regression was performed for those variables with p-value of <0.25 on binary logistic regression. P-value <0.05 was considered as statistically significant. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were used to identify independent predictors of VAP.

Descriptive statistics used for prevalence and predictors of VAP patients. Tables and graphs were used for the result.

3.9.4 Ethical clearance

The study protocol was submitted for ethical clearance to the institutional review board of BDU, college of medicine and health science, school of Public Health. After ethical clearance obtained data collection was started. Consent was waived by the Institutional Review Board. Patient confidentiality was maintained by anonymizing data. Data collected from participants of this study used for the purpose of this study only.

3.9.5 Dissemination of the results

The final result and finding of this study Submitted to department of Internal Medicine, School of Medicine, School Public Health and it will also be sent for publication.

4. Result

4.1. Socio-demographic characteristics

Although the calculated sample size were 340, 314 complete charts were analyzed due to incomplete or missing records. This sample remained adequate to detect statistically significant associations with a response rate of 92%. More than half of the participants, 165 (52.5%), were male and 149(47.5%) were females. The median age of patients was 40 years.

Table 1 demographic characteristics

Variable	Category	Ventilator Associated Pneumonia		
		Yes, %	No, %	Total, N
Sex	Male	26(16)	139(84)	165
	Female	31(21)	118(79)	149
Age	>=45	23(19)	96(81)	119
	<45	34(17)	161(83)	195
Total				314

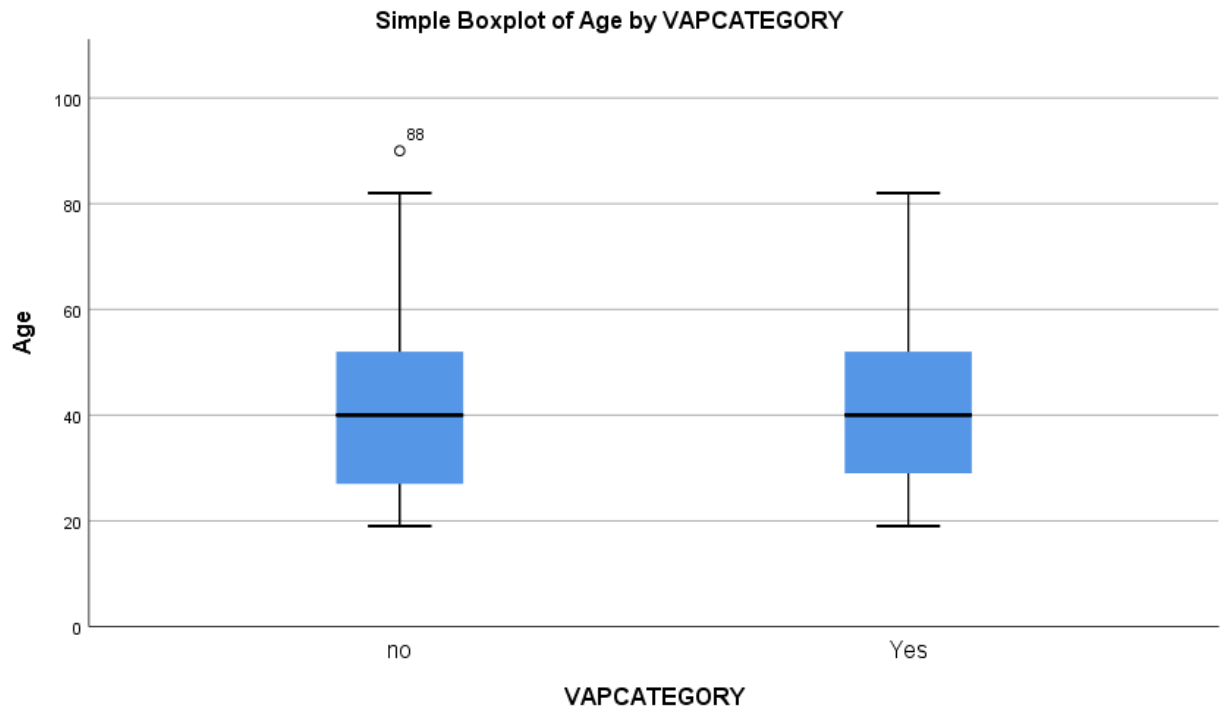


Figure1. VAP across age, the median is 40years

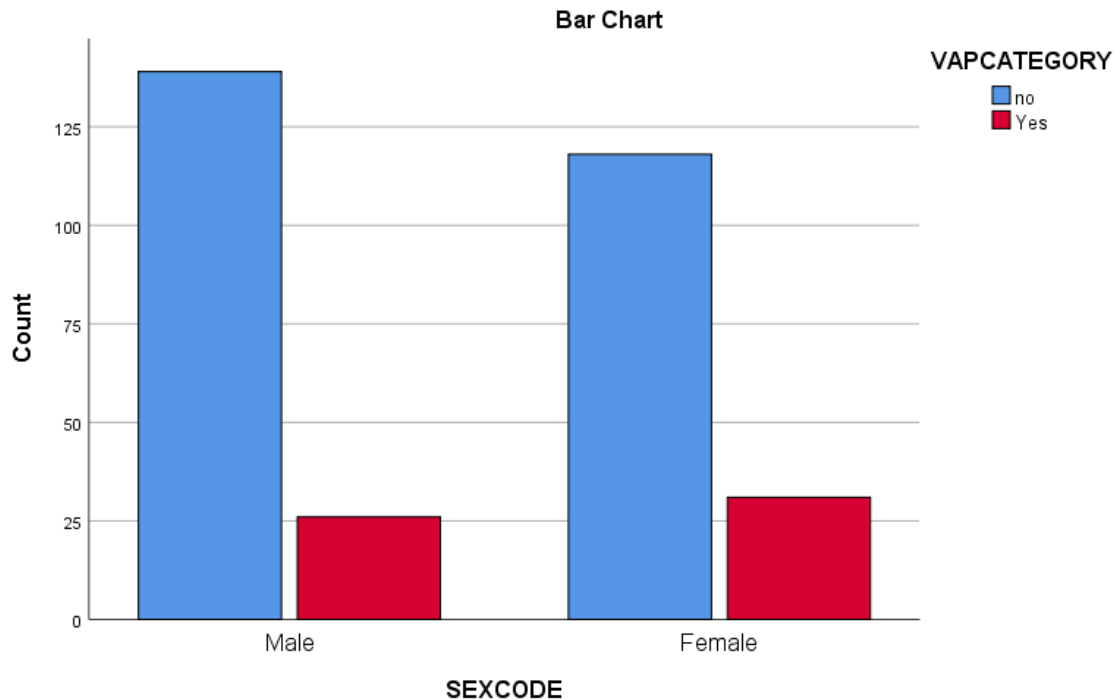


Figure 2.VAPacross Sex distribution

VAP occurred slightly more often in females than males

4.2. Prevalence of ventilator-associated pneumonia (VAP)

This study found that the prevalence of ventilator-associated pneumonia (VAP) among mechanically ventilated patients was **18.2% (95% CI: 13.9–22.4%)**. This indicates that nearly one in five patients developed VAP during mechanical ventilation, highlighting it as a significant nosocomial infection in the intensive care setting.

The observed prevalence is consistent with reports from many low- and middle-income countries, reflecting ongoing challenges in infection prevention, critical care practices, and patient-related vulnerabilities. Among patients who developed VAP, **24% experienced early-onset VAP (within 4 days of ventilation)**, while **76% had late-onset VAP**, emphasizing the

higher risk associated with prolonged mechanical ventilation.

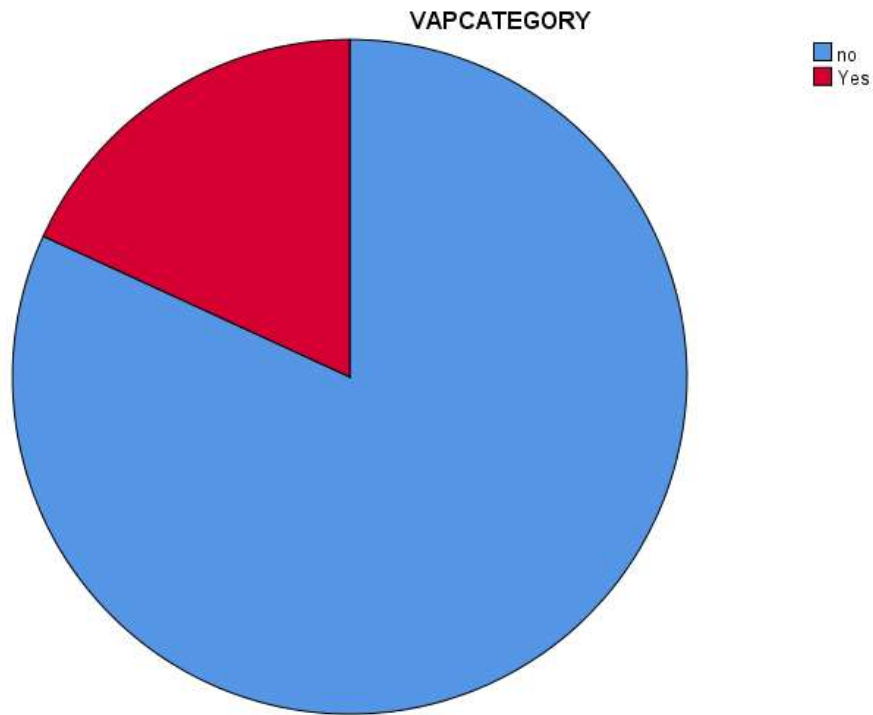


Figure 3 VAP prevalence

Figure4VAP prevalence

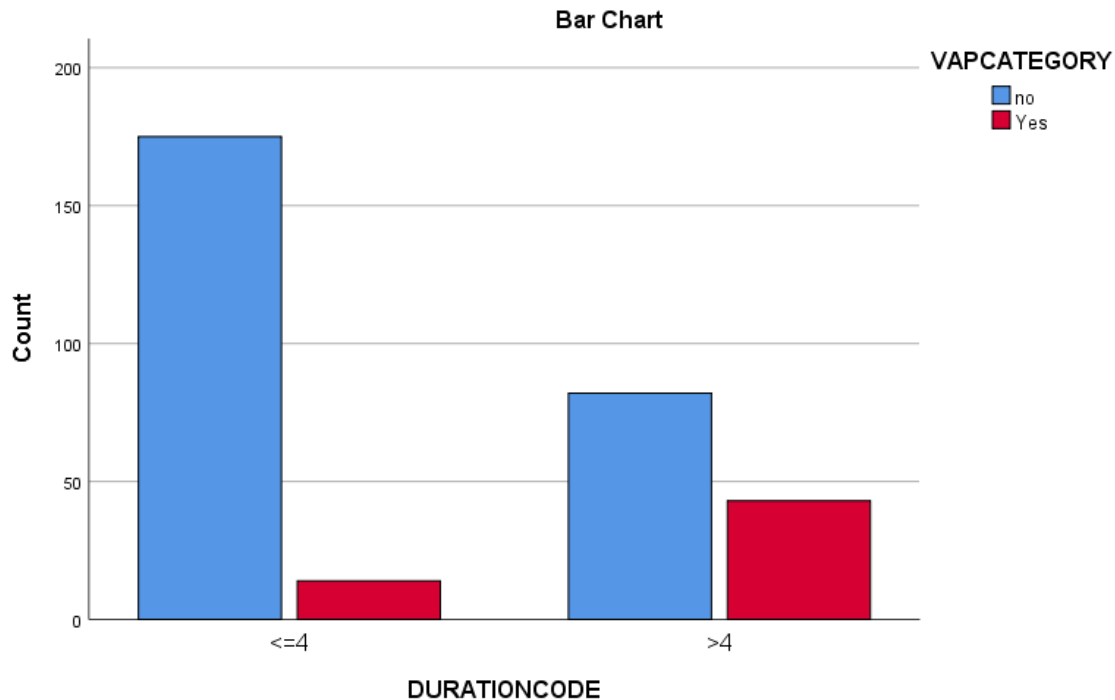


Figure 4 This bar chart shows early and late onset VAP.

From the total of patients with VAP, 24% of them encountered within 4day (early onset) and 76% are late onset.

4.3. Factors Associated with Ventilator-Associated Pneumonia

Multivariable logistic regression analysis identified several factors that were independently associated with increased odds of developing VAP. These factors are classified as intervention-related factors **and** admission diagnosis-related factors.

Table 2. Variables with p-value <0.25 and subsequent multivariate regression

Variables	Category	Ventilator Pneumonia, N		Associated	Bivariate Regression		Multivariate Analysis		Regression	
		Yes,	No,	COR	95%CI	P-Value	AOR	95%CI	P-Value	
Low GCS	Yes	38(21)	143(79)	1.59	0.87–2.91	0.130				
	No	19(14)	114(86)		1					
Continuous Sedation	Yes	25(32)	53(68)	3.01	1.64 – 5.50	0.001	2.83	1.26 – 6.35	–	0.012
	No	32(14)	204(86)		1			1		
Tracheostomy	Yes	11(65)	7(35)	8.52	3.15–23.18	0.001	7.12	1.92–26.39		0.003
	No	46(15)	250(85)		1			1		
Sepsis	Yes	51(27)	136(73)	7.56	3.14–18.24	0.001	7.47	2.52–22.13		0.002
	No	6(5)	121(95)		1			1		
Prior broad spectrum antibiotics	Yes	49(24)	146(76)	4.66	2.12–10.23	0.001	4.14	1.69 – 10.16	–	0.002
	No	8(7)	111(93)		1			1		
Duration of MV	>=7	43(34)	82(66)	6.56	3.40–12.65	0.001	7.27	3.39 – 15.57	–	0.001
	<7	14(7)	175(93)		1			1		
Surgery	Yes	20(22)	70(78)	1.44	0.79–2.66	0.237				
	No	37(17)	187(83)		1					
Type of surgery	Neuro	12(32)	26(68)	2.57	0.92–7.02	0.073				
	Others	8(15)	44(85)		1					

DM	Yes	11(30)	28(70)	1.96	0.92– 4.21	0.08 6	3.23	1.14 9.09	–	0.027
	No	46(17)	229(83)		1			1		
HIV/AIDS	Yes	12(32)	35(68)	1.69	0.82– 3.51	0.15 7				
	No	45(17)	222(83)		1					

*COR = Crude Odds Ratio

* AOR = Adjusted Odds Ratio

* Variables included in multivariate regression were those with $p < 0.25$ in bivariate analysis

This study identified the following factors that increased the odds of ventilator-associated pneumonia, In multivariable logistic regression analysis, sedation (AOR 2.83, 95% CI 1.26–6.35, $p=0.012$), prolonged mechanical ventilation (AOR 7.27, 95% CI 3.39–15.57, $p=0.001$), diabetes mellitus (AOR 3.23, 95% CI 1.14–9.09, $p=0.027$), Tracheostomy (AOR 7.12, 95% CI 1.92–26.39, $p = 0.003$), sepsis (AOR 7.47, 95% CI 2.52–22.13, $p=0.002$), and prior antibiotic use (AOR 4.14, 95% CI 1.69–10.16, $p=0.002$) were independently associated with the VAP occurrence.

4.3.1.InterventionRelated Factors

Table 3. Interventional related factors.

Variables	Category	Ventilator Associated Pneumonia		
		Yes, %	No, %	Total, N
Sedation	Yes	25(32)	53(68)	78
	No	32(14)	204(86)	236
Prior antibiotics	Yes	49(25)	146(75)	195
	No	8(7)	111(93)	119
Corticosteroids	Yes	33(15)	186(85)	219
	No	24(25)	71(75)	95

H2blockers	Yes	10(15)	55(85)	65
	No	47(19)	202(81)	249
Blood transfusion	Yes	13(18)	58(82)	71
	No	44(18)	199(82)	243
Surgery	Yes	20(22)	70(78)	90
	No	37(17)	187(83)	224
Tracheostomy	Yes	11(61)	7(39)	18
	No	46(16)	250(84)	296
Duration of MV	≥ 7	43(34)	82(66)	125
	< 7	14(7)	175(93)	189
ICU stay	> 10	36(30)	86(70)	122
	≤ 10	21(11)	171(89)	192

*Only 3 patients had maintenance and 311 patients have NG tube feeding, 1 patient on IV fluid had VAP.

*There were 3 patients who had re-intubation with the reason of extubation failure and 2 of them had VAP, and there were 4 patients with supine position and 1 had VAP.

*The mean ICU stay was **9.19 ± 4.33 days** (range 3–26 days), and the mean duration of mechanical ventilation was **6.58 ± 3.08 days** (range 3–20 days).

4.3.2 Admission Diagnosis-Related Factors

Table 4 .Admission diagnosis related factors

Variables	Category	Ventilator Associated Pneumonia		
		Yes, %	No, %	Total, N
DM	Yes	11(28)	28(72)	39
	No	46(17)	229(83)	275

Low GCS	Yes	38(21)	143(79)	181
	No	19(14)	114(86)	133
Sepsis	Yes	51(27)	136(73)	187
	No	6(5)	121(95)	127
ARDS	Yes	17(9)	167(91)	184
	No	40(31)	90(69)	130
Trauma	Yes	18(19)	76(81)	94
	No	39(18)	181(82)	220
HIVAIDS	Yes	12(26)	35(74)	47
	No	45(17)	222(83)	267
Cardiac disease	Yes	18(20)	72(80)	90
	No	39(17)	185(83)	224

The mean duration of ICU stay was 9.19 ± 4.33 days, ranging from 3 to 26 days. The mean duration of mechanical ventilation was 6.58 ± 3.08 days, with a minimum of 3 days and a maximum of 20 days. Other factors such as corticosteroid use, H2 blockers, blood transfusion, surgery, and other comorbidities, such as low GCS, ARDS, trauma, HIV/AIDS, and cardiac disease, were also considered, with sepsis and diabetes showing independent significance in multivariate analysis.

Interventional related factors

Prolonged duration of mechanical ventilation was one of the strongest predictors of VAP, with patients being more than **seven times more likely** to develop VAP(**AOR = 7.27, 95% CI: 3.39–15.57, p = 0.001**).

Patients who underwent tracheostomy had approximately **seven times higher odds** of developing VAP(**AOR = 7.12, 95% CI: 1.92–26.39, p = 0.003**).

Prior broad-spectrum antibiotic use was associated with a fourfold increase in the odds of developing VAP(**AOR = 4.14, 95% CI: 1.69–10.16, p = 0.002**).

Patients who received sedation had nearly **three times higher odds** of developing VAP compared to those who were not sedated(**AOR = 2.83, 95% CI: 1.26–6.35, p = 0.012**).

Admission diagnosis related factors

Sepsis was independently associated with a markedly increased risk of VAP, with affected patients being more than seven times more likely to develop the condition (AOR = 7.47, 95% CI: 2.52–22.13, $p = 0.002$).

Patients with diabetes mellitus were more than three times more likely to develop VAP compared to non-diabetic patients, (AOR = 3.23, 95% CI: 1.14–9.09, $p = 0.027$).

5. DISCUSSION

This study aimed to determine the prevalence of VAP and identify factors of VAP among intubated adult intensive care unit admitted patients in TGSH. Despite the mechanical ventilator being an essential feature of modern intensive care unit service, it is associated with a substantial risk of VAP. In this study the prevalence of VAP is 18.2% (95% CI: 13.9–22.4%), indicating that VAP remains a substantial burden in the intensive care unit (ICU).

The observed prevalence is lower than that reported in a previous study conducted in Bahir Dar (27.9%).

This difference may be attributed to improvements in ICU practices, better infection prevention measures, increased awareness of VAP prevention bundles, and differences in study periods and patient characteristics. It is within the range of reports from similar settings, particularly in low- and middle-income countries, where VAP incidence ranges between 13% and 57% (10, 11, 16).

Some variables, such as re-intubation, supine positioning, and parenteral nutrition, had **very small frequencies** in the study population and lost statistical power to be predictor of VAP.

Other factors might be overshadowed by strongly associated factors.

In this study, ARDS was not independently associated with VAP unlike many other studies, possibly due to early antibiotic exposure and confounding by prolonged ventilation.

Sepsis

Sepsis was strongly associated with the development of VAP, with septic patients having markedly increased odds of infection. Sepsis leads to immune dysregulation characterized by an initial hyperinflammatory response followed by immunosuppression, rendering patients more vulnerable to secondary infections such as VAP. Additionally, patients with sepsis often require

aggressive supportive interventions, including prolonged mechanical ventilation, sedation, and invasive procedures, which further elevate VAP risk. Early recognition and management of sepsis, along with strict adherence to infection prevention measures, are therefore crucial in reducing VAP incidence among these patients.(31)

Prolonged duration

Mechanical ventilation duration was one of the strongest predictors of VAP. Patients who remained on mechanical ventilation for extended periods had more than seven times higher odds of developing VAP.

The longer the duration of ventilation, the greater the opportunity for bacterial aspiration into the lower respiratory tract(4, 11).

This finding emphasizes the need for early weaning protocols, spontaneous breathing trials, and close monitoring to reduce unnecessary prolongation of mechanical ventilation(25, 30).

Tracheostomy

Tracheostomy was found to be independently associated with a significantly increased risk of VAP. It is associated with an increased risk of ventilator-associated pneumonia due to loss of natural airway defenses, impaired cough reflex, and facilitation of bacterial colonization of the lower respiratory tract(19).

The presence of a tracheostomy tube promotes biofilm formation and microaspiration of contaminated secretions, which can contribute to both early- and late-onset VAP. This finding is supported with prior evidence suggesting that tracheostomy disrupts normal airway defense mechanisms and provides a direct route for microbial entry into the lower respiratory tract(11). Frequent suctioning, manipulation of the tracheostomy tube, and inadequate tracheostomy care may further increase infection risk(19, 30).

Prior Broad Spectrum Antibiotic Use

Prior antibiotic use was associated with more than **a fourfold increase** in the likelihood of developing VAP. This finding is supported by existing evidence demonstrating that previous exposure to antibiotics alters normal respiratory flora and promotes colonization with multidrug-resistant organisms, which are common causative agents of VAP(31).

ATS/IDSA guidelines documented that prior intravenous antibiotic use within 90 days is a strong predictor of VAP caused by multidrug-resistant organisms and recommend antibiotic stewardship, risk-based empiric therapy, and short treatment durations to reduce VAP incidence. Inappropriate or prolonged antibiotic use may therefore predispose patients to secondary infections, it also underscores the critical role of **antimicrobial stewardship** programs in ICU

settings to ensure appropriate antibiotic selection, dosing, and duration, thereby reducing the risk of resistant infections and VAP(31, 32).

Diabetes Mellitus

Patients with diabetes mellitus had significantly higher odds of developing VAP compared to non-diabetic patients. This association can be explained by diabetes-related immune dysfunction, including impaired neutrophil function, reduced cytokine response, and poor glycemic control, all of which increase susceptibility to infection. Hyperglycemia also provides a favorable environment for bacterial growth and may worsen pulmonary inflammation. So strict glycemic control and close monitoring of diabetic patients are essential components of VAP prevention strategies in the ICU.

Hyperglycemia may also impair pulmonary host defenses and create *a favorable environment for bacterial growth*(36).

Sedation

Sedation was found to significantly increase the odds of developing VAP by nearly threefold. This finding is consistent with previous studies that have demonstrated an association between deep or prolonged sedation and VAP occurrence(37).

Sedation suppresses cough reflexes, impairs mucociliary clearance, and promotes pooling of oropharyngeal secretions above the endotracheal tube cuff, which increases the risk of microaspiration.

Additionally, sedated patients are more likely to experience prolonged mechanical ventilation, which further elevates VAP risk.

It evidences that the importance of implementing sedation minimization strategies, such as daily sedation interruption and the use of validated sedation assessment tools, as part of VAP prevention bundles (37, 38)

6. Strengths and Limitations

Strength

- ✓ Provides updated prevalence and determinants of VAP in TGS.
- ✓ Contributing to local surveillance and ICU practice improvement.

Limitation

- ✓ Retrospective cross-sectional design; cannot infer causality.
- ✓ Potential selection bias and incomplete data due to reliance on secondary records.
- ✓ No microbiological confirmation
- ✓ Residual confounding still could not be completely avoided

7. Conclusion

- Nearly one-fifth of intubated ICU patients developed VAP which was lower than the previous study finding.
- Independent predictors: sedation, prolonged MV, tracheostomy, prior broad-spectrum antibiotic use, diabetes mellitus, and sepsis.

Sedation minimization and daily interruption protocols, early weaning and spontaneous breathing trials, strict tracheostomy care and suctioning protocols, antimicrobial stewardship and culture-guided therapy, glycemic control for diabetic patients, early recognition and management of sepsis are recommended.

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10. Data Extraction Checklist

s.no	Socio demographic part	MRN...	
101	Age		
102	Sex	1.male 2.Female	
	Intervention related factors		
201	Patient CU admission date		
202	Does the patient develop VAP	1.yes 2.no	if no go to 204
203	Date of VAP development		
204	Duration of MV in days		
205	Patient extubation date		
206	Is there re-intubation	1.yes 2.no	If no go to 208
207	Reason for re-intubation		
208	Duration of ICU stays in		

	days		
209	Tracheostomy	1. yes 2. No	
210	Corticosteroid use	1.yes 2. No	
211	NG tube feeding	1. yes 2. No	
212	Use of H2 blocker	1.yes 2.no	
213	Was the patient in supine position	1. yes 2. No	
214	Prior broad spectrum antibiotics use	1.yes 2.no	
215	Blood transfusion	1.yes 2.no	
216	Patient use of continuous iv sedation	1.yes 2.no	
217	Surgical intervention	1.yes 2.no	
	Admission diagnosis related factors		
301	Admission diagnosis of AIDS?	1. yes 2. No	
302	Admission diagnosis of cardiac disease	1. yes 2. No	
303	Low GCS	1.yes 2.no	
304	Admission diagnosis of DM	1.yes 2.no	
305	Does the patient have ARDS	1.yes 2.no	
306	Does the patient have sepsis	1.yes 2.no	
307	Does the patient have trauma	1.yes 2.no	If yes go to 308
308	Type of trauma	1. head 2. Chest	

		3.abdomen 4.others	
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11. Declaration

This is to certify that the thesis entitled **"Ventilator-Associated Pneumonia and Associated Factors Among Intubated Patients in Adult Intensive Care Units at TibebeGhion Specialized Hospital, Bahir Dar, Northwest Ethiopia, Jan.2023–Dec.2025"** is submitted in partial fulfillment of the requirements for the specialty in Internal Medicine at the Department of Internal Medicine, Bahir Dar University.

This thesis is a record of original work carried out by me and has not been submitted to this or any other institution for the award of any degree or certification. All sources of assistance and support received during the course of this study have been duly acknowledged.

Dr. BazezewKoyachew

Email: bazkoy1123@gmail.com

Mobile: +251918437339

Signature..... Date 08/08/18

12. Advisor's approval form

I hereby certify that I have supervised, read, and evaluated this thesis entitled **"Ventilator-Associated Pneumonia and Associated Factors Among Intubated Patients in Adult Intensive Care Units at TibebeGhion Specialized Hospital, Bahir Dar, Northwest Ethiopia, Jan.2023–Dec.2025"**, submitted by Dr. BazezewKoyachew. I recommend that this thesis be accepted and submitted for oral defense (mock viva and viva voce).

1. Dr.DrYilkalAbie (MD, Internist)

Email: yilkala7@gmail.com

Mobile: +251918750340

Signature..... Date 08/08/2018

2. Mr.MekonenMelkie, (Lecture at Bahir Dar University.)

Email:

Mobile: +251-930525010

Signature..... Date 08/08/18

Jan. 2026.

