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Clinical Outcomes of Ventilator-Associated Pneumonia and Its Associated Factors Among Critically Ill Patients at Muhimbili National Hospital, 2024-2025

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ABSTRACT

Introduction: Ventilator-associated pneumonia (VAP) is the most common nosocomial infection in patients on mechanical ventilators. It significantly contributes to mortality and prolonged ICU stay which shows the need to re-evaluate the outcomes and its contributing factors in critically ill patients.

Objectives: To determine clinical outcomes of ventilator-associated pneumonia (VAP) and its associated factors among critically ill patients at Muhimbili National Hospital, from January 2024 to November 2025.

Methods: A facility based retrospective cross-sectional study was conducted at Muhimbili National Hospital (MNH) from January 2024 to November 2025. It included all adult patients who developed VAP after at least 48 hours of MV and stayed in the Medical Intensive Care Unit (MICU) for at least 5 days. Data on demographics, co-morbidities, ventilation factors, clinical signs, complications and outcomes were extracted from the patient medical files on Microsoft Excel and managed on SPSS software to make descriptive statistics to summarize patient characteristics, while Chi-square tests assessed the associations between the factors and outcomes.

Results: A total of 117 patients developed VAP during the study period and among the 560 mechanically ventilated patients, the proportion of VAP was found to be 20.9%. The mean age was 53.1 years (SD ± 21.2), and the gender distribution was nearly equal. Most cases were late-onset VAP (70.9%). Hypertension (54.7%) and diabetes (23.1%) were the most common comorbidities found. Almost all patients (99.1%) required invasive ventilation, and one-third remained ventilated for more than 20 days. The most frequently documented clinical features were leukocytosis (75.2%), fever (64.1%), and purulent secretions (58.1%). Overall mortality was high at 68.4%, while only 23.9% of patients were discharged from the ICU. Poor outcomes were significantly associated with hypertension, diabetes, chronic respiratory disease, older age, and prolonged ventilation duration (all $p < 0.05$).

Conclusion: VAP is still a public health concern as the proportion of cases in MNH during the study period was 20.9%. There was a higher case-fatality rate than most studies, of 68.4% among the study population. Early identification of these factors will help in reducing the problem through early intervention and therefore improve outcome.

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Abbreviations
CI: Confidence Interval
DM: Diabetes Mellitus
ETT: Endotracheal Tube
ETTS: Endotracheal Tube Suctioning
HAI: Hospital Acquired Infections
HTN: Hypertension
ICU: Intensive Care Unit
EOVAP: Early Onset Ventilator Associated Pneumonia
LOVAP: Late onset Ventilator Associated Pneumonia
LMIC: Lower-Middle Income Countries
MICU: Medical Intensive Care Unit
MNH: Muhimbili National Hospital
MODS: Multiple Organ Dysfunction Syndrome
MV: Mechanical Ventilation
OR: Odds ratio
SPSS: Statistical Package for the Social Science
VAP: Ventilator Associated Pneumonia
WHO: World Health Organization

Introduction

Mechanical Ventilation (MV) is an important medical device that provides assistance or fully supplements a patient's breathing when they are unable to do so on their own. The purpose of ventilation therapy is to reduce respiration work effort and re-establish adequate tissue oxygenation [1]. Ventilator associated Pneumonia (VAP) is the second most common type of nosocomial infection in

ICUs worldwide that happens as a result. It has rates ranging from 13 to 51 per 1000 ventilation days globally [2]. Although MV can improve survival with an odds ratio of 0.66 (95% CI, 0.52 to 0.83), it also poses significant risks, contributing to increased mortality such as in Muhimbili National Hospital in Tanzania, the overall mortality rate among patients on MV is 58.7%, emphasizing the fine balance between its life-saving potential and associated risks [3]. Moreover, technological advancement and growing awareness of respiratory diseases contribute to increasing demand for MV. This is supported in a new study in Ethiopia reporting 43.1% of the total 1395 patients requiring intubation that were admitted to medical intensive care unit (ICU), highlighting the surging use of MV's in ICUs [4].

There are two types of ventilation: Invasive and Non-Invasive methods (NIV). Invasive methods including endotracheal tube and tracheostomy which provide direct access to lower respiratory tract. A study from southern Africa showed a trend toward increased risk of multidrug-resistant organisms in patients with tracheostomy (RR 1.68; 95% CI 0.78–3.57) [5]. This could possibly be due to longer ICU stays and higher chances of bacterial colonization in these patients. On the contrary, NIV methods use a mask or nasal prongs to deliver air or oxygen like CPAP (Continuous Positive Airway Pressure) and BIPAP (Bilevel Positive Airway Pressure). These are used in patients who require respiratory support; for conditions like chronic obstructive pulmonary diseases (COPD), sleep apnea and were extensively used during the corona virus period [6]. In a study where non-invasive ventilation was used more often, pneumonia cases dropped by 51%, from 13.2 to 6.5 per 1000 ventilator-days (mean difference 6.7; 95% CI: 2.9–10.4; p = 0.02), strongly suggesting that avoiding invasive ventilation wherever possible can help lower VAP risk [7].

Although MV is a crucial intervention, it presents with a significant complication called Ventilator-associated pneumonia (VAP) as the most significant one that requires dedicated attention. According to WHO, Ventilator-associated pneumonia (VAP) is a term used to describe nosocomial lung infection that develops in a patient who has been on mechanical ventilation for equal to or more than 48 hours [3]. It is the most common complication in patients on MV. VAP rates range from 1.2 to 8.5 per 1,000 ventilator days because ICU patients experience severe respiratory issues that necessitate support by MV; however, this particularly predisposes patients to VAP [8]. There are two types: Early-onset VAP (EO-VAP) is a term used for pneumonia occurring within ≤5 days (≤96–120 hours) of endotracheal intubation or mechanical ventilation. Late-onset VAP (LO-VAP) is a term used for pneumonia occurring after >5 days (>120 hours) of mechanical ventilation. Early-onset VAP is usually less severe and is associated with a better prognosis, and is more likely to be caused by antibiotic-responsive bacteria. On the other hand, Late-onset VAP, is usually caused by multi-drug resistant bacterias and is associated with increased morbidity and mortality [3]. According to the ATS/IDSA VAP protocol, the diagnosis of VAP is based on clinical and microbiological criteria. The presence of new infiltrates on chest radiograph, fever of >37.5°C, WBC count of >11,000/ml or <4000/ml and confirmed by cultures from endotracheal secretions.

Over 60% of VAP is caused by aerobic Gram-Negative bacteria (GNB). When specified, the most common were Klebsiella spp., 15.6%; Escherichia coli, 24.1%; Proteus spp., 22.3%; A related African study found Pseudomonas aeruginosa in 24.7% of isolates with an addition of Staphylococcus aureus-the only Gram-positive isolate-which was found to be responsible for 19.1%. Furthermore, the mortality rate was much higher in patients with MDR infections (81.1%) versus those with non-MDR infections (45.8%). This is also supported by another study in South Africa which showed trend towards an increased risk of multidrug-resistant organisms with LO-VAP (adjusted relative risk 2.26; 95% CI 0.92 - 5.57; p=0.077) [9-10].

VAP has been linked to a number of patient and care-related variables. Patient characteristics like age, gender, co-morbidities, duration of ventilation and primary indication for ventilation were found to play a role in VAP development. A study found that 24.0% of patients had co-morbidities like diabetes, 19.7% had chronic heart failure, 22.1% had a history of smoking, and nearly half of patients (48.5%) were admitted for neurosurgical disorders. As for care-related factors; nearly one-third of patients had tracheotomies, and 53.4% had constant cuff-pressure control with subglottic secretion suctioning. Extended ICU stays of more than 5 days in 62% of patients and prolonged mechanical ventilation (median 8 days) substantially raised the risk for development of VAP. Studies showed patients who died were found to be significantly older than those who survived, and the mortality rate was high at 44.7% [11,12].

There are several strategies in place to prevent VAP. Worldwide, the main goal is to reduce its incidence, mortality, hospital length of stay, and health care costs. In a study conducted in the United States, the VAP prevention bundle that was made up of head-of-bed elevation, peptic ulcer and deep venous thrombosis prophylaxis, oral decontamination with 0.12% chlorhexidine, and continuous aspiration of subglottic secretions brought about a significant decrease in VAP rates. The adoption of the bundle was followed by a drop in VAP from 4.08 to 1.16 cases per 1,000 ventilator-days, giving an incidence density ratio of 0.28 (95% CI 0.275–0.292). Therefore, the application of VAP care bundles along with a focused training program that may promote greater compliance has demonstrated its effectiveness in the reduction of VAP cases [13].

Literature Review

Prevalence of VAP

There is no single, universally accepted global prevalence of VAP. However, a study that pooled data from multiple regions across Asia found that VAP rates were 18.5 per 1,000 ventilator-days in low-income countries, 15.2 in middle-income countries, and 9 in high-income countries [14].

A study conducted at Kilimanjaro Christian Medical Centre (KCMC) in Tanzania reported a point prevalence of VAP of 4.1%, with a sex-specific prevalence of 3.5% in males and 4.5% in females [15]. On the other hand, an Ethiopian study conducted recently reports a substantially high prevalence of 31.3% among intubated ICU patients which is on the higher end compared to other observed prevalence [16].

Moreover, a meta-analysis from India reported a pooled VAP prevalence of 12.7% (95% CI 10.0–16.1%) among mechanically ventilated patients, along with an incidence density of 15.1 per 1,000 ventilator days. In line with these findings, in Belgium, France, Germany, Greece, Ireland, Italy, Portugal, Spain, and Turkey, a prospective multicenter study across 27 ICUs showed an incidence density of 18.3 per 1,000 ventilator days, with prevalence varying between 10% and 20% depending on ICU type [17]. Additionally, a retrospective study from China documented a VAP prevalence of 14.5% among adult ICU patients receiving mechanical ventilation [18].

Associated Factors for Development of VAP

Ochoa et al. (2025) conducted a systematic review and meta-analysis of 22 studies including 16,731 mechanically ventilated ICU patients to examine risk factors for VAP. They found that several patient characteristics increased VAP risk, including male sex (OR 1.30; 95% CI 1.18–1.44), COPD (OR 1.52; 95% CI 1.10–2.09), impaired consciousness (OR 3.14; 95% CI 1.28–7.69), and trauma at admission (OR 1.47; 95% CI 1.12–1.93). Furthermore, multiple care-related factors contributed to VAP development, such as tracheostomy (OR 3.44; 95% CI 2.00–5.92), re-intubation (OR 5.11; 95% CI 2.29–11.42), enteral feeding (OR 4.73; 95% CI 2.54–8.78), nasogastric tube use (OR 2.94; 95% CI 1.56–5.53), prior antibiotic therapy (OR 1.52; 95% CI 1.08–2.15), H_2-blocker use (OR 2.24; 95% CI 1.50–3.37), neuromuscular blockers (OR 1.30; 95% CI 1.13–1.49), and prolonged intubation (OR 6.20; 95% CI 1.09–11.30). Patients who developed VAP also experienced much longer mechanical ventilation (+12.3 days), ICU stay (+12.7 days), and hospital stay (+16.1 days), demonstrating the heavy clinical burden associated with VAP [19].

Conversely, findings from a 2024 single-center prospective cohort study in Egypt by Elsheikh et al. indicated somewhat different risk factors. Emergency surgery (SHR 2.11, 95% CI 1.25–3.56), re-intubation (SHR 3.74, 95% CI 2.23–6.28), blood transfusion (SHR 2.23, 95% CI 1.32–3.75), and prolonged mechanical ventilation (SHR 1.04 per day, 95% CI 1.03–1.06) were significant, while new corticosteroid use showed no association (SHR 0.94, 95% CI 0.56–1.57) [20] .

Supporting this point, a 2021 retrospective cross-sectional study from Ethiopia by Hunegnaw also emphasized the role of comorbidities and complications, reporting that 65.2% of patients had comorbid conditions, electrolyte abnormalities occurred in 73.4%, acute renal failure in 28.3%, and chronic renal failure in 30% [21].

A notable omission in most studies is the lack of mention of the gender as a factor. A study which emphasized despite the significantly high incidence in men, the women who got VAP suffered a higher death rate than the men (24% vs 15%; $p = 0.009$), revealing a notable difference between the genders regarding VAP results [22].

Clinical Outcomes of VAP

A 2022 retrospective cohort study from China demonstrated that VAP was associated with markedly worse outcomes: in-hospital mortality was 64.7% versus 25.5% in matched non-VAP patients, and 30-day mortality was 54.6% versus 13.9% ($p < 0.001$). VAP patients also required longer mechanical ventilation (16.9 vs 12.7 days; $p = 0.022$) and had extended ICU stays (17.1 vs 15.3 days; $p < 0.001$). Moreover, late-onset VAP (≥5 days) increased 30-day mortality risk (adjusted OR 3.45; 95% CI 1.20–9.92), and inappropriate initial antibiotic therapy further heightened mortality (adjusted OR 4.08; 95% CI 1.06–15.72), reinforcing the importance of early recognition and correct antibiotic management [23].

Likewise, a 2002 retrospective matched-cohort study from the USA by Rello et al. found that 9.3% of mechanically ventilated ICU patients developed VAP and experienced significantly greater morbidity and resource use, including longer mechanical ventilation (14.3 ± 15.5 vs 4.7 ± 7.0 days), ICU stay (11.7 ± 11.0 vs 5.6 ± 6.1 days), and hospital stay (25.5 ± 22.8 vs 14.0 ± 14.6 days), all $p < 0.001$. Hospital charges were also substantially higher, demonstrating the economic impact of VAP [24].

VAP Prevention Strategies

The 2025 meta-analysis on VAP prevention in adults in the Middle East and North Africa showed that preventive interventions significantly reduced VAP risk, with a pooled risk ratio of 0.36 (95% CI 0.20–0.65), representing a 64% reduction. Among 1,049 ICU patients, 272 VAP events were recorded. Interventions such as oral-care protocols-including clove mouthwash and Miswak-and aerosolized antibiotics were particularly effective, whereas ondansetron and N-acetylcysteine did not demonstrate significant benefit. Overall, this review illustrates that preventive measures can reduce VAP incidence by nearly two-thirds [25].

Correspondingly, a 2023 systematic review by Alqahtani et al. reported similar findings across 38 studies: 22 demonstrated more than a 36% reduction in VAP incidence, and 10 showed reductions exceeding 65%. In several cases, VAP rates approached zero following implementation of care bundles. The most effective bundles consisted of head-of-bed elevation, oral hygiene, sedation/weaning protocols, subglottic suctioning, and cuff-pressure control, underscoring the value of multifaceted preventive strategies in ICU practice [25].

Statement of Research Problem

Ventilator associated pneumonia (VAP) is the second most common nosocomial infection in intensive care units worldwide (ICU) and the most common in patients on mechanical ventilators. It significantly contributes to mortality ranging from 6-68% all over the world depending on the population [3]. It remains one of the most serious complications accountings for 25-70% of all hospital and ICU acquired infections globally [14,15]. There is scarcity of data in our settings regarding this topic of which is important, much can be done to control this issue and ensure that these patients should not suffer. Therefore, there is a need to investigate the burden and magnitude of VAP at Muhimbili National Hospital for better management and outcome for the patients.

Rationale

Knowledge of the local burden of VAP in terms of its prevalence andimpactisfundamentaltoimprovingpatientcareandhospital policy-making. This omission further underscores the urgent need for research on mechanical ventilation in low-resource settings like Tanzania, where such research can guide dramatic patient improvement. Ventilation technique refinement, infection prevention, and complication detection are key steps towards mortality reduction that the findings will guide

Chapter Two

Objectives

Research Question

What are the clinical outcomes of Ventilator-associated Pneumonia (VAP) and its associated factors among critically ill patients at Muhimbili National Hospital in 2024-2025?

Research Hypothesis

Not applicable

General Objective

To determine clinical outcomes of ventilator-associated pneumonia (VAP) and its associated factors among critically ill patients at Muhimbili National Hospital, from January 2024 to November 2025

Specific Objectives

1. To determine the proportion of patients with Ventilator associated Pneumonia (VAP)
2. To identify the clinical profile of patients with Ventilator associated Pneumonia (VAP).
3. To determine the factors associated to outcomes of patients with Ventilator associated pneumonia (VAP

Chapter Three

Materials And Methods

Study Design

A facility-based retrospective cross-sectional study was implemented to determine the clinical outcomes of ventilator-associated pneumonia and its associated factors among patients on mechanical ventilation in Muhimbili National Hospital, from January 2024 to November 2025.

Study Area and Population

Dar es Salaam is the largest city of United Republic of Tanzania with a fast-growing population of 10.59 million people and is situated on the eastern coast of Africa. It is neighbored by countries like Uganda and Kenya to its north and Mozambique and Malawi to its south, Rwanda and Burundi to its west and the extensive Indian Ocean to its east. There are 32 well-established hospitals in Dar es salaam which are District hospitals, regional referral hospitals, zonal referral hospitals, specialized hospitals and national hospitals. The study will be conducted at Muhimbili National Hospital (MNH), in Ilala district, Dar es Salaam. This hospital in particular was chosen because it is the largest national tertiary referral hospital, research center and university teaching hospital in Dar es Salaam with a bed capacity of 1500 and attending 2,000 outpatients per day from all over Tanzania. The Medical Intensive Care Unit (MICU) for pulmonology unit (respiratory diagnostics) have 17-bed capacity and 14 mechanical ventilators. The MICU has specialists, super-specialists, registrars, residents, and fellows with advanced services and modern equipment and technology for assessing respiratory conditions to provide best care.

The focused population in this study includes all adult patients admitted to the Medical Intensive Care Unit (MICU) at Muhimbili National Hospital (MNH), Dar es Salaam, who have been on mechanical ventilation for more than 48 hours and stayed in ICU for more than 5 days during the study period of January 2024 to November 2025. Patients who meet this criterion will be identified from ICU admission and ventilation records with the help of ICU staff and hospital records personnel.

Sampling Technique and Sample Size

Purposive sampling technique was used in this study to include Muhimbili National Hospital as it serves as the largest national referral and tertiary care facility in Tanzania, and the sample size included all cases that fulfilled the inclusion criteria. The maximum number of VAP patients that

could be recruited and fulfilled the inclusion criteria in the study period of January 2024 to November 2025 in MNH was found to be 117.

Inclusion and Exclusion Criteria

Inclusion criteria

- All adult patients above the age of 18 years on mechanical ventilation regardless of gender admitted to MICU for atleast 48 hours from January 2024 to November 2025
- All patients who have been in ICU for at least 5 days.
- All patients with complete data

All patients who developed VAP according to the standard diagnostic criteria

Exclusion criteria

- All patients admitted to MICU who are not on mechanical ventilators or have been admitted to MICU for less than 5 days (120 hours) during the study period.
- All patients who are less than 18 years of age
- All patients on mechanical ventilation for less than 48 hours
- All patients with pneumonia prior to initiation of mechanical ventilation IE; patients who developed hospital acquired pneumonia (HAP) or aspirated and developed aspiration acquired pneumonia (AAP)

Data Collection, Management and Statistical Analysis

A standardized, pre-tested questionnaire was used following pilot testing. The Primary data collection tool was developed through a review of relevant literature and adapted to the study objectives. In Tanzania, several protocols for diagnosing pneumonia are in use (e.g., ATS/IDSA criteria, Berlin criteria). For consistency, this study relied on clinician notes and reports as documented in patient files, with whichever criteria used to diagnose VAP. The primary source of data was hospital medical records obtained from the Muhimbili National Hospital database, including admission books, discharge books, and reports from the Medical ICU. It included patient-specific variables like: unique patient ID, age and sex. Clinical specific variables like comorbidities, primary ICU admission diagnosis and indication for mechanical ventilation. Additionally, ventilation-related details like date of initiation, duration of ventilation, mode of ventilation, and other early or late onset VAP, ventilator-associated complications were collected. Lastly, care-related specifics like patient positioning, bed elevation, suctioning, antibiotics and outcomes like, discharge status, prolonged stay, or death were also collected. Data was entered using Google Forms, transferred to a Microsoft Excel spreadsheet, and subsequently managed and analyzed using SPSS version 29.0.

Data Analysis

Age, length of hospital stays, and duration of ventilation were turned into ordinal variables to ease analysis. All variables were categorical, so no tests of normality were required. Descriptive statistics were used to summarize characteristics of ventilator-associated pneumonia patients and data was displayed in frequency tables and bar charts for visual insight. Inferential statistical analysis was conducted through Chi-square test or Fisher's exact test to determine associations between independent variables (demographics, comorbidities, mechanical ventilation factors, clinical signs) and Outcomes (discharge, prolonged ICU stay, and death) Or complications (MODS, septic shock, and others). A p value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board (IRB) to make sure the study follows all the research guidelines. Implementation of the field data collection was authorized by administration of the hospital. Consent was obtained from the treating doctors after providing full and complete information on the research objectives. The confidentiality of the participants was ensured by the use of anonymous questionnaire using a unique identification number. Confidentiality of the data collected was

maintained and was not to be shared with anyone or used for any purpose other than the research objectives. Additionally, medical records were used ethically, with the data only used to satisfy the research objectives and adhering to hospital and institutional policies for patient data and research purposes. The data was fully kept safe until the discussion of the thesis after which they will be destroyed.

Chapter Four

Results

The Proportion of Patients with Ventilator Associated Pneumonia (VAP)

There was a total of 560 mechanically ventilated patients who were admitted to the MICU over the study period, out of which 117 patients acquired VAP; thus, the proportion of VAP was 20.9% (n=117/560).

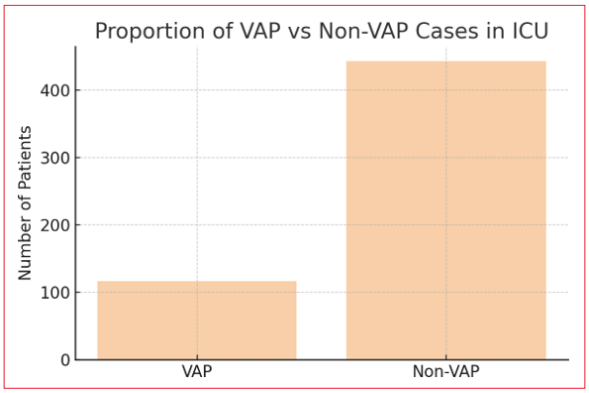


Figure 4.1.1: Bar Graph Represents Proportion of Patients with VAP

Clinical Profile and Factors of Patients with VAP Attending Muhimbili National Hospital

Table 4.2.1: Represents Demographic and Clinical Factors of Patients

Demographic and clinical factors			
		Count	%
Age	Mean ± SD	53.15 ± 21.237	
Age groups	Young adult (18-39)	39	33.3%
	Middle-aged adult (40-59)	24	20.5%
	Older adult (60-79)	40	34.2%
	Elderly (≥80)	14	12.0%

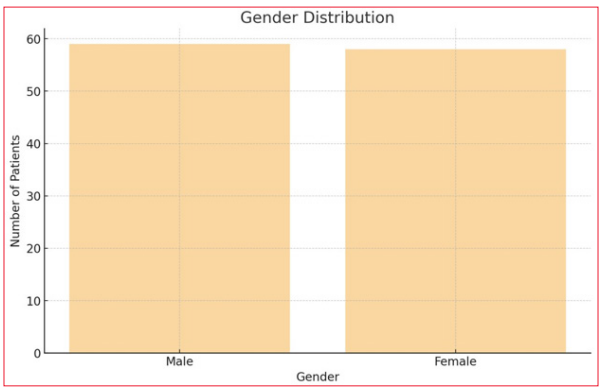


Figure 4.2.1: Bar Chart Demonstrating Gender Distribution of Patients

The average age of the patients was 53.15 years with a wide variation (± 21.24), showing a mix of younger and older adults in the sample. Young adults (18–39 years) made up 33.3% (39 patients), while middle-aged adults (40–59 years) accounted for 20.5% (24 patients). Older adults (60–79 years) were the largest age group at 34.2% (40 patients), and elderly patients (≥80 years) represented 12% (14 patients). Gender distribution was almost equal, with males at 50.4% (59 patients) and females at 49.6% (58 patients), indicating a well-balanced sample.

Clinical Factors associated to VAP

Table 4.3.1: Represents Co-Morbidities Among VAP Patients

Comorbidities Among VAP Patients			
		Count	%
Hypertension	Yes	64	54.7%
	No	53	45.3%
Diabetes Mellitus	Yes	27	23.1%
	No	90	76.9%
Chronic Respiratory Disease	Yes	14	12.0%
	No	103	88.0%
HIV/AIDS	Yes	12	10.3%
	No	105	89.7%

Hypertension (HTN) was the most common comorbidity, affecting 54.7% (64 patients). Diabetes mellitus (DM) was present in 23.1% (27 patients), with the majority 76.9% (90 patients) being non-diabetic. Chronic respiratory disease was reported in 12% (14 patients), while 88% (103 patients) had no such condition. HIV/AIDS was present in 10.3% (12 patients).

Table 4.3.2: Represents Mechanical Ventilator Factors in VAP Patients

Mechanical Ventilation Factors in VAP Patients			
		Count	%
Type of Ventilation	Invasive	116	99.1%
	Non-invasive	1	0.9%
Duration of ventilation	<10 days	37	31.6%
	10-14 days	29	24.8%
	15-20 days	12	10.3%
	>20 days	39	33.3%
	Yes	12	10.3%
	No	105	89.7%

Almost all patients were managed with invasive mechanical ventilation, accounting for 99.1% (116 patients), while only 0.9% (1 patient) received non-invasive ventilation. The duration of ventilation varied widely: 31.6% (37 patients) were ventilated for less than 10 days, and 24.8% (29 patients) required ventilation for 10–14 days. A smaller proportion, 10.3% (12 patients), were ventilated for 15–20 days, while the largest group, 33.3% (39 patients), remained on ventilation for more than 20 days, indicating prolonged dependence in many cases.

Length of ICU stay

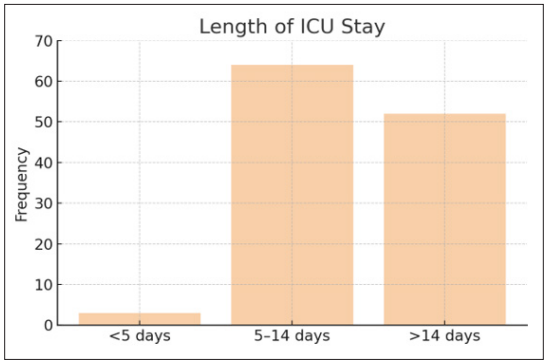


Figure 4.3.1: Bar Chart Showing Length of ICU Stay

ICU stay varied, with 1.7% (2 patients) staying <5 days, 53.8% (63 patients) staying 5–14 days, and 44.4% (52 patients) staying more than 14 days.

Frequencies of Clinical Signs

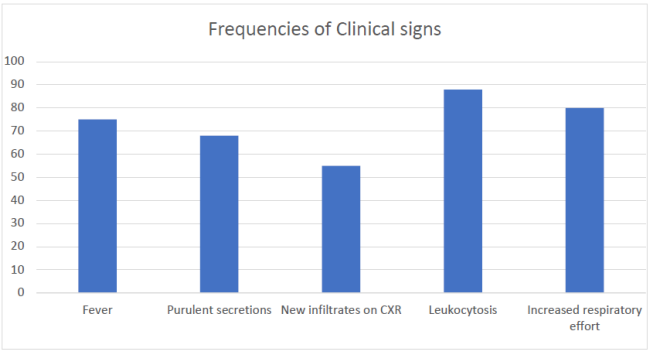


Figure 4.3.2: Bar Chart Showing Clinical Signs Among VAP Patients

Leukocytosis was one of the most common findings, present in 75.2% (88 patients). Fever was present in 64.1% (75 patients), Purulent respiratory secretions were observed in 58.1% (68 patients), with 41.9% (49 patients) showing none. New infiltrates on chest X-ray were noted in 47% (55 patients), whereas 53% (62 patients) had no radiological diagnosis Increased respiratory effort was reported in 68.4% (80 patients), while 31.6% (37 patients) did not show increased effort.

The Outcomes of Patients with VAP:
Table 4.4.1: Table Showing Outcomes of VAP

Outcomes of VAP patients				
			Count	**%**
Early or late onset VAP		Early-onset	34	29.10%
		Late-onset	83	70.90%
Complications	Septic shock	Yes	19	16.20%
		No	98	83.80%
	MODS	Yes	44	37.60%
		No	73	62.40%
	Others	Yes	42	35.90%
		No	75	64.10%
		Discharged from ICU	28	23.90%
Outcome		Prolonged ICU stay (>14days)	9	7.70%
		Dead	80	68.40%

Late-onset VAP was far more common, occurring in 70.9% (83 patients), while 29.1% (34 patients) developed early-onset VAP. Septic shock occurred in 16.2% (19 patients), with 83.8% (98 patients) experiencing no septic shock. MODS was recorded in 37.6% (44 patients), while 62.4% (73 patients) did not develop multi-organ dysfunction. Other complications (such as pulmonary embolism, hypoxemia secondary to respiratory failure, hypovolemic shock etc.) were present in 35.9% (42 patients), with 64.1% (75 patients) experiencing none. ICU stay varied, with 1.7% (2 patients) staying <5 days, 53.8% (63 patients) staying 5–14 days, and 44.4% (52

patients) staying more than 14 days. Final outcomes showed that 23.9% (28 patients) were successfully discharged from the ICU, 7.7% (9 patients) remained for a prolonged stay beyond 14 days, and 68.4% (80 patients) unfortunately died, indicating a high mortality rate among the patients with VAP inthis study.

Association between demographical factors and Outcomes of VAP patients

Table 4.5.1: Demonstrating Association Between Demographics/Clinical Factors and Outcomes

		Early or late onset VAP			Outcome			P value
		Early- onset	Late-onset	P value	Discharged from ICU	Prolonged ICU stay (>14days)	Dead	
		Count (%)	Count (%)		Count (%)	Count (%)	Count (%)	
Age groups	Young adult (18-39)	20.5	79.5		35.9	20.5	43.6	0.003
	Middle aged adult (40-59)	50.0	50.0		20.8	0	79.2	
	Older adult (60-79)	25.0	75.0	0.091	17.5	2.5	80	
	Elderly (≥80)	28.6	71.4		14.3	0	85.7	
Gender	Male	32.2	67.8	0.450	22.0	8.5	69.5	0.870
	Female	25.9	74.1		25.9	6.9	67.2	
Length of ICU stay	<5 days	100.0	0.0	0.033	50.0	0	50.0	0.003
	5-14 days	33.3	66.7		28.6	4.8	66.7	
	>14 days	21.2	78.8		17.3	11.5	71.2	

		Complications								
		Septic shock			MODS			Others		
		Yes	No	P value	Yes	No	P value	Yes	No	P value
		(%)	(%)		(%)	(%)		(%)	(%)	
Age groups	Young adult (18-39)	10.3	89.7	0.341	23.1	76.9	0.012	25.6	74.4	0.273
	Middle aged adult (40-59)	25	75		33.3	66.7		41.7	58.3	
	Older adult (60-79)	20	80		42.5	57.5		45	55	
	Elderly (≥80)	7.1	92.9		71.4	28.6		28.6	71.4	
Gender	Male	16.9	83.1	0.834	33.9	66.1	0.404	35.6	64.4	0.945
	Female	15.5	84.5		41.4	58.6		36.2	63.8	
Length of ICU stay	<5 days	0	100	0.201	0	100	0.204	50	50	0.796
	5-14 days	11.1	88.9		44.4	55.6		33.3	66.7	
	>14 days	23.1	76.9		30.8	69.2		38.5	61.5	

Early and Late onset VAP (LO-VAP) differed significantly with respect to age groups (P=0.001) and length of ICU stay (p=0.003), where late onset VAP was linked to prolonged hospitalization. No association with gender was found (P=0.45) additionally a significant relationship was found between VAP onset and patient related outcomes (p=0.03) such as a higher mortality and prolonged ICU stay and early-onset (EO-VAP) was more common among ones discharged from ICU. Moreover, development of MODS demonstrated a strong affiliation with elderly age group (>80 years) with (p=0.012) indicating greater systemic deterioration among this particular age group. Overall, LO-VAP was associated with worse outcomes and severe complications whereas EO-VAP was associated with a relatively better prognosis.

Table demonstrating Association between co-morbidities and outcomes of VAP patients

		Association between Co-morbidities and Outcomes of VAP patients											
		Early or late onset VAP			Complications								
					Septic shock			MODS			Others		
		Early-onset	Late-onset	P value	Yes	No	P value	Yes	No	P value	Yes	No	P value
		(%)	(%)		(%)	(%)		(%)	(%)		(%)	(%)	
Hypertension	Yes	10.9	89.1	0	23	77	0.02	53	47	0	48	52	0
	No	50.9	49.1		7.5	93		19	81		21	79	
Diabetes Mellitus	Yes	25.9	74.1	0.81	30	70	0.04	44	56	0.4	59	41	0
	No	30	70		12	88		36	64		29	71	
Chronic Respiratory Disease	Yes	50	50	0.11	21	79	0.7	64	36	0.03	36	64	1
	No	26	73.8		16	85		34	66		36	64	
HIV/AIDS	Yes	91.7	8.3	0	17	83	1	42	58	0.76	50	50	0.3
	No	21.9	78.1		16	84		37	63		34	66	

		Outcomes			
		Discharged from ICU	Prolonged ICU stay (>14days)	Dead	P value
		(%)	(%)	(%)	
Hypertension	Yes	4.7	0	95.3	
	No	47.2	17	35.8	
Diabetes Mellitus	Yes	7.4	0	92.6	
	No	28.9	10	61.1	
Chronic Respiratory Disease	Yes	0	0	100	
	No	27.2	8.7	64.1	
HIV/AIDS	Yes	8.3	0	91.7	
	No	25.7	98.6	65.7	

Analysis of the co-morbidities showed strongly significant links with adverse outcomes among VAP patients. Hypertension was linked to LO-VAP ($p<0.001$) and markedly linked to septic shock (23%) with ($p=0.024$). Additionally hypertensive patients resulted in high death rates (95.3%) compared to non-hypertensive patients ($p<0.001$) and caused MODS (53%) and other complications (such as Pulmonary embolism, respiratory failure, etc) ($p<0.002$). Diabetes mellitus showed no association with VAP onset but a significant association was found with septic shock and other complications both showing a p value of <0.0041 as well as mortality rate of 92.6% with ($p=0.01$) Chronic respiratory disease did not influence VAP onset ($p = 0.112$), yet illustrated a strong link with MODS (64% vs 34%; $p = 0.028$) and a 100% death rate ($p = 0.030$). As for HIV/AIDS being significantly associated with EO-VAP ($p=<0.001$), no other relationships were formed with complications or mortality rate. Overall, these findings highlight pre-existing co-morbidities substantially raise risk for complications and mortality among VAP patients.

Table Demonstrating Association Between Mechanical Ventilator Factors and Outcomes of Vap Patients

		Association between Mechanical ventilation factors and Outcomes of VAP patients		
		Early or late onset VAP		
		Early- onset	Late-onset	P value
		(%)	(%)	
Type of Ventilation used	Invasive	29.3	70.7	1.000
	Non-invasive	0	100	
Duration of ventilation	<10 days	59.5	40.5	0.000
	10-14 days	24.1	75.9	
	15-20 days	33.3	66.7	
	>20 days	2.6	97.4	

		Complications								
		Septic shock			MODS			Others		
		Yes (%)	No (%)		Yes (%)	No (%)		Yes (%)	No (%)	P value
Type of Ventilation used	Invasive	16.4	83.6	1.000	37.9	62.1	1.000	36.2	63.8	1.000
	Non-invasive	0	100		0	100		0	100	
Duration of ventilation	<10 days	16.2	83.8		43.2	56.8		43.2	56.8	
	10-14	6.9	93.1	0.071	27.6	72.4	0.463	34.5	65.5	0.288
	days	41.7	58.3		50	50		50	50	
	15-20	15.4	84.6		35.9	64.1		26.5	74.4	
	days									
	>20 days									

		Outcomes			
		Discharged from ICU (%)	Prolonged ICU stay (>14days) (%)	Dead (%)	P value
Hypertension	Invasive	23.3	7.8	69	
	Non-invasive	100	0	0	
Duration of ventilation	<10 days	21.6	0	78	
	10-14 days	34.5	3.4	62	
	15-20 days	8.3	8.3	83	
	>20 days	23.1	17.9	59	

Most patients (116/117) received invasive ventilation, with 29.3% developing early-onset VAP and 70.7% late-onset; no significant difference in VAP onset by type of ventilation (P = 1.000. Septic shock occurred in 16.2–41.7% of patients depending on ventilation duration, with a trend toward more complications with longer ventilation, though not statistically significant. MODS and other complications also increased with longer ventilation, but associations were not statistically significant (P > 0.05). Duration of ventilation was significantly associated with outcomes (discharge, prolonged ICU stay, death) (P = 0.042), while type of ventilation showed no significant effect (P = 0.316). Overall, the duration of mechanical ventilation had a stronger impact on VAP onset, complications, and patient outcomes than the type of ventilation used.

Table demonstrating Association between clinical signs and outcomes of VAP

		Early or late onset VAP			Outcome			
		Early-onset (%)	Late-onset (%)	P value	Discharged from ICU (%)	Prolonged ICU stay (>14days) (%)	Dead (%)	P value
Fever	Yes	25.3	74.7	0.235	27	6.7	66.7	0.6
	No	35.7	64.3		19	9.5	71.4	
Purulent secretions	Yes	25	75	0.255	22	8.8	69.1	0.8
	No	34.7	65.3		27	6.1	67.3	
New infiltrates on CXR	Yes	21.8	78.2	0.104	20	9.1	70.9	0.6
	No	35.5	64.5		27	6.5	66.1	
Leukocytosis	Yes	22.7	77.3	0.00G	22	10	68.2	0.2
	No	48.3	51.7		31	0	69	
Increased respiratory effort	Yes	27.5	72.5	0.585	21	8.8	70	0.5
	No	32.4	67.6		30	5.4	64.9	

		Complications								
		Septic shock			MODS			Others		
		Yes (%)	No (%)	P value	Yes (%)	No (%)	P value	Yes (%)	No (%)	P value
Fever	Yes	15	85		43	57		31	69	
	No	19	81		29	71		45	55	
Purulent secretions	Yes	12	88		38	62		35	65	
	No	22	78		37	63		37	63	
New infiltrates on Chest XRay	Yes	20	80		35	66		44	56	
	No	13	87		40	60		29	71	
Leukocytosis	Yes	14	86		39	61		34	66	
	No	24	76		35	66		41	59	
Increased respiratory effort	Yes	14	86		39	61		41	59	
	No	22	78		35	65		24	76	

Fever was present in 75.3% of patients, with no significant association with early or late-onset VAP (P = 0.235), ICU stay, complications, or outcomes (all P > 0.05). Leukocytosis was present in 77.3% of patients and was significantly associated with VAP onset (P = 0.009), with 22.7% of cases early-onset and 77.3% late-onset; other outcomes, and complications were not significantly affected (P > 0.05). Overall, leukocytosis was the only clinical sign significantly associated with the timing of VAP onset and showed predicted LO-VAP, while other clinical signs did not show significant relationships with VAP onset, complications, or outcomes and lacked predictive value.

Association between Antibiotic choice and Outcomes of VAP
All patients received a wide range of empirical antibiotic therapy. Penicillin was used in 37 patients, with no significant association with ICU stay, or most complications (all P > 0.05); however, it was significantly associated with septic shock, showing a higher proportion in those receiving penicillin (P = 0.018). Cephalosporins were administered in 28 patients, with no significant associations with ICU stay, complications, or outcomes (all P > 0.05).

B-lactams were used in 35 patients, with no significant associations with ICU stay, complications, or outcomes (all P > 0.05). Aminoglycosides, nitroimidazoles, tetracyclines, lincosamides, showed no significant association with ICU stay, complications, or outcomes (all P > 0.05).

Chapter Five
Discussion

This study aims to explore the outcomes and associated factors of VAP among critically ill patients at Muhimbili National Hospital and has revealed a substantial clinical burden, with 117 confirmed VAP cases.

Proportion of Vap Patients Among All Patients on Mechanical Ventilation
There was a total of 560 mechanically ventilated patients who were admitted to the MICU over the study period , out of which 117 patients acquired VAP; thus, the proportion of VAP was 20.9% (117/560) notably higher in MNH than rates reported in other low- and middle-income countries. KCMC and MNH in Tanzania previously documented 4.1% and 2.5 respectively [3,15]. This reflects a substantial rise in the observed burden of VAP compared with earlier reports from the same institution. Similarly, India and China reported higher prevalence ranging from 12.7% to 17% but overall, the prevalence in our study falls at the higher end of the spectrum, which reflects VAP as a significant clinical challenge in this setting than prior documented [18].

Clinical Profile of Patients with VAP
Of the total 117 patients with VAP, the mean age of this study was 53.1 ± 21.2 years, closely aligning with international findings that place VAP predominantly in older adults. Age of the study participants were categorized into four groups in which age group age group 18-39 covered a total of 33%, 40-59 had 20.5%, 60-79 had 34% and >80 had 12%. The gender distribution in this study was nearly equal (50.4% male; 49.6% female), unlike the meta-analysis by Ochoa et al., which found male sex to significantly increase VAP risk (OR 1.30; 95% CI 1.18–1.44) [19]. Furthermore, the study by Napolitano et al. also demonstrating a higher VAP incidence in males, further reinforcing male gender being a recognized risk factor in other populations which does not align with this study, hence indicating that sex might not be a crucial determinant in this context [22].

Clinical Factors and Comorbidities Associated to VAP
Comorbidities were noticeably prevalent, with hypertension showing the strongest association with outcomes including higher septic shock rates (23% with p=0.0024), MODS at 53% (p<0.001), and an exceptionally high mortality of 95.3% (p<0.001). Diabetic patients showed an increased risk of septic shock at 30% these values are consistent with the Ethiopian cohort, where comorbidities were present in 65.2% of ventilated patients. Chronic respiratory disease was identified in 12% of the patients and significantly associated with 100% mortality (p=0.03), supporting evidence from Ochoa et al. that COPD increases VAP susceptibility (OR 1.52; 95% CI 1.10–2.09). HIV/AIDS was also found to have significant associations with EO-VAP (p=<0.001), The presence of numerous comorbidities likely contributed to the high rates of complications observed in our study [19].

Mechanical ventilation and ICU stay
Almost all patients in our study received invasive MV (99.1%). Duration of ventilation also was a key determinant of development of VAP and outcomes. Late-onset VAP (>5 days) constituted 70.9% of all the cases, a finding that is strongly associated with prolonged ventilation (>20 days) with (p<0.001); which in turn corresponded with higher mortality (59-83%) with (p=0.042). These patterns align closely with Elsheikh et al. (2024), who demonstrated that each additional day of mechanical ventilation

increased VAP risk (SHR 1.04 per day; 95% CI 1.03–1.06) [20]. Similarly, the 2025 meta-analysis reported prolonged intubation to be strongly associated with increased odds for VAP (OR 6.20; 95% CI 1.09–11.30). These comparative statistics reinforce prolonged ventilation as a critical modifiable risk factor [19].

Length of ICU stay also correlated significantly with both VAP onset and outcomes. Patients who stayed >14 days had the highest mortality (71.2%, p = 0.003), while early discharges were most common among those with short ICU stays.

Additionally, the type of ventilation (invasive vs non-invasive) did not show any significant relationship with the development of VAP, its complications or mortality, which suggests that the duration of MV rather than its type is the main risk factor.

Clinical Signs of VAP

Clinical presentation in this cohort mirrored classical VAP features, with leukocytosis documented in 75.2% and was significantly linked to LO-VAP with (P=0.009), fever, increased respiratory effort, infiltrates and purulent secretions in did not predict VAP complications, onset or outcomes. These findings highlight only relying on clinical signs may lead to delay in diagnosis and treatment.

Therefore, emphasis on VAP diagnosis through radiology and microbiology needs to be recognized.

Outcomes of VAP

Complications were numerous with septic shock in 16.2%, MODS in 37.6% and other complications (such as respiratory failure and Pulmonary embolism etc.) at 35.9%. The elderly group was the age category that was most likely to develop MODS (p=0.012) and LO-VAP was found to have a stronger association with complications compared to EO-VAP.

Mortality levels were unexpectedly high at 68.4%, surpassing many LMIC and high-income researches. Comparable studies such as the Chinese study similarly found overall mortality ranging from 54.6 to 64.7% with late-onset VAP to triple mortality risk (adjusted OR 3.45; 95% CI 1.20–9.92). Conversely attributable review globally was found to be 10% [18,25].

Predictors of poor outcome in this study were recognized to be hypertension, diabetes, chronic respiratory disease, prolonged ventilation duration due to longer ICU stay, and advanced age (all p value<0.05). These findings closely parallel the 2025 meta-analysis, which reported strong associations for re-intubation (OR 5.11; 95% CI 2.29-11.42), and tracheostomy, which is a long-term procedure for ventilation (OR 3.44; 95% CI 2.00–5.92) [19]. Supporting this point, the Egyptian cohort similarly identified re-intubation (SHR 3.74; 95% CI 2.23-6.28) as major determinants of mortality, affirming the significant impact of interventions that increase aspiration and pathogen invasion [20].

All patients received empirical antibiotic therapy, consisting of multiple classes including penicillins, cephalosporins, β-lactams, aminoglycosides, nitroimidazoles, tetracyclines, and lincosamides. Overall, the choice of antibiotic class was not significantly associated with ICU stay, most complications, or outcomes, suggesting that broad empirical therapy may not influence these parameters. Moreover, penicillin usage was associated with a higher incidence of septic shock, which may signify patient severity rather than a direct effect of the antibiotic itself. These findings in line with previous studies indicating that while broad-spectrum empirical antibiotics are necessary in VAP, their class alone may not determine patient outcomes, highlighting the importance of targeted therapy.

Finally, the mentioned literature is in strong support of prevention strategies to reduce VAP cases. According to the data collection database, 100% (117/117) of the patients received the VAP preventative care in MNH, which consisted of daily nebulization with NaCl, salbutamol, and ipratropium, routine suctioning, head-of-bed elevation (30-45°), and full application of the standardized VAP bundle used at MNH. This universal implementation ensured that all mechanically ventilated patients were managed under the same preventive protocol, essential to highlight when interpreting the study's VAP prevalence and associated outcomes. In support of this, Meta-analyses from the MENA region demonstrated that VAP prevention bundles reduced VAP incidence by 64% (RR 0.36; 95% CI 0.20–0.65), while Alqahtani et al. found reductions of 36–65% across multiple ICU settings [24]. In the U.S. before–after study, VAP rates fell from 4.08 to 1.16 per 1,000 ventilator-days following implementation of a bundle including HOB elevation, chlorhexidine oral care, DVT prophylaxis, PUD prophylaxis, and subglottic secretion drainage-achieving an incidence density ratio of 0.28 (95% CI 0.275–0.292) [25]. These comparative statistics suggest complying with such protocols ensures optimum outcomes.

In conclusion, this study's findings are broadly consistent with international evidence regarding VAP risk factors and outcomes, yet the mortality rate is among the highest reported in comparable studies. The convergence of prolonged ventilation, late-onset infection, comorbidities, and complications underscores the urgent need for strengthened prevention measures, early recognition through appropriate diagnostic techniques. Integrating evidence-based VAP bundles-shown elsewhere to reduce incidence by over 60%-holds substantial potential to improve outcomes within this setting.

Limitations

One of the study's limitations is the amount of missing information in patients' medical records. Several important factors identified in the literature-such as smoking status, history of re-intubation, and microbiological or chest-X-ray evidence used for diagnosis-were incomplete or inconsistently documented. This limited the ability to fully explore the variables of interest like pathogen-targeted therapy in association to outcomes and therefore reduced the overall scope of the study.

Additionally, VAP was not routinely or clearly recorded in the medical records; therefore, diagnosis often had to be established manually based on clinical criteria such as fever, purulent secretions, increased respiratory effort, leukocytosis, or the presence of new infiltrates on chest X-ray. However, radiological findings were themselves infrequently documented, further constraining diagnostic accuracy. In addition, microbiological confirmation could not be consistently obtained because access to the laboratory information system required a lengthy administrative process, which was not feasible within the study timeframe. As a result, only a few cases had culture results documented in the files.

Finally, the results cannot be applied to other institute, as numerous factors causing VAP may vary from institution to institution. this is a single tertiary-level hospital therefore, findings and interpretation of our result cannot be generalized to other institutions or ICU.

Conclusions

VAP is still a public health concern as the proportion of cases in MNH during the study period was 20.9%. There was a higher

case-fatality rate than most studies, of 68.4% among the study population. VAP was predominantly late-onset (70.9%), occurred in patients with a high comorbidity burden (hypertension 54.7%, diabetes 23.1%), and was associated with prolonged mechanical ventilation (33.3% ventilated >20 days). Clinical deterioration was frequent (MODS 37.6%, septic shock 16.2%) and overall ICU mortality was 68.4%. Hypertension, diabetes, chronic respiratory disease, advanced age and longer duration of ventilation were independently associated with worse outcomes (all $p < 0.05$). Early identification of these factors will help in reducing the problem through early intervention and therefore improve outcome. Additionally, health care providers like nurses should be well trained on infection prevention protocols.

Recommendations

- Implementation of standardized and consistent documented diagnostic techniques for VAP which integrates routine recording of clinical signs, radiological findings, and microbiological results. Streamlining access to laboratory data and ensuring complete documentation would improve accuracy. The consent to collect data should be granted early, allowing the researcher more space to explore additional information during the process.
- Continuing The VAP prevention bundles: HOB elevation, oral hygiene with chlorhexidine, sedation-weaning protocols with subglottic secretion drainage, DVT/PUD prophylaxis and implementing audits with adherence targets and monthly reporting.
- Early intervention protocols for high-risk patients need to be strengthened. Patients with hypertension (95.3%), diabetes (92.6%), and chronic respiratory disease (100%) have a very high mortality. Therefore, ICU protocols should be adjusted to give priority to these high-risk groups through early monitoring and aggressive treatment that includes tighter control of blood sugar levels, , and respiratory optimization.

Dedication

To my dearest mother,
Words cannot express the depth of gratitude I feel for you. You are not only my mother but also my greatest teacher, my fiercest cheerleader, and my closest confidante. Your selflessness, resilience, and boundless love have been the bedrock of my journey through medical school and research.

I also wish to express my heartfelt appreciation to my father, Asim Shilla and my sister Soudy for their continuous encouragement, understanding, and belief in my aspirations. Their encouragement and support have been invaluable to me throughout this journey. With every milestone I reach, every challenge I overcome, and every achievement I celebrate, it is your love and support that I carry in my heart. This thesis is a testament to the profound impact you have had on my life, and I dedicate it to you with all love and gratitude.

I am indebted to my supervisor, Dr. Baraka, for his invaluable guidance, expertise, and support throughout this research endeavor. And to Dr Asterius for his mentorship and encouragement that played a pivotal role in shaping my research skills and academic growth.

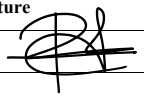
I am grateful to my friends Arwa, Awadia, Dinzie, Hiba, Leena, Lina and Mimi for standing by me through the challenges and triumphs of medical school and research. Your unwavering support, camaraderie, and encouragement have provided me with strength and motivation during the most demanding times.
Lastly, I extend my heartfelt thanks to all those who have contributed to my academic and personal development, whether through their guidance or support. Your belief in me has been instrumental in my success, and I am deeply grateful for your presence in my life.

Acknowledgements

This thesis is dedicated to Nahid Mohamed Ahmed Abdelkhalig, my mother, whose love, sacrifices, and belief in my potential have been the guiding force behind my academic pursuits. Her boundless support has been my anchor through the highs and lows of this journey, shaping not only my academic endeavors but also the person I am today. To my father Asim Abdulla and sister Soudy, your encouragement and faith in me have been influential in my success, and I am forever grateful for your presence in my life. I am immensely grateful to Dr. Baraka for his guidance, expertise, and encouragement throughout this research journey. And to Dr. Asterius for his dedication to fostering academic excellence which drove me to reach new heights in my research.

DECLARATION

I, Raghad Asim Abdulla Ahmed Shilla the undersigned, declare that the thesis is my original work and has not been presented for a degree at the University or any other university.

Name of student	**Signature**
Raghad Asim Abdulla Ahmed Shilla	

Name of Supervisor	Baraka E. Mrisho
Signature of Supervisor	
Date of signature	4/12/2025
Name of Co-Supervisor	Dr Asterius A Muganyizi
Signature of Co-Supervisor	
Date of Signature	4/12/2025

Citation: Raghad Asim Abdulla Ahmed Shilla, Baraka E Mrisho, Asterius a Muganyizi (2026) Clinical Outcomes of Ventilator-Associated Pneumonia and Its Associated Factors Among Critically Ill Patients at Muhimbili National Hospital, 2024-2025. Japan Journal of Clinical & Medical Research. SRC/JJCMR-265.
DOI: doi.org/10.47363/JJCMR/2026(6)203

APPENDICES

Appendix A

Clinical outcomes of Ventilator-associated Pneumonia (VAP) and associated factors among Critically Ill Patients at Muhimbili National Hospital in 2024-2025.

Researcher: Raghad Asim Abdulla **Institution**: Muhimbili National Hospital

(MNH)

Section A: Patient Demographics

1. Patient ID/Code: _____
2. Age: _____ years
3. Sex: ☐ Male ☐ Female
4. Length of stay in ICU:_____
5. Primary diagnosis:_____

Section B: Comorbidities (Tick all that apply)

6. ☐ Hypertension
7. ☐ Diabetes Mellitus
8. ☐ Chronic Respiratory Disease (e.g. COPD, asthma)
9. ☐ HIV/AIDS
10. ☐ None
11. ☐ Other (specify): _____

Section C: Mechanical Ventilation Information

12. Type of ventilation: ☐ Invasive
13. Ventilation duration (in days): _____

Section D: VAP Assessment

14. Did the patient develop VAP? ☐ Yes ☐ No

→ If Yes:

15. Clinical signs observed:

☐ Fever ☐ Purulent secretions ☐ New infiltrate on X-ray ☐ Leukocytosis

☐ Increased respiratory effort

16. Early or Late-onset VAP (Based on ≥ or < 5 days of MV): ☐ Early ☐ Late

17. Microorganism isolated (if any): _____ ☐ Yes ☐ No

Section E: Treatment & Outcomes

18. Empirical antibiotic given: ☐ Yes ☐ No

If yes, choice of Antibiotic:_____

19. Complications observed: ☐ Septic shock. ☐ multi-Organ dysfunction (MODS)

☐ None ☐ Other:

20. Outcome of patient: ☐ discharged. ☐ Prolonged stay in ICU (>14 days) ☐ Dead

21. VAP bundle application: daily nebulization with NaCl, salbutamol, or ipratropium ☐ routine suctioning. ☐ head-of-bed elevation (30-45°) ☐

Citation: Raghad Asim Abdulla Ahmed Shilla, Baraka E Mrisho, Asterius a Muganyizi (2026) Clinical Outcomes of Ventilator-Associated Pneumonia and Its Associated Factors Among Critically Ill Patients at Muhimbili National Hospital, 2024-2025. Japan Journal of Clinical & Medical Research. SRC/JJCMR-265.
DOI: doi.org/10.47363/JJCMR/2026(6)203

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Email: Rwand@UMSTEDU.com

Appendix B

Raghad Asim Abdulla Ahmed Shilla
MD-2019-117

Internal medicine

Muhimbili National Hospital
P.O. Box 65000
Dar es Salaam, Tanzania

22/08/2025

The Executive Director
Muhimbili National Hospital
P.O. Box 65000
Dar es Salaam, Tanzania

Supervisor
Dr Baraka E. Mrisho
ICU intensivist
Internal Medicine

Dear Madam,

RE: SUBMISSION OF RESEARCH PROPOSAL FOR ETHICAL CLEARANCE

I am a fifth-year student currently undertaking my undergraduate research project under the supervision of Dr Baraka E. Mrisho from ICU of Internal Medicine department. I hereby submit my research proposal titled:**“** Clinical Outcomes of Ventilator-Associated Pneumonia and Associated Factors Among Critically Ill patients at Muhimbili National Hospital, 2024-2025**” for your kind consi**deration and ethical clearance.

This research will be conducted as part of the partial fulfillment for the award of Bachelor of Medicine at [MUHAS/MNH], and it will involve human participants and/or the use of hospital data under appropriate confidentiality and ethical standards. I have attached the required documents for ethical clearance, including the proposal, data collection tools, and consent forms where applicable. I kindly request your office to review and grant ethical clearance to proceed with the study.

Yours sincerely,

Raghad Asim Abdulla Ahmed Shilla
MD-2019-117.
+255749749259
raghadiisqis@gmail.com

Citation: Raghad Asim Abdulla Ahmed Shilla, Baraka E Mrisho, Asterius a Muganyizi (2026) Clinical Outcomes of Ventilator-Associated Pneumonia and Its Associated Factors Among Critically Ill Patients at Muhimbili National Hospital, 2024-2025. Japan Journal of Clinical & Medical Research. SRC/JJCMR-265. DOI: doi.org/10.47363/JJCMR/2026(6)203

Appendix C

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

MUHIMBILI NATIONAL HOSPITAL

In reply please quote;

Ref. No.: MNH/TRCU/PERM/2024/400 Date: 7th October, 2025

Heads of Department,

Internal Medicine,

Medical Records

MUHIMBILI NATIONAL HOSPITAL

RE: PERMISSION TO COLLECT DATA AT MNH

Name of student	Raghad Asim Abdulla Ahmed Shilla
Title	"Clinical Outcomes of Ventilator – Associated Pneumonia and Associated Factors Among Critically Ill Patients at Muhimbili National Hospital 2024-2025"
Institution	Muhimbili National Hospital
Co - Supervisor	Dr. Baraka Mrisho (MNH)
Period	13th October, 2025 to 30th April, 2025

Approval has been granted to the above principal investigators to collect data at MNH. Data dissemination at MNH will be overseen by **Dr. Baraka Mrisho** MNH supervisor.

Kindly ensure the named principal investigator abide to the ethical principles and other conditions of the research approval.

Sincerely,

Dr. Robert D. Moshiro

Head of Clinical Research, Training and Consultancy Unit

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Appendix D

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

MUHIMBILI NATIONAL HOSPITAL

Raghad Asim Abdulla Ahmed Shilla
Muhimbili National Hospital,
P.o. Box 65000
Dar es Salaam

02.10.2025

Certificate Reference Number: MNH/IRB/VOL.I/2025/090

Project Title: Clinical Outcomes of Ventilator – Associated Pneumonia and Associated Factors Among Critically Ill Patients at Muhimbili National Hospital 2024-2025

Principal Investigator: Raghad Asim Abdulla Ahmed Shilla

Date of Approval: October 02nd 2025

Expiration Date: April 04th 2026

On behalf of the Muhimbili National Hospital's Institutional Review Board (MNH-IRB), I am pleased to inform you that you have been granted ethical approval in respect to the first phase of the study stated above. Subsequent phases will need independent approvals. Renewal of ethical approval is to be done yearly.

The Principal investigator must ensure the following conditions are fulfilled:

1. Progress report is submitted to the MNH-IRB where applicable, bi-annually, and final report at the conclusion of the project.
2. **All amendments (including change of personnel) are submitted to MNH-IRB for approval before they are implemented**.
3. Other investigators are aware of the terms of this approval and the project is conducted as approved by MNH-IRB
4. All services rendered to the research study by the hospital should be directly funded by the respective project.

We wish you well in your research.

P.O. Box 65000 DAR-ES-SALAAM

Dr. Robert D. Moshiro
IRB Secretary and Head of Clinical Research, Training and Consultancy Unit

Dr. Delilah Kimambo
Executive Director

Version: October, 2025

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