



ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE

GRADUATE STUDY PROGRAM

INTERNAL MEDICINE DEPARTMENT

**PREVALENCE OF HOSPITAL-ACQUIRED PNEUMONIA
AND ITS ASSOCIATED FACTORS AMONG ADULT
PATIENTS ADMITTED TO THE INTENSIVE CARE UNIT AT
ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE,
ADDIS ABABA, ETHIOPIA**

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FEBRUARY, 2024

ADDIS ABABA, ETHIOPIA



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ABBREVIATIONS AND ACRONYMS

ATS	American Thoracic Society
AKI	Acute Kidney Injury
COPD	Chronic Obstructive Pulmonary Disease
CPIS	Clinical Pulmonary Infection Score
FiO ₂	Fractional Inspired Oxygen
GCS	Glasgow Coma Scale
HAI	Health Care Associated Infection
HAP	Hospital Acquired Pneumonia
ICU	Intensive Care Unit
NP	Nosocomial Pneumonia
PaO ₂	Arterial Oxygen Partial Pressure
PPIs	Proton Pump Inhibitors
SPHMMC	Saint Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science
VAP	Ventilator-Associated Pneumonia
WBC	White Blood Cell
WHO	World Health Organization

ABSTRACT

Background: Hospital-acquired pneumonia is a serious and potentially life-threatening infection that can occur in patients who have been hospitalized, particularly in the intensive care unit. It can be caused by various patient and healthcare-related factors, which include modifiable and non-modifiable risk factors. Hospital-acquired pneumonia is associated with significant morbidity and mortality, as well as a prolonged hospital stay and a significant financial burden on healthcare systems.

Objective: The main aim of the study was to assess the prevalence and associated factors of hospital-acquired pneumonia in the adult intensive care unit at St. Paul's Hospital Millennium Medical College from July 2023 to January 2024.

Methodology: A cross-sectional study was conducted in the adult intensive care unit at St. Paul's Hospital Millennium Medical College from July 2023 to January 2024. A total of 247 patients were included using a purposive sampling technique, wherein all patients who met the inclusion criteria and did not meet the exclusion criteria during the study period were enrolled. Binary and multivariable logistic regression analyses were performed to identify predictors of the prevalence of HAP in the ICU

Result: The prevalence of hospital-acquired pneumonia in this study was 26%, which is higher than rates seen in developed nations but consistent with prior studies in Ethiopia. Several risk factors were identified, including advanced age, neurological abnormalities, prior hospital stays, mechanical ventilation, immunosuppressant use, patient transport, and blood transfusions. This data highlights the substantial burden of HAP among critically ill patients at this facility.

Conclusion & recommendation: The study found a hospital-acquired pneumonia prevalence of 26%, highlighting a significant burden among critically ill patients. Health professionals should implement infection prevention bundles and enhance precautions. Policymakers must prioritize patient safety through regular education. Further research is needed to assess HAP's long-term impact in Ethiopia, guiding improved patient care strategies.

Keywords: HAP, ICU, prolonged hospital stay, SPHMMC, Ethiopia

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1. INTRODUCTION

1.1. Background

According to ATS guidelines, hospital-acquired pneumonia (HAP) is a type of pneumonia that is diagnosed after a patient has been in the hospital for 48 hours or longer and was not present or incubating at the time of admission. Of nosocomial pneumonia, ventilator-associated pneumonia specifically refers to the infection that develops in patients who have been admitted to an intensive care unit and have been intubated for 48 hours or more (1). The pathogenesis of HAP is dependent upon the number and virulence of microorganisms entering the lower airways and the patient's immune, mechanical, humoral, or cellular reactions. The primary way of transmission of a pathogen into the airways is most commonly by microaspiration of microbes colonizing the oropharyngeal region or the upper gastrointestinal tract, or by droplet infection from the environment. (2,3) Studies have shown that various patient and healthcare-related factors are associated with an increased risk of developing HAP; these can be modifiable and non-modifiable risk factors, including mechanical ventilation, bronchoscopy, intolerance to enteral nutrition, immunosuppression, critical illness, and exposure to antimicrobial agents. (4–6)

Both ventilator-associated and non-ventilator HAP in intensive care unit (ICU) patients are linked to serious health risks and hold a significant mortality and morbidity risk, with a higher 30-day readmission rate for those who survived and got discharged. (7),(8) The outcome of HAP is affected by multiple factors, including the underlying illness, etiology, and choice and duration of antibiotic initiation (5). According to various studies, patients who develop Ventilator associated pneumonia (VAP) tend to have longer durations of mechanical ventilation and hospitalization compared to those without VAP. Moreover, the economic cost of VAP has been estimated to be around \$40,000 per patient in the United States (9,10). Due to the significant health risks and financial costs associated with VAP, preventing this type of pneumonia has become a major goal for many infection control programs. (11)

1.2. Statement of the problem

The prevalence of ventilator-associated pneumonia (VAP) is often used as a measure of the safety and quality of care for critically ill patients who have been admitted to the ICU (12,13). HAP is typically the result of bacterial infections and ranks as the second most prevalent healthcare-associated infection in the United States. This condition carries a high risk of both mortality and morbidity (14). On average, the occurrence of HAP results in an extended hospital stay of approximately 7 to 9 days per patient, and it has been reported to incur an additional cost of over \$40,000 per patient (15–17). While HAP is not a disease that hospitals are required to report, the available data indicates that it arises at a frequency of around 5 to 10 cases per 1,000 hospital admissions. However, this rate can increase significantly in patients who are undergoing mechanical ventilation, with the incidence possibly rising by as much as 6-20 times (5,15,18). Though limited studies are done in the African setting, available literature indicates that the prevalence is significantly higher in studies done in Libya and Egypt (19–21)

According to the ATS, HAP makes up a significant portion of ICU infections, accounting for as much as 25% of them, and is responsible for more than 50% of the antibiotics prescribed. VAP affects 9-27% of patients who require intubation. In ICU patients, almost 90% of HAP cases happen during mechanical ventilation, and the risk of VAP increases with the duration of ventilation. The risk of VAP is highest in the early stages of hospitalization, with an estimated daily incidence of 3% during the first 5 days of ventilation, 2% during days 5-10 of ventilation, and 1% after this period. Since most mechanical ventilation is short-term, approximately 50% of all VAP episodes occur within the first 4 days of mechanical ventilation. (1)

In the ICU, HAP is linked to a mortality rate of approximately 20%. (22). However, the mortality that can be directly attributed to HAP is estimated to be between 5 and 13%. (22). In certain populations, such as patients with chronic obstructive pulmonary disease (COPD), the mortality that can be specifically attributed to HAP is likely to be even higher. (23). For some other populations, such as trauma patients, HAP appears to have a relatively minor

impact on mortality. (23). While the precise impact of HAP on mortality is a topic of ongoing debate, it is nonetheless associated with increased morbidity due to factors such as prolonged mechanical ventilation (or a decrease in ventilator-free days), longer stays in the ICU, and extended hospital stays in general. (23). As a consequence, HAP leads to a significant overuse of healthcare resources such as mechanical ventilation, ICU and hospital beds, and other related resources. Furthermore, it is associated with increased costs related to hospital stays, which can be substantial. (24).

Various measures were taken in different setups across the globe to prevent the burden and consequence of HAP in the ICU, among which is the "Pneumonia Zero" project, which was a national intervention aimed at preventing ventilator-associated pneumonia in Spanish ICU patients. It involves the simultaneous implementation of a set of evidence-based measures known as a bundle and has been successful in significantly reducing the incidence of VAP in Spanish ICUs. The implementation of the bundle measures that were included in the "Pneumonia Zero" project resulted in a significant reduction of over 50% in the incidence of ventilator-associated pneumonia in ICUs across Spain. This reduction was maintained for a period of 21 months after the implementation of the measures. (25)

This cross-sectional study aims to determine the prevalence and associated factors of HAP in the SPHMMC adult ICU due to its impact on patient outcomes, healthcare costs, and quality of care. It will help develop effective strategies for preventing and controlling HAP, leading to improved patient outcomes and reduced costs.

1.3 Significance of the study

This study aimed to assess the prevalence and associated factors of HAP in patients admitted to the adult ICU at SPHMMC, as there are only a few studies done in our country on this issue. Furthermore, it is the first study conducted in our hospital, and it may serve as a springboard for future research. Moreover, the study's findings will be used as a foundation and guide for the hospital to develop institution-based interventions as well as an initiative for national policymakers to adopt best practices in the country at large. This will ultimately improve the quality of health care, decrease health care costs, and decrease HAP-related morbidity and mortality in patients admitted to the ICU.

2. LITERATURE REVIEW

2.1. Prevalence of HAP in the ICU

The prevalence of ICU-acquired pneumonia, particularly VAP, has notably decreased in recent years, possibly as a result of the widespread adoption of preventive bundles. Nevertheless, determining the precise prevalence of HAP and VAP is challenging due to various reasons, such as variations in definitions and their use, diagnostic constraints, differences in the methods of microbiological sampling, and diverse monitoring systems in different countries. Incidence rates vary considerably based on the populations under study. (26,27) The occurrence rate of HAP in high-income settings ranges from 6 to 8.6 cases per 1000 admissions, whereas it is much higher in low-resource settings. (23,28) The ICU has the highest occurrence of HAP, with 12-29% of patients affected, and out of this number, 90% are VAP. (28) HAP is responsible for over 50% of the antibiotics prescribed in the ICU, and the majority of HAP cases in the ICU occur during mechanical ventilation, making up nearly 90% of cases. The risk of VAP, which increases with the duration of mechanical ventilation, is highest during the early days of a patient's hospital stay, with daily incidence rates estimated at 3% during the first 5 days of ventilation, 2% per day between days 5 and 10 of ventilation, and 1% per day after day 10. (1)

In a prospective observational study done on 27 ICUs in nine European countries in 2006, the prevalence rate of VAP was 18.3 cases per 1000 ventilator days, with the diagnosis being made within the first 10 days of ICU admission in 89.1% of cases. HAP had a prevalence rate of 8.1% and VAP was 18.0%. The most common indications of nosocomial pneumonia were a decrease in oxygen levels, changes in respiratory secretions or purulence, and a new rise in temperature. A minimum of three criteria from the Clinical Pulmonary Infection Score (CPIS) were present in 77.9% of patients, but only 0.2% of patients met all six CPIS criteria. (23).

Reviews undertaken by the WHO indicate that the prevalence of healthcare-associated infections (HAI) in Africa is significantly higher than that in developed countries. However, there is limited information available on the endemic burden of HAI in Africa. (19) In a study done in general hospitals in Tripoli, Libya, during the period from February 2018 to

October 2019, a total of 109 patients were admitted. Among them, 94 cases (86.2%) were diagnosed with ventilator-associated pneumonia (VAP), while only 15 patients (13.7%) were diagnosed with hospital-acquired pneumonia (HAP). The onset of pneumonia varied among the cases after admission. A large proportion of patients in the ICUs had indwelling devices, including almost 75 patients with endotracheal intubation or tracheostomy (68.8%), 66 patients with nasogastric intubation (60.5%), and 70 patients with urinary catheterization (64.2%) (20). A separate study, performed at the Suez Canal University Hospital's ICU department in Ismailia, Egypt, between May and August 2013, revealed that 89% of patients had ventilator-associated pneumonia (VAP) and 11% had hospital-acquired pneumonia (HAP). The average age of the patients was 63.8 +/- 10.47 years. (21)

There is a paucity of literature when we come to Ethiopia regarding HAP in the adult ICU setup. The overall prevalence of healthcare-associated infection was estimated based on 18 studies involving 13,821 patients, according to a systematic review and meta-analysis of the available literature on HAI from various parts of the country. The combined prevalence was found to be 16.96%. The most common types of healthcare-associated infection were surgical site infection (39.66%), urinary tract infection (27.69%), bloodstream infection (19.9%), dual infections (involving both surgical site and urinary tract infections) (14.01%), and respiratory tract infection (13.51%). Subgroup analysis revealed that the highest prevalence was observed in surgical, gynecology, and obstetrics wards, with a prevalence rate of 22.42%. (29) A cross-sectional study was conducted prospectively at Zewditu Memorial Hospital, covering the period from March 1, 2017, to August 30, 2017. The study included medical, pediatrics, gynecology and obstetrics, and surgical wards and found that the prevalence of healthcare-associated infections (HAIs) was 19.8%. Among the infections, surgical site infection (SSI) and pneumonia were responsible for 20 cases (24.7%) and 24 cases (29.6%), respectively. (30)

2.2. Associated factors of HAP in the ICU

In the intensive care units, patients are exposed to various factors that can lead to hospital-acquired pneumonia, with ventilator-associated pneumonia being a specific type. The risk factors for developing VAP are present in patients from the day of their admission to the unit

and are linked to their underlying medical conditions and the invasive procedures they undergo. (31)

A study conducted at St. Luke District Hospital in Tarnów between 2010 and 2014 revealed that prolonged mechanical ventilation was a major determinant of VAP. This study's finding also depicts that reintubation, tracheostomy, and bronchoscopy were significant risk factors for developing VAP. (31)

A retrospective cohort study in Korea found that HAP was associated with several well-known risk factors, including older age, male sex, pre-existing lung diseases such as asthma, chronic obstructive pulmonary disease, and chronic lower airway disease, as well as tube feeding, suctioning, positioning, mechanical ventilation, and intensive care unit admission. The study also found that poverty, general hospitals, a higher bed-to-nurse ratio, a higher number of beds per hospital room, and wards with caregivers were related to the incidence of HAP. (32)

In 2018, a retrospective cross-sectional study was conducted in the adult intensive care unit of Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia. The study found that out of 164 patients, 40 (24.3%) developed VAP. The study identified several factors associated with the development of VAP, including tracheostomy, re-intubation, admission to the medical ICU, coma, transportation out of the ICU, and continuous use of IV sedation. (33) Another retrospective follow-up study conducted in Bahir Dar Specialized Hospital in 2021, found that approximately 25% of participants developed VAP. The study also identified several independent risk factors that increase the likelihood of developing VAP, including longer periods on a mechanical ventilator, the use of corticosteroids, being in a supine position, receiving blood transfusions, and having a low GCS. Knowing these important risk factors can help healthcare professionals implement effective preventive measures, such as using non-invasive ventilation, taking precautions during emergency intubation, minimizing the duration of mechanical ventilation and ICU stays, avoiding supine positioning of patients, and reducing the use of histamine blockers and corticosteroids. (34)

2.3. Outcome of HAP in the ICU

When contracted in the intensive care unit, nosocomial pneumonia is linked to a poorer outlook, with mortality rates ranging from 12 to 48%. (35) VAP is linked to a high mortality rate ranging from 33% to 50%. (28)

In the study that was conducted in 27 ICUs from different European countries, the mortality rate in the ICU was 34.4%. Nosocomial pneumonia was found to be the direct cause of death in 19.6% of patients who died, and it contributed to the deaths of 43.9% of patients. However, patients with NP had a mortality rate that was only 6% higher than patients without pneumonia. ICU patients who survived with NP had a more extended ICU stay and were on mechanical ventilation for a longer period than survivors without pneumonia. (23) Another prospective observational cohort study was conducted in the ICU of a tertiary care teaching public hospital in western India over 18 months. The study found that, out of a total of 120 patients with nosocomial pneumonia, 60% died and 40% survived. Of the 91 patients with VAP, 76% died and 24% survived, while of the 29 patients with HAP, 10% died and 90% survived. The study also found a significant association between the development of VAP and mortality (36).

2.4. Conceptual framework

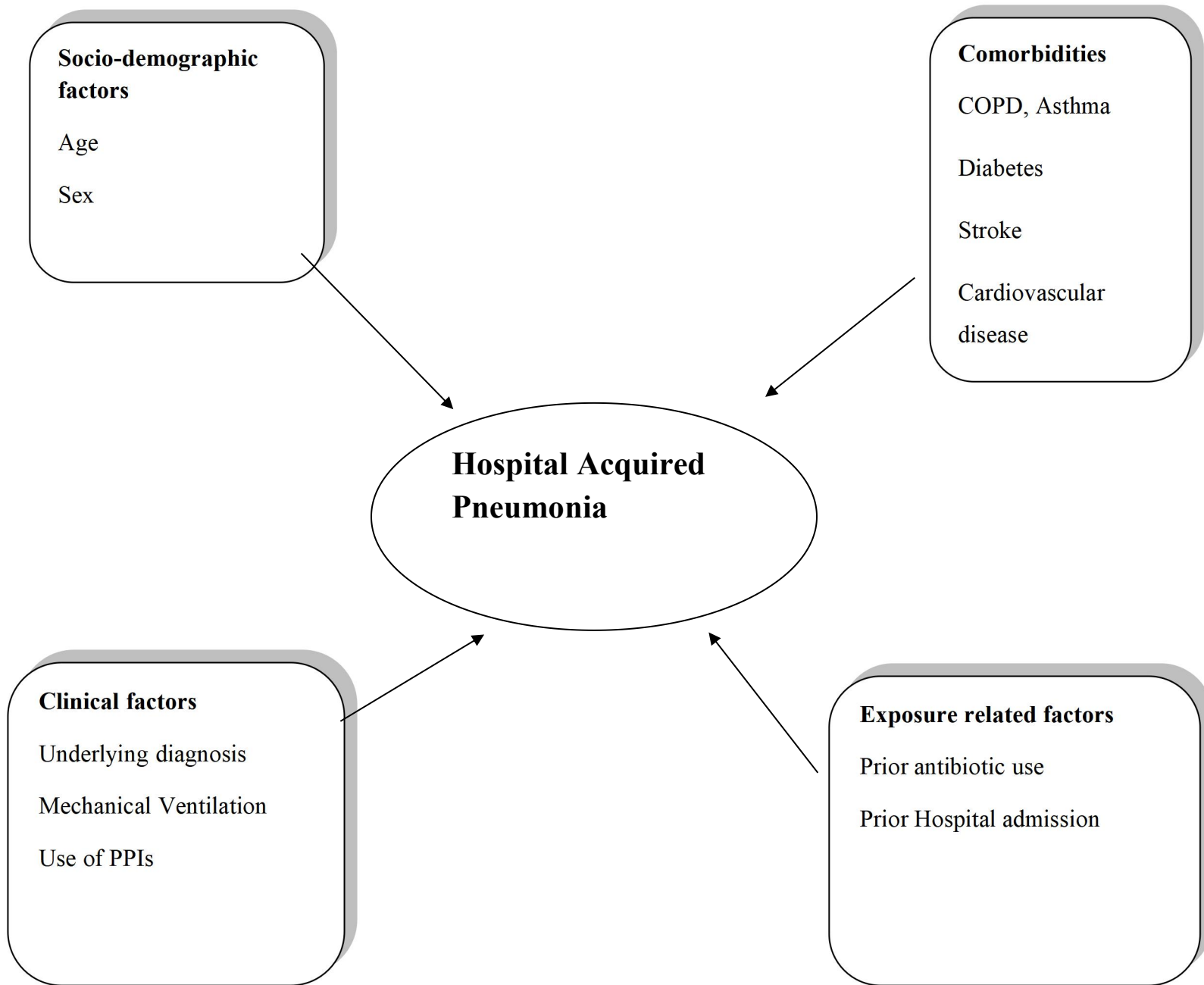


Figure 1: Conceptual framework of prevalence and associated factors of HAP in ICU patients(32–34)

3. OBJECTIVES

3.1. General objective

The general objective of this study is to determine the prevalence of hospital-acquired pneumonia and its associated factors in St. Paul's Hospital Millennium Medical College adult intensive care unit, Addis Ababa, Ethiopia, from July 2023 to January 2024.

3.2. Specific objective

3.2.1. To assess the prevalence of hospital-acquired pneumonia among adult patients admitted to the intensive care unit in St. Paul's Hospital Millennium Medical College, from July 2023 to January 2024.

3.2.2. To identify the factors associated with hospital-acquired pneumonia in St. Paul's Hospital Millennium Medical College adult intensive care unit from July 2023 to January 2024.

4. METHODS AND MATERIALS

4.1 Study area and period

This study was conducted at St. Paul's Hospital Millennium Medical College (SPHMMC), located in Addis Ababa, the capital city of Ethiopia. Established in 1961 by Emperor Haile Selassie, SPHMMC expanded its services with the establishment of a medical college in 2007, becoming a key teaching hospital for preclinical and clinical training in various disciplines. Furthermore, the hospital provides specialized clinical services to serve the entire nation. With a workforce of over 2800 staff members, including clinical, academic, administrative, and support personnel, SPHMMC is dedicated to delivering healthcare, educating students, and advancing research endeavors. (37). Among the clinical departments is internal medicine, which has sub-specialties including pulmonology and critical care. Despite a shortage of human resources, the pulmonology specialty unit offers outpatient and inpatient services as well as academic activities. Due to the hospital's size and reputation for receiving referrals for critical cases from throughout the country, it is an ideal location for this research. The study period was from July 2023 to January 2024.

4.2. Study design

This study is a cross-sectional, institution-based study of adult patients admitted to the adult ICU at St. Paul's Hospital Millennium Medical College from July 2023 to January 2024.

4.3. Population

4.3.1. Source population

All patients admitted to SPHMMC adult ICU.

4.3.2. Study population

All adult patients admitted to SPHMMC adult ICU during the study period who fulfill the inclusion criteria

4.4. Inclusion and exclusion criteria

4.4.1. Inclusion criteria

- Adult medical or surgical patients (15 years of age or older) admitted to the ICU at SPHMMC during the study period who have stayed in the hospital for at least 48 hours.

4.4.2. Exclusion criteria

- Patients who stayed less than 48 hours in the ICU

4.5. Sample size determination and sampling technique

In this study, 247 patients were included, which was the number of patients admitted during the study period. For this study, a purposive sampling method was employed, where all eligible patients who met the inclusion criteria and did not meet the exclusion criteria were enrolled in the study until the study period was completed.

4.6. Study variables

4.6.1. Dependent variable

Prevalence of HAP in adult ICU

4.6.2. Independent variables

Demographic variables: age, gender

Clinical variables: length of ICU stay, mechanical ventilation

Risk factors: comorbidities (such as chronic obstructive pulmonary disease (COPD), diabetes, and heart failure), immunosuppression.

Healthcare utilization factors: prior hospitalizations, prior ICU admissions, prior antibiotic use

4.7. Operational definitions

Clinical diagnosis of VAP/HAP: Characterized by the appearance of new or worsening infiltrates on chest radiographs along with at least two other indications of a respiratory tract infection, such as a fever (temperature $>38^{\circ}\text{C}$) or hypothermia (temperature $<35^{\circ}\text{C}$), purulent sputum, purulent tracheobronchial secretions, leukocytosis ($\text{WBC} >10 \times 10^3/\text{mm}^3$) or leukopenia ($\text{WBC} <4 \times 10^3/\text{mm}^3$) signs of inflammation on auscultation and/or a

reduction of partial pressure of oxygen (PaO_2)/ FiO_2 ratio of at least 15% in the last 48 hours (23,26)

HAP: pneumonia that is diagnosed after a patient has been in the hospital for 48 hours or longer, and was not present or incubating at the time of admission (1).

VAP: a new episode of lower respiratory tract infection in a mechanically ventilated patient, occurring more than 48 hours after intubation. (37)

Underlying medical conditions: presence of chronic diseases such as diabetes, heart disease, asthma, COPD, and others (32)

Duration of ICU stay: time from admission to discharge from the ICU, in days (38)

Mechanical ventilation: use of a ventilator to assist or control breathing (39)

Prior antibiotic use: use of antibiotics in the past 3 months (40)

4.8. Data collection method and tools

Patient medical records review: The medical records of all patients admitted to the adult ICU of SPHMMC were reviewed to obtain demographic and clinical information, such as age, gender, prior hospitalizations, underlying medical conditions, duration of ICU stay, mechanical ventilation, presence of a central venous catheter, prior antibiotic use, presence of nosocomial pathogens, and colonization with antibiotic-resistant bacteria.

Clinical examination and laboratory tests: The patients were clinically examined for signs and symptoms of HAP.

Data collection forms: A standardized data collection form was used to collect all relevant information from the medical records, clinical examination, and laboratory tests. The data collection form included the study variables, operational definitions, and response categories. The data collection was done from July 2023 to January 2024.

4.9. Data management and analysis

The cleaned data was entered into a computer using Statistical Package for Social Science (SPSS) version 27.0. Frequency tables and descriptive summaries were conducted for the study variables. Additionally, graphs and charts were used to illustrate the findings. Binary and multivariable logistic regression were performed to identify predictors of the prevalence of HAP in the ICU. First, bivariate relationship between each independent variable and dependent variable was investigated using binary regression analysis. The variables that show a significant association on bivariate analysis with a p-value of <0.25 were used for

multivariate logistic regression. Multivariable logistic regression analyses were used to minimize the effect of confounding variables and to identify the statistically significant associated factors of HAP. Variables with a P-value < 0.05 were considered statistically significant.

4.10. Data quality control

To ensure the quality of the data, the data collectors received one day of training from the principal investigator before data collection began. The training covered the study's objectives, relevance, and the importance of confidentiality. During data collection, at the end of each day, the data was manually checked for completeness, organization, and cleanliness. Subsequently, the data was coded and analyzed using SPSS version 27.0. A pre-test was also conducted two weeks before data collection using 5% of the total sample size to test for variability and assess the checklist's clarity, length, and completeness.

4.11. Ethical consideration

The study obtained ethical clearance from the Institutional Review Board of St. Paul's Hospital Millennium Medical College. Patients were informed about the study's purpose, benefits, and possible drawbacks. They were also assured that the information they provided would be kept before data collection began, and they had the option to withdraw from the study at any time if they wished to do so. Verbal consent was obtained from participants

4.12. Dissemination of results

After the research was completed, the study's findings were communicated to the Department of Internal Medicine and Public Health at St. Paul's Hospital Millennium Medical College as part of the requirements for a specialty certificate in internal medicine. The findings will also be submitted to the hospital's ICU. Furthermore, the study's results will be presented at scientific conferences, including those held by SPHMMC. Every effort will be made to publish the study's results in local or international journals.

5. RESULTS

5.1 Sociodemographic characteristics of the study participants

The majority (42.5%) of the study participants were in the age group of 15-35 years (mean =44.2; SD=±17.7 years). 51% of the study participants were female, while 49% were male.

Table 1: The sociodemographic characteristics of the study participants among adult ICU patients at SPMMC from July 2023 to January 2024

Variable	Category	Frequency	Percent
Age in years	15-35	105	42.5
	36-50	58	23.5
	51-65	47	19
	>65	37	15
Sex	Male	121	49
	Female	126	51

5.2 Characteristics of patterns of admission diagnosis

As shown in Figure 2, The top three diagnoses at admission were sepsis of chest focus (33.6%), followed by severe community-acquired pneumonia (CAP) (32.8) and acute kidney injury (AKI) (25.1).

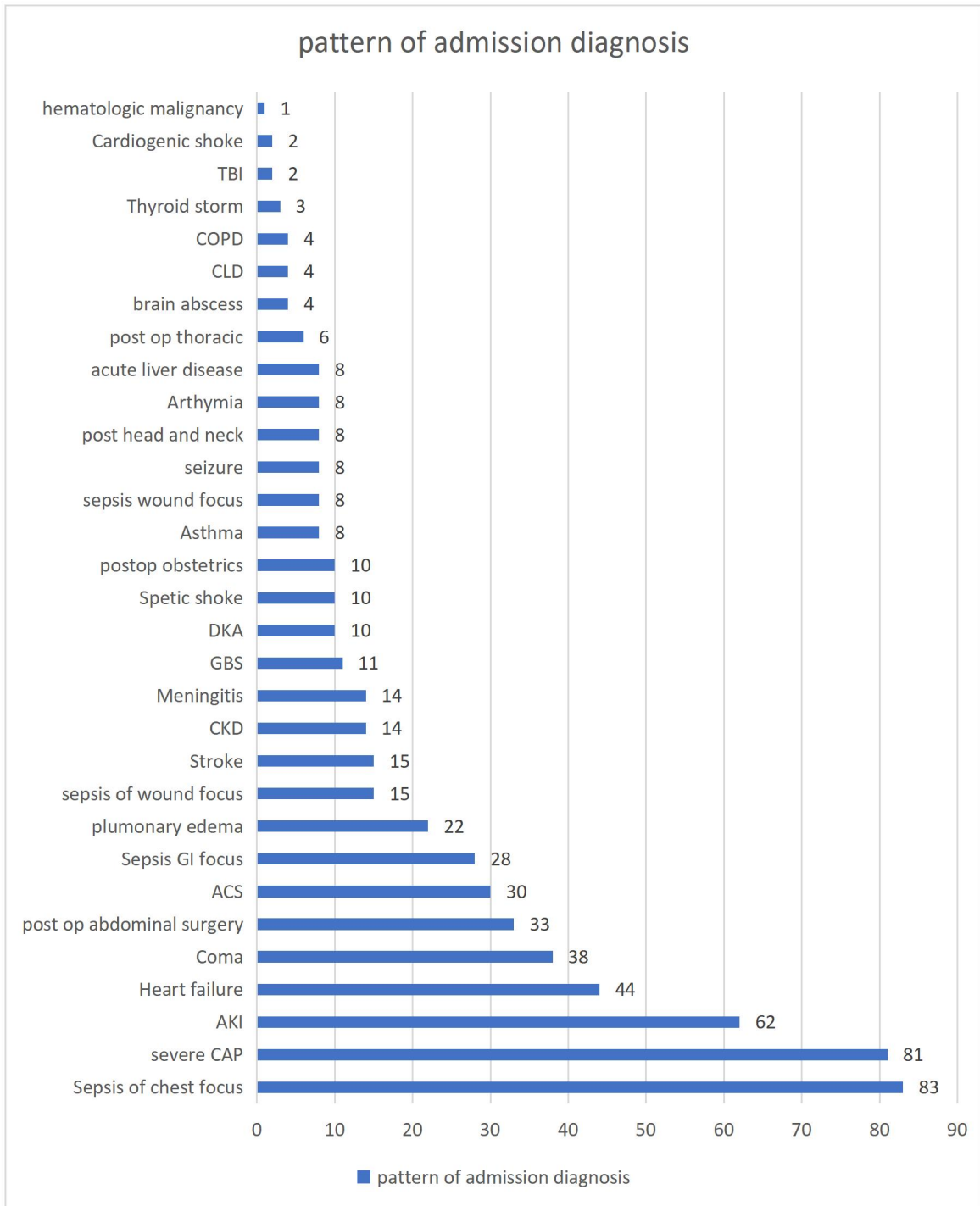


Figure 2: The pattern of admission diagnosis among adult ICU patients at SPMMC from July 2023 to January 2024

5. 3 Distribution of Comorbid diseases among the study participants

As shown in Figure 3, Among the study participants 51.8% had comorbid diseases. The commonest comorbidity was found to be CHF (28.1%) followed by DM (24.2%), HTN (21.1%), and CKD (11.7%).

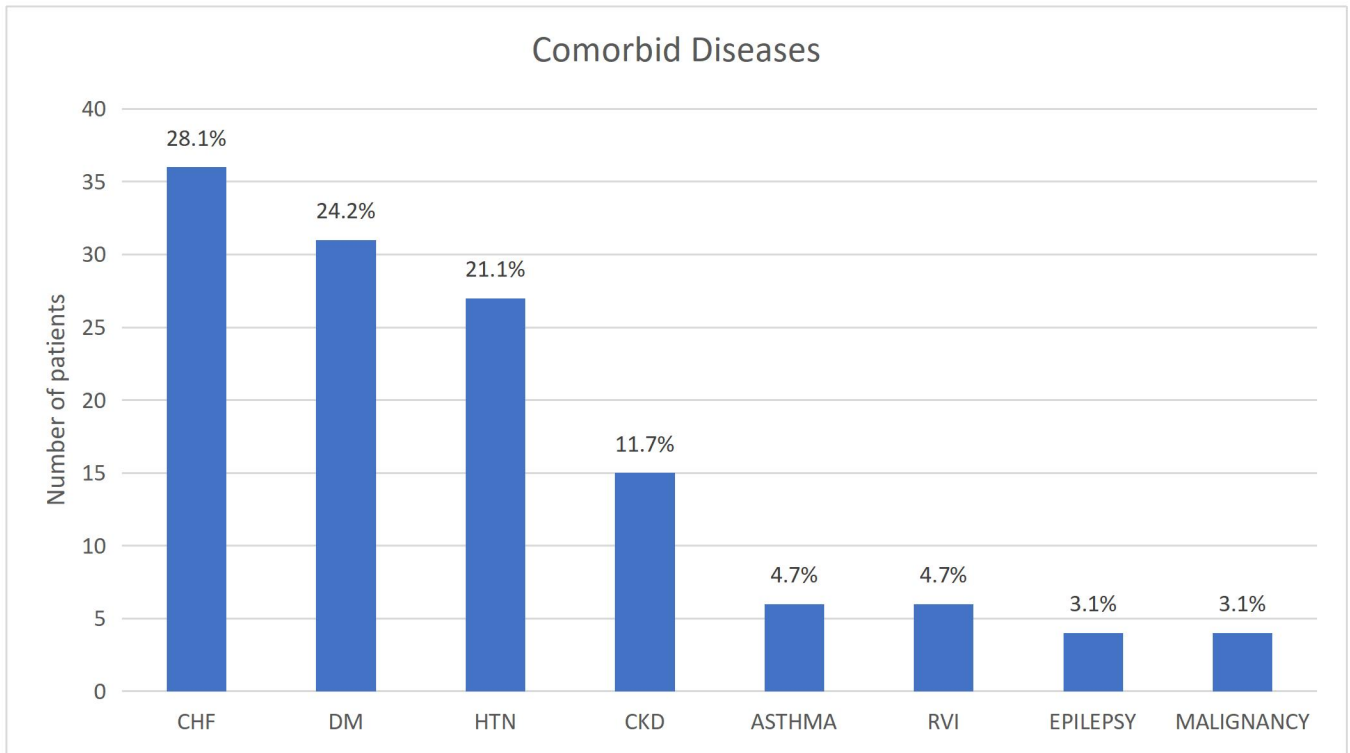


Figure 3: Distribution of Comorbid diseases among adult ICU patients at SPMMC from July 2023 to January 2024

5.4 Risk Factors for HAP among Study Participants

Among the study participants, 38 (15%) patients had a previous history of hospitalization, and 175 (70.9%) had a history of recent antibiotic use. Additionally, 175 (71%) of the study participants were mechanically ventilated, and 35 (14.2%) had undergone recent central line insertion. Furthermore, 196 (79.3%) had NG tube insertion. Of the participants, 205 (83%) were on ulcer prophylaxis, while 16 (6.5%) received immunosuppressant therapy. Also, 130 (53%) had organ failure other than respiratory, and 55 patients (22.3%) had neurologic abnormalities.

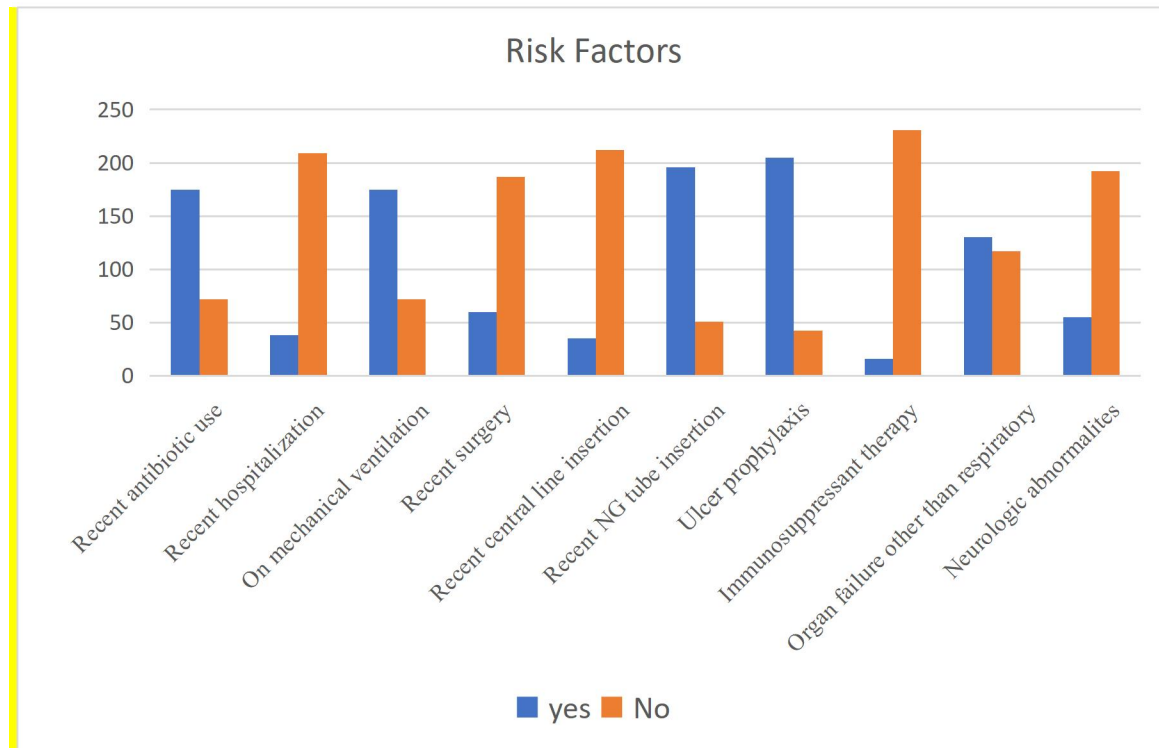


Figure 4: Risk Factors for HAP among adult ICU patients at SPMMC from July 2023 to January 2024

Among those with neurologic abnormalities, stroke accounted for 38.2%, followed by coma (36.4%), seizure (21.8%), and dysphagia (10.9%).

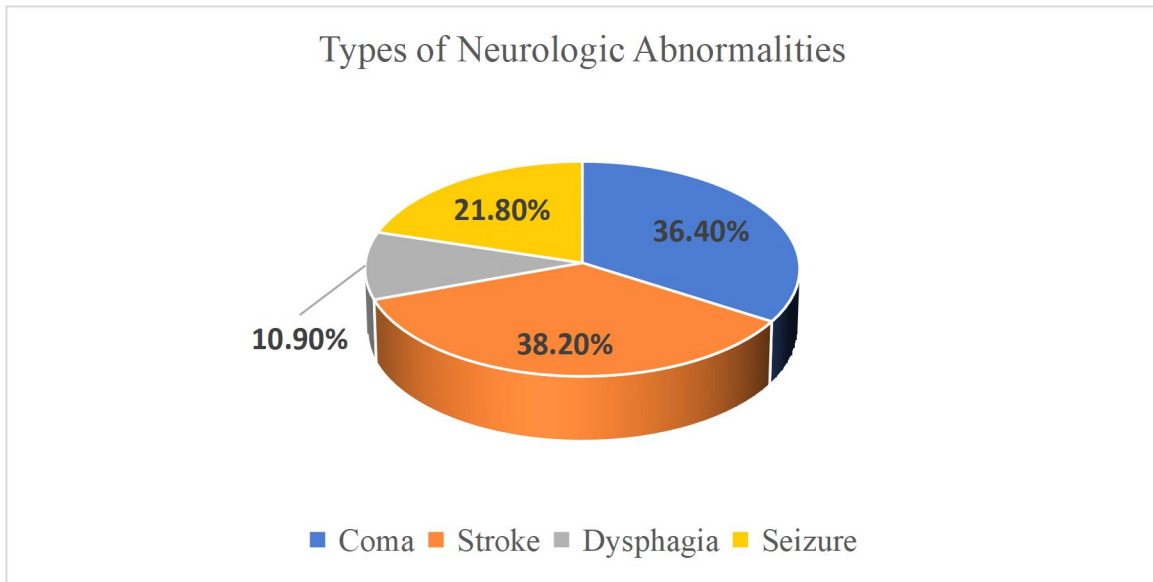


Figure 5:Types of neurologic abnormalities among adult ICU patients at SPMMC from July 2023 to January 2024

Among those with organ failure (other than respiratory), renal failure accounted for 78.5%, followed by heart and liver failure (42 (32.3%) and 12 (9.3%) respectively).

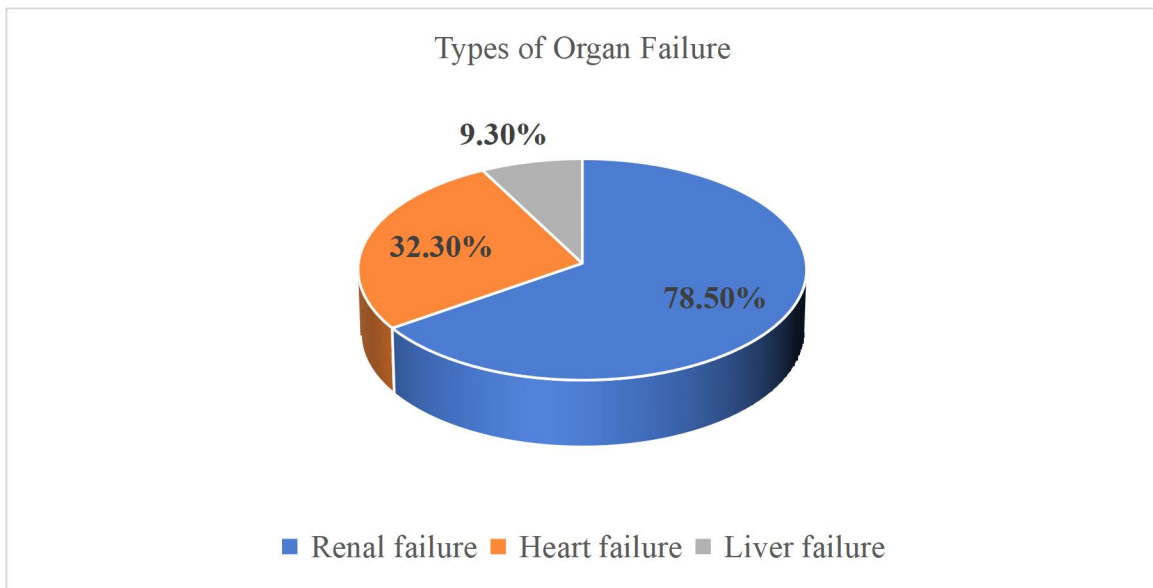


Figure 6:of Organ failure among adult ICU patients at SPMMC from July 2023 to January 2024

5.4 Management characteristics of the study participants

As demonstrated in Table 2, a small number (1.2%) used noninvasive ventilation, while 83% used invasive ventilation. Among the cases using invasive ventilation, 76.1% were due to respiratory failure. Additionally, 2.4% of the cases required reintubation, with 66.7% (n=4) being reintubated only once, primarily due to repeat respiratory failure. Nearly 10% of the study participants underwent tracheostomy, with 58.3% of these procedures indicated for prolonged intubation. Furthermore, 11.7% of the participants were transported outside the ICU, mainly for imaging purposes, and 15.4% received blood transfusions.

Table 2: Management characteristics of the study participants

Variable	Categories	Frequency	Percent
Use invasive ventilation	Yes	205	83
	No	42	17
Indication of invasive ventilation	Airway protection	49	23.9
	Respiratory failure	156	76.1
Reintubation	Yes	6	2.4
	No	241	97.6
Number of reintubated patients	Reintubated once	4	66.7
	Reintubated twice	2	33.3
Reasons for reintubation	Failed weaning	2	33.3
	Repeat respiratory failure	4	66.7
Tracheostomy done	Yes	24	9.7
	No	223	90.3
Indication of tracheostomy	Prolonged intubation	14	58.3
	Upper airway obstruction	10	41.7
Use of sedatives	Yes	38	15.4
	No	209	84.6
Transported outside ICU	Yes	29	11.7
	No	218	88.3
Reasons for transportation	Imaging	27	93.1
	Other	2	6.9
Blood transfusion	Yes	38	15.4
	No	209	84.6
Duration of ICU stay in days	<=2	27	10.9
	3-7	100	40.5
	8-14	52	21.1
	>=15	68	27.5

5.5. Prevalence of hospital-acquired pneumonia

The findings of the study revealed that 26% of the study participants developed hospital-acquired pneumonia, as shown in Figure 7.

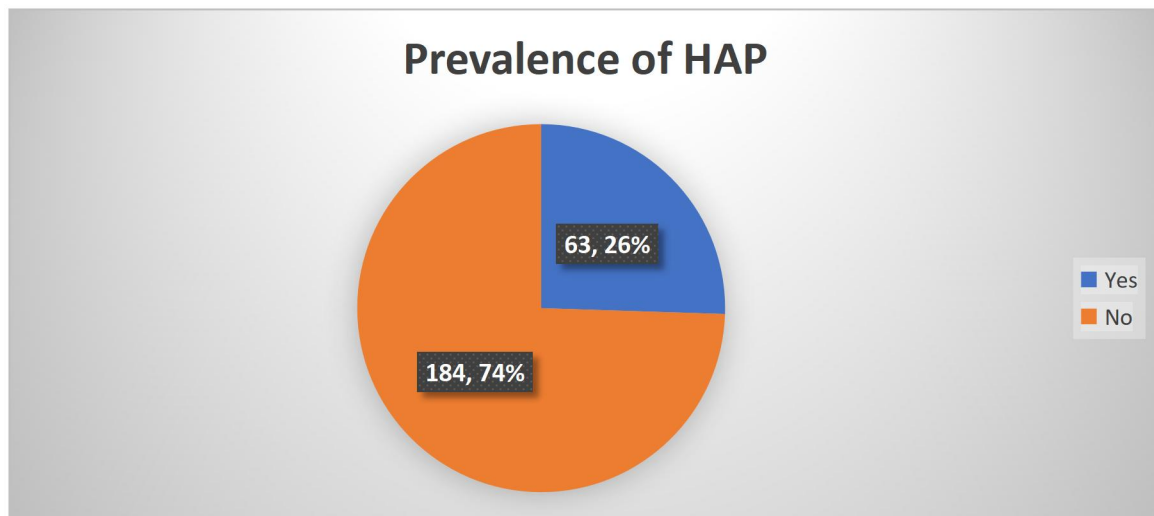


Figure 7: The prevalence of hospital-acquired pneumonia among ICU-admitted patients

As shown in Table 3, Among those HAP patients, 57.1% developed symptoms before mechanical ventilation. Nearly 59% of the HAP cases presented with fever, followed by purulent sputum (34.9%)—with all of them showing an increase in FiO₂ requirement from baseline or a decrease in SPO₂. Moreover, 90.5% of the HAP patients displayed radiologic findings suggestive of pneumonia.

Table 3: Diagnosis-related characteristics of patients with HAP

Variable	Categories	frequency	Percent
Time of HAP diagnosis	Before mechanical ventilation	36	57.1
	After intubation (VAP)	27	42.9
Clinical sign at diagnosis of HAP	Fever	37	58.7
	Hypothermia	16	25.4
	Purulent sputum	22	34.9
	Sign of inflammation on chest auscultation	63	100
	Increment in FiO ₂ requirement from baseline or reduction of SPO ₂	63	100
Radiologic findings suggesting pneumonia	Yes	57	90.5
	No	6	9.5

5.6. Laboratory results of patients diagnosed with HAP

Nearly eighty-six percent of those diagnosed with HAP had a WBC count of >10,000. Additionally, 1.6% of the patients showed nonrevealing sputum on aspiration gram stain. Among those with HAP, 22.2% had a positive tracheal aspirate culture, with pseudomonas accounting for 57.1% of these cases. Furthermore, six percent of the HAP patients tested positive in blood cultures, with E. coli being the predominant finding.

Table 4. Laboratory results characteristics of the study participants

Variables	Categories	Frequency	Percent
White blood cell count	<4000	2	3.2
	4000-10000	7	11.1
	>10000	54	85.7
Sputum/tracheal aspirate gram stain	Note done	62	98.4
	Nonrevealing	1	1.6
Sputum/tracheal aspirate culture result	Not done	30	47.6
	No growth	19	30.1
	Positive	14	22.2
Isolated organism	Acinetobacter	4	28.6
	Klebsiella pneumonia	10	71.4
	Pseudomonas species	8	57.1
Gene X-pert	Not done	51	81
	MTB detected	2	3.2
	MTB detected	2	3.2

5.8 Associated factors of hospital-acquired pneumonia

As per bivariate logistic regression, age, sex, stroke, neurologic abnormalities, recent hospitalization, recent mechanical ventilation, recent surgery, central line insertion, NG tube insertion, immunosuppressant therapy usage, reintubation, transportation out of ICU, and blood and blood product transfusion were associated with HAP. In the multivariate logistic regression analysis, participants aged over 65 years had a 7.2 times higher risk of HAP compared to those aged 18-35 years (AOR=7.2, 95%CI=2.04, 25.65). Participants with neurologic abnormalities showed a 3.6-fold increased risk of HAP compared to those without (AOR=3.6, 95%CI=1.12, 11.82). A previous hospitalization history was associated with a 19.1 times higher risk of HAP (AOR=19.1, 95%CI=5.21, 70.37). Recent mechanical ventilation, immunosuppressant therapy, transportation out of ICU, and blood transfusion were also associated with increased risk of HAP: 8.6 times (AOR=8.6, 95%CI=2.07, 35.63), 17.8 times (AOR=17.8, 95%CI=3.31, 95.42), 17.7 times (AOR=17.7, 95%CI=4.86, 64.39), and 5.9 times (AOR=5.9, 95%CI=1.78, 19.81) higher, respectively, compared to their respective counterparts.

Table 5. Bivariate and multivariate logistic regression analysis of the association between independent variables and HAP among ICU-admitted patients at SPMMC in 2023

Variable	Categories	HAP		COR (95%CI)	AOR (95%CI)	p-value
		Yes	No			
Age in years	18-35	22	83	1	1	
	36-50	12	46	0.98(0.45, 2.17)	0.46(0.13, 1.59)	0.221
	51-65	11	36	1.2(0.51, 2.62)	1.2(0.38, 3.93)	0.734
	>65	18	19	3.6(1.61, 7.94)	7.2(2.04, 25.65)	0.002
Sex	Male	22	99	1	1	
	Female	41	85	2.2(1.19, 3.93)	1.2(0.44, 3.05)	0.767

Neurologic abnormalities	Yes	21	34	2.2(1.16, 4.16)	3.6(1.12, 11.82)	0.032
	No	42	150	1	1	
Recent hospitalization	Yes	22	15	5.6(2.72, 11.68)	19.1(5.21, 70.37)	0.000
	No	41	168	1	1	
Recent mechanical ventilation	Yes	55	120	3.7(1.65, 8.17)	8.6(2.07, 35.63)	0.003
	No	8	64	1	1	
Recent surgery	Yes	22	38	2.1(1.09, 3.86)	1.4(0.07, 27.79)	0.812
	No	41	146	1	1	
Recent central line insertion	Yes	18	20	2.6(1.22, 5.39)	2.9(0.84, 10.52)	0.093
	No	48	164	1	1	
Recent NG tube	Yes	48	86	3.6(1.91, 6.97)	2.1(0.81, 5.68)	0.123
	No	15	98	1	1	
Immunosuppressant therapy	Yes	10	6	5.6(1.94, 16.12)	17.8(3.31, 95.42)	0.001
	No	53	178	1	1	
Reintubation	Yes	4	2	6.2(1.10, 34.54)	6.9(0.36, 13.46)	0.200
	No	59	182	1	1	
Transport outside ICU	Yes	21	8	11(4.56, 26.55)	17.7(4.86, 64.39)	0.000
	No	42	176	1		
Blood transfusion	Yes	21	17	4.9(2.38, 10.13)	5.9(1.78, 19.81)	0.004
	No	42	167	1	1	

6. Discussion

This research was conducted at SPHMMC adult ICU to assess the prevalence and associated factors of HAP in the intensive care setup, with HAP being the dependent variable and modifiable and non-modifiable independent variables including sociodemographic factors, comorbidities, clinical, and exposure-related factors.

The findings of this study revealed a prevalence of HAP at 26%. This rate was higher compared to studies conducted in European countries (8.1%),⁽²³⁾ but similar to those conducted in Ethiopia at Tikur Anbessa Specialized Hospital and Bahir Dar Specialized Hospital (24.3% and 25% respectively).^(33,34) The disparity from European countries aligns with WHO reviews indicating a significantly higher prevalence of healthcare-associated infections (HAI) in Africa, attributed possibly to factors such as advanced ICU setups, adherence to infection control protocols, and access to advanced diagnostic and treatment modalities in developed countries. Conversely, challenges such as limited resources, overcrowding, and inadequate sanitation in low-income countries may contribute to higher rates of hospital-acquired infections. Differences in demographic factors, underlying health conditions, and prevalence of risk factors for pneumonia (such as malnutrition and low socioeconomic status) may also play a role.

Participants aged over 65 years demonstrated a 7.2-fold increase in HAP compared to those aged 18-35 years. A similar finding of old age being an association was also seen in a study conducted in Korea where those above 70 were 3.6-fold more likely to acquire HAP than those aged 20-29.⁽³²⁾ The elevated risk among elderly individuals may be attributed to multiple comorbidities compromising their immune function. Physiological changes in the respiratory system associated with aging, such as decreased lung elasticity and weakened cough reflex, can impair clearance of respiratory secretions, predisposing to pulmonary infections like pneumonia. Functional impairments commonly seen in elderly ICU patients, including dysphagia and immobility, increase susceptibility to aspiration events and subsequent aspiration pneumonia. Moreover, prolonged hospitalizations, exposure to invasive procedures, mechanical ventilation, and indwelling medical devices heighten the risk of colonization with pathogenic microorganisms and subsequent development of HAP in this population.

Participants with neurologic abnormalities demonstrated a 3.6-fold increase in HAP compared to those without such abnormalities. This finding aligns closely with a study conducted at Bahir Dar Specialized Hospital, where they reported a 2.5-fold increased risk.(34) The increased risk in this population may be attributed to impaired cough reflexes associated with neuromuscular diseases, compromising the effective clearance of respiratory secretions and thereby increasing the risk of aspiration pneumonia. Additionally, individuals with conditions such as stroke or neurological degenerative diseases often experience dysphagia, predisposing them to aspiration of oral or gastric contents into the lungs. Prolonged immobility further contributes to atelectasis, reduced mucociliary clearance, and stasis of respiratory secretions, collectively increasing the susceptibility to pneumonia.

A 19.1-fold increase in HAP was observed among participants with a history of previous hospitalizations compared to those without such a history. Notably, this finding is not consistent with any previous study. The heightened risk in this group may be attributed to prior exposure to healthcare-associated pathogens, including antibiotic-resistant bacteria, due to multiple hospital admissions. Additionally, patients with underlying comorbidities often require repeated hospitalizations, leading to repeated exposure to such pathogens. This increased exposure heightens the likelihood of colonization and subsequent infection with multidrug-resistant organisms, which are commonly implicated in cases of HAP.

Mechanically ventilated participants had an 8.6-fold for HAP, compared to those not requiring mechanical ventilation. This finding is supported by studies conducted in Bahir Dar Specialized Hospital where they had 8.1-fold increased risk.(34) The heightened risk in mechanically ventilated patients may be attributed to several factors. Firstly, patients requiring mechanical ventilation often necessitate prolonged periods of respiratory support, increasing their exposure to invasive devices and the risk of complications such as ventilator-associated pneumonia. Additionally, mechanically ventilated patients are often sedated and may exhibit impaired consciousness or reduced gag reflexes, predisposing them to aspiration of oropharyngeal secretions, gastric contents, or oral flora. Aspiration of contaminated material into the lungs can lead to aspiration pneumonia in the hospital setup.

Participants using immunosuppressant therapy showed a 17.8-fold increase in the risk of HAP compared to those not receiving such therapy, which is notably higher than the 2.1 times increased risk observed in the study conducted at Bahir Dar Specialized Hospital.(34)

This variation may stem from differences in the types of immunosuppressants used and the underlying diseases for which they were prescribed.

Participants who were transported outside the ICU demonstrated a 17.7-fold increase in the risk of HAP compared to those not transported. This finding is consistent with a study conducted at Tikur Anbessa Specialized Hospital.(33) The heightened risk during transport may be attributed to several factors. Firstly, ICU patients often have compromised immune systems due to underlying illnesses, invasive procedures, and prolonged hospitalizations, increasing susceptibility to infections such as pneumonia. Additionally, transporting ICU patients involves temporary disconnection from vital life-support equipment such as mechanical ventilation, intravenous lines, and monitoring devices. This interruption in care can compromise patient stability, respiratory function, and immune function, further increasing the risk of infection.

Blood and blood product transfusions were associated with a 5.9-fold increase in HAP risk, compared to those who did not receive transfusions. This finding is consistent with a study conducted at Bahir Dar Specialized Hospital where they had a 2.78-fold increased risk. (34)

7. Conclusion

The prevalence of hospital-acquired pneumonia in this study was 26%, which is higher than rates seen in developed nations but consistent with prior studies in Ethiopia. Several risk factors were identified, including advanced age, neurological abnormalities, prior hospital stays, mechanical ventilation, immunosuppressant use, patient transport, and blood transfusions. This data highlights the substantial burden of HAP among critically ill patients at this facility.

8. Limitations

- This was a single center study with a small sample size, which limits the generalizability of the findings. A larger, multi-center study is needed to confirm the results.
- The study did not evaluate long-term outcomes after ICU discharge. The impact of HAP on post-hospital outcomes is unknown.

9. Recommendation

To health professionals

- Implementation of infection prevention bundles shown to reduce ventilator-associated pneumonia
- Enhanced precautions when handling and transporting critically ill patients outside the ICU

To policymakers

- To increase patient safety and adherence to protocols by regularly educating and training healthcare professionals on infection control procedures, how to use medical devices properly, and risk factors for HAP.

To researchers

- Further investigation is warranted to assess the long-term implications of Hospital-Acquired Pneumonia (HAP) on post-discharge outcomes within the Ethiopian healthcare context. A comprehensive examination of the extended effects of HAP beyond hospitalization, including its impact on patient recovery, readmission rates, and long-term morbidity and mortality, would provide valuable insights into the overall burden of this condition and inform strategies for improved patient care and management.

10. REFERENCES

1. Guidelines for the Management of Adults with Hospital-acquired, Ventilator-associated, and Healthcare-associated Pneumonia. *Am J Respir Crit Care Med*. 2005 Feb 15;171(4):388–416.
2. Herkel T, Uvizl R, Doubravska L, Adamus M, Gabrhelik T, Htoutou Sedlakova M, et al. Epidemiology of hospital-acquired pneumonia: Results of a Central European multicenter, prospective, observational study compared with data from the European region. *Biomed Pap Med Fac Univ Palacky Olomouc Czechoslov*. 2016 Sep;160(3):448–55.
3. Podnos SD, Toews GB, Pierce AK. Nosocomial Pneumonia in Patients in Intensive Care Units. *West J Med*. 1985 Nov;143(5):622–7.
4. Uvizl R, Kolar M, Herkel T, Vobrova M, Langova K. Possibilities for modifying risk factors for the development of hospital-acquired pneumonia in intensive care patients: results of a retrospective, observational study. *Biomed Pap Med Fac Univ Palacky Olomouc Czechoslov*. 2017 Sep;161(3):303–9.
5. Celis R, Torres A, Gatell JM, Almela M, Rodríguez-Roisin R, Agustí-Vidal A. Nosocomial pneumonia. A multivariate analysis of risk and prognosis. *Chest*. 1988 Feb;93(2):318–24.
6. Joshi N, Localio AR, Hamory BH. A predictive risk index for nosocomial pneumonia in the intensive care unit. *Am J Med*. 1992 Aug;93(2):135–42.
7. Evidence-Based Study Design for Hospital-Acquired Bacterial Pneumonia and Ventilator-Associated Bacterial Pneumonia - PubMed [Internet]. [cited 2023 Feb 21]. Available from: <https://pubmed.ncbi.nlm.nih.gov/30649434/>
8. Zilberberg MD, Nathanson BH, Puzniak LA, Shorr AF. Descriptive Epidemiology and Outcomes of Nonventilated Hospital-Acquired, Ventilated Hospital-Acquired, and Ventilator-Associated Bacterial Pneumonia in the United States, 2012-2019. *Crit Care Med*. 2022 Mar 1;50(3):460–8.
9. Muscedere JG, Day A, Heyland DK. Mortality, attributable mortality, and clinical events as end points for clinical trials of ventilator-associated pneumonia and hospital-acquired pneumonia. *Clin Infect Dis Off Publ Infect Dis Soc Am*. 2010 Aug 1;51 Suppl 1:S120-125.
10. Kollef MH, Hamilton CW, Ernst FR. Economic impact of ventilator-associated pneumonia in a large matched cohort. *Infect Control Hosp Epidemiol*. 2012 Mar;33(3):250–6.

11. Klompas M, Branson R, Eichenwald EC, Greene LR, Howell MD, Lee G, et al. Strategies to prevent ventilator-associated pneumonia in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014 Aug;35(8):915–36.
12. Rhodes A, Moreno RP, Azoulay E, Capuzzo M, Chiche JD, Eddleston J, et al. Prospectively defined indicators to improve the safety and quality of care for critically ill patients: a report from the Task Force on Safety and Quality of the European Society of Intensive Care Medicine (ESICM). *Intensive Care Med*. 2012 Apr;38(4):598–605.
13. Junta Directiva de la Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias (SEMICYUC). [Intensive medicine in Spain]. *Med Intensiva*. 2011 Mar;35(2):92–101.
14. Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R, CDC, et al. Guidelines for preventing health-care--associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recomm Rep Morb Mortal Wkly Rep Recomm Rep*. 2004 Mar 26;53(RR-3):1–36.
15. Chastre J, Fagon JY. Ventilator-associated pneumonia. *Am J Respir Crit Care Med*. 2002 Apr 1;165(7):867–903.
16. Rello J, Ollendorf DA, Oster G, Vera-Llonch M, Bellm L, Redman R, et al. Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. *Chest*. 2002 Dec;122(6):2115–21.
17. Fagon JY, Chastre J, Hance AJ, Montravers P, Novara A, Gibert C. Nosocomial pneumonia in ventilated patients: A cohort study evaluating attributable mortality and hospital stay. *Am J Med*. 1993 Mar 1;94(3):281–8.
18. Torres A, Aznar R, Gatell JM, Jiménez P, González J, Ferrer A, et al. Incidence, risk, and prognosis factors of nosocomial pneumonia in mechanically ventilated patients. *Am Rev Respir Dis*. 1990 Sep;142(3):523–8.
19. Bagheri Nejad S, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in Africa: a systematic review. *Bull World Health Organ*. 2011 Oct 1;89(10):757–65.
20. Said A, Elgared S, Altayar M, Attitalla I. Hospital-acquired pneumonia and ventilator-associated pneumonia in adults at Tripoli Hospitals: incidence of infection, etiology, and clinical outcomes. 2021 Apr 27;
21. Eida M, Nasser M, El-Maraghy N, Azab K. Pattern of hospital-acquired pneumonia in Intensive Care Unit of Suez Canal University Hospital. *Egypt J Chest Dis Tuberc*. 2015 Jul 1;64(3):625–31.

22. Melsen WG, Rovers MM, Groenwold RHH, Bergmans DCJJ, Camus C, Bauer TT, et al. Attributable mortality of ventilator-associated pneumonia: a meta-analysis of individual patient data from randomised prevention studies. *Lancet Infect Dis*. 2013 Aug;13(8):665–71.
23. Koulenti D, Tsigou E, Rello J. Nosocomial pneumonia in 27 ICUs in Europe: perspectives from the EU-VAP/CAP study. *Eur J Clin Microbiol Infect Dis*. 2017 Nov 1;36(11):1999–2006.
24. Branch-Elliman W, Wright SB, Howell MD. Determining the Ideal Strategy for Ventilator-associated Pneumonia Prevention. Cost-Benefit Analysis. *Am J Respir Crit Care Med*. 2015 Jul 1;192(1):57–63.
25. Álvarez-Lerma F, Palomar-Martínez M, Sánchez-García M, Martínez-Alonso M, Álvarez-Rodríguez J, Lorente L, et al. Prevention of Ventilator-Associated Pneumonia: The Multimodal Approach of the Spanish ICU “Pneumonia Zero” Program*. *Crit Care Med*. 2018 Feb;46(2):181–8.
26. Bussini L, Pascale R, Rinaldi M, Bartoletti M. Diagnosis, management and treatment of nosocomial pneumonia in ICU: a narrative review. *J Emerg Crit Care Med*. 2022 Oct;6:25–25.
27. Ferrer M, Torres A. Epidemiology of ICU-acquired pneumonia. *Curr Opin Crit Care*. 2018 Oct;24(5):325–31.
28. Hospital-Acquired Pneumonia - an overview | ScienceDirect Topics [Internet]. [cited 2023 Feb 16]. Available from: <https://www.sciencedirect.com/topics/medicine-and-dentistry/hospital-acquired-pneumonia>
29. Alemu AY, Endalamaw A, Bayih WA. The burden of healthcare-associated infection in Ethiopia: a systematic review and meta-analysis. *Trop Med Health*. 2020 Sep 7;48(1):77.
30. Tassew SG, Alebachew Woldu M, Amogne Degu W, Shibeshi W. Management of hospital-acquired infections among patients hospitalized at Zewditu memorial hospital, Addis Ababa, Ethiopia: A prospective cross-sectional study. *PLoS ONE*. 2020 Apr 24;15(4):e0231949.
31. Wałaszek M, Kosiarska A, Gniadek A, Kołpa M, Wolak Z, Dobroś W, et al. The risk factors for hospital-acquired pneumonia in the Intensive Care Unit. *Przegl Epidemiol*. 2016;70(1):15–20, 107–10.
32. Kim BG, Kang M, Lim J, Lee J, Kang D, Kim M, et al. Comprehensive risk assessment for hospital-acquired pneumonia: sociodemographic, clinical, and hospital environmental factors associated with the incidence of hospital-acquired pneumonia. *BMC Pulm Med*. 2022 Jan 12;22(1):21.

33. Molalign G. Assessment of disease burden and risk factors associated with the development of ventilator associated pneumonia and its outcome in adult intensive care unit of tikur anbessa specialized hospital, Addis Ababa, Ethiopia, 2018 [Internet] [Thesis]. Addis Ababa Universty; 2018 [cited 2023 Feb 24]. Available from: <http://etd.aau.edu.et/handle/123456789/14281>
34. Belay CM, Zewale TA, Amlak BT, Abebe TG, Hailu G. Incidence and Predictors of Ventilator-Associated Pneumonia Among Adult Intubated Patients in Bahir Dar Specialized Hospitals, 2021: A Retrospective Follow-Up Study. *Int J Gen Med*. 2022 Nov 11;15:8173–82.
35. Wicky PH, Martin-Loeches I, Timsit JF. HAP and VAP after Guidelines. *Semin Respir Crit Care Med*. 2022 Apr;43(2):248–54.
36. Bhadade R, Harde M, deSouza R, More A, Bharmal R. Emerging Trends of Nosocomial Pneumonia in Intensive Care Unit of a Tertiary Care Public Teaching Hospital in Western India. *Ann Afr Med*. 2017;16(3):107–13.
37. Rotstein C, Evans G, Born A, Grossman R, Light RB, Magder S, et al. Clinical practice guidelines for hospital-acquired pneumonia and ventilator-associated pneumonia in adults. *Can J Infect Dis Med Microbiol*. 2008 Jan;19(1):19–53.
38. Term: Length of Stay (LOS) | MCHP Concept Dictionary and Glossary for Population-Based Research | Max Rady College of Medicine | University of Manitoba [Internet]. [cited 2023 Feb 23]. Available from: <http://mchp-appserv.cpe.umanitoba.ca/viewDefinition.php?definitionID=102959>
39. mechanical-ventilation.pdf [Internet]. [cited 2023 Feb 23]. Available from: <https://www.thoracic.org/patients/patient-resources/resources/mechanical-ventilation.pdf>
40. Antimicrobial resistance [Internet]. [cited 2023 Feb 16]. Available from: <https://www.ecdc.europa.eu/en/antimicrobial-resistance>

11. ANNEXES

Annex I: Information sheet

Title of the Research proposal: Prevalence and associated factors of Hospital Acquired Pneumonia in SPHMMC adult ICU from July 2023 to January 2024, Addis Ababa, Ethiopia

Name of Investigator: Peniel Yigezu (MD)

Name of the Organization: St. Paul's Hospital Millennium Medical College, Department of Internal Medicine

Name of the Sponsor: SPHMMMC research office

Introduction: This information sheet is prepared for SPHMMC Department of Internal Medicine, Pulmonology and Critical Care Unit, Addis Ababa, Ethiopia. This information sheet will clarify the purpose of the research for the concerned office and explain the procedures for data collection. It will also aid in getting permission to conduct the study.

Purpose of the Research thesis: To assess the prevalence and associated factors of hospital-acquired pneumonia in SPHMMC adult ICU Addis Ababa, Ethiopia, from July 1 2023 to January 31, 2024

Procedure: To achieve the above objective, information will be taken from the treating team and patient charts from July 1 2023 to January 31, 2024

Risk and /or Discomfort: As this study is non-interventional, it will not inflict any harm on the study participants. The privacy, confidentiality, and anonymity of information collected from patients' charts will be maintained.

Benefits: The study participants will not benefit from this study directly. However, they may benefit from the results of the study, as it may be utilized for service improvement in the future.

Confidentiality: To ensure confidentiality, the data will be collected by data collectors, handled anonymously, coded, and entered into secure software.

Person to contact: This research project will be reviewed and approved by the institutional review board of SPHMMC.

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Annex II: Data collection tool

	SECTION A: DEMOGRAPHIC INFORMATION	
1	Patient ID	
2	Age	
3	Sex	
4	Address/ Region	
	SECTION B: CLINICAL CHARACTERISTICS	
1	Number of days the patient stayed in the hospital prior to admission to the ICU	
2	HAP Diagnosed	1. Yes 2. No
3	If yes to Q2, Date of HAP diagnosis	
4	If yes to Q2, how many days after admission?	
5	If yes to Q2, how many days after intubation? (If applicable)	
6	If yes to Q2 clinical signs at diagnosis (fever > 38°C, hypothermia < 35°C, cough, purulent sputum, signs of inflammation on auscultation, reduction of partial pressure of oxygen (PaO ₂)/FiO ₂ ratio of at least 15% in the last 48 hours)	Mention if present
7	Radiologic findings suggesting pneumonia	1. Yes 2. No
8	Admission diagnosis	
9	Comorbidities (mention if any)	
10	Any neurologic abnormality (including stroke, dysphagia)	1. Yes 2. No
11	If yes to Q 10, mention the diagnosis	
12	Previous hospitalization	1. Yes 2. No
13	If yes, how many days before current admission?	
14	Recent antibiotic use	1. yes 2. No
15	Recent mechanical ventilation	1. Yes 2. No
16	If yes to the above question how many days before current admission?	
17	Recent surgery	1. Yes 2. No
18	Recent central line insertion	
19	Recent nasogastric tube insertion	
20	Use of ulcer prophylaxis (PPIs/ H2 blockers)	1. Yes 2. No
21	Use of immunosuppressant therapy	1. Yes 2. No
22	If yes to Q 10, mention the drug name/s	
23	GCS	

Annex II: Data collection tool

24	Positioning	1. Supine 2. Other
25	If other for Q 24, mention	
26	Surgical patient?	1. Yes 2. No
27	If yes to Q 26, mention the type/types of procedure/s done	
28	Does the patient have organ failure?	1. Yes 2. No
29	Mention if any	
	SECTION C: LABORATORY DATA	
1	(WBC >10×10 ³ /mm ³ or WBC <4×10 ³ /mm ³)	1. Yes 2. No
2	Sputum gram stain	
3	Sputum culture results	
	SECTION D: MANAGEMENT DETAILS	
1	Use on non- Invasive ventilation	1. Yes 2. No
2	Use of invasive ventilation	1. Yes 2. No
3	Re- intubation	1. Yes 2. No
4	If yes, how many times? And the reason for reintubation	
5	Tracheostomy	1. Yes 2. No
6	Use of sedatives	1. Yes 2. No
7	Transported outside of the ICU for any purpose including imaging?	1. Yes 2. No
8	If yes to Q 7, mention the reason	1. Yes 2. No
9	Blood transfusion?	

1. Assurance of investigator

I the undersigned resident agree to accept all responsibilities for the scientific, ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the Research and Publication Directorate and /or Department of Public Health of St. Paul's Hospital Millennium Medical College.

Name of the Resident: _____

Signature: _____

Date: _____

Approval of Advisors

Name of Public Health Advisor: _____

Signature: _____

Date: _____

Approval of Advisors

Name of Clinical Advisor: _____

Signature: _____

Date: _____