SCHOOL OF GRADUATE STUDIES

INCIDENCE OF HOOSPITAL ACQUIRED INFECTION, TREATMENT OUTCOMES AND FACTORS ASSOCIATED WITH POOR TREATMENT OUTCOMES AMONG ADULT INPATIENTS WITH HOSPITAL ACQUIERD INFECTION AT HIWOT FANA COMPREHENSIVE SPECIALIZED UNIVERSITY HOSPITAL, EASTERN ETHIOPIA PROSPECTIVE LONGTUDNAL STUDY

MSc THESIS

FEDILA SHUKRALA

DECEMBER, 2025

HARAR, ETHIOPIA

HARAMAY UNIVERSITY

SCHOOL OF GRADUATE STUDIES

INCIDENCE OF HOOSPITAL ACQUIRED INFECTION, TREATMENT OUTCOMES AND FACTORS ASSOCIATED WITH POOR TREATMENT OUTCOMES AMONG ADULT INPATIENTS WITH HOSPITAL ACQUIERD INFECTION AT HIWOT FANA COMPREHENSIVE SPECIALIZED UNIVERSITY HOSPITAL, EASTERN ETHIOPIA PROSPECTIVE LONGTUDNAL STUDY

A Thesis Submitted to the College of Health and Medical Sciences, School of Graduate Studies, Haramaya University, in Partial Fulfillment of the Requirements for the Degree of Master of Sciences in Clinical Pharmacy.

Major Advisor: Mr. Kirubel Minsamo (B.Pharm, MSc, Assistant Professor).

Co- advisor: Mr. Jemal Abdela (B. Pharm, MSc, Assistant Professor)

DECEMBER, 2025

HARAR, ETHIOPIA

APPROVAL SHEET

HARAMAYA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

As a thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared under my guidance by Fedila Shukrala entitled: Treatment Outcome and Associated Factors of Hospital-Acquired Infection among adult Patients admitted to Hiwot Fana Comprehensive Specialized University Hospital, Eastern Ethiopia

______________________	______________	______________
Major Advisor	Signature	Date
______________________	______________	______________
Co advisor	Signature	Date

As a member of the Board of Examiners of the MSc Thesis Open Defense Examination, I certify that I have read and evaluated the Thesis prepared by Fedila Shukrala and examined the candidate. I recommend that the Thesis be accepted as fulfilling the Thesis requirements for the degree of Master of Science in Clinical Pharmacy.

______________________	______________	______________
Chair person	Signature	Date
______________________	______________	______________
Internal Examiner	Signature	Date
______________________	______________	______________
External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent up on the submission of final copy of the thesis to council of graduate studies (CGS) through the departmental or school graduate committee (DGC or SGC) of the candidate.

STATEMENT OF THE AUTHOR

I hereby declare that this thesis is my original work. I have adhered to all ethical principles in its preparation, data collection, analysis, and completion. All sources used have been properly cited and referenced, and every effort has been made to avoid plagiarism.

This thesis is submitted in partial fulfillment of the requirements for a degree at the School of Graduate Studies, Haramaya University. It has been deposited in the university library and is available to borrowers under the library rules. I confirm that this work has not been submitted elsewhere for any academic award.

Brief quotations may be used without special permission, provided proper acknowledgment is given. Permission for extended quotations or reproduction, in whole or in part, may be granted by the Head of the School, Department, or Dean of the School of Graduate Studies, if deemed in the interest of scholarship. In all other cases, permission must be obtained from the author.

Name: Fedila shukrala

Signature: __________

Date of submission: ___________

School: ___________

BIOGRAPHICAL SKETCH

I was born in Addis Ababa on November 18 1990. I attended basic education at Medhaniyalem primary school at Addis Ababa Ethiopia and secondary and Preparatory school education at Medhaniyalem Secondary and Preparatory School. I was graduated From Haramaya University with BSc in Pharmacy on 6th July, 2013 G.C. In 2015, I worked as a pharmacist at Dilchora Referral Hospital in Dire Dewa, Ethiopia. After that, I spent five years as an assistant instructor at Harar Health Science College. And I started taking my MSc degree in Clinical Pharmacy at Haramaya University in 2022.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere gratitude to Haramaya University, College of Health and Medical Sciences, for providing me with the opportunity to undertake this thesis.

I am deeply grateful to my advisors, Mr. Kirubel Minsamo and Mr. Jemal Abdela, for their continuous guidance, valuable suggestions, and unwavering support throughout the development of this study.

I would also like to extend my heartfelt appreciation to my family for their encouragement, strength, and motivation, as well as to my friends for their support during this journey.

Finally, I sincerely thank the staff of Hiwot Fana Comprehensive Specialized University Hospital for their assistance during data collection, and I am grateful to all the study participants for their time and cooperation.

TABLE OF CONTENTS

LIST OF TABLES

LISTS OF FIGURES

ACRONYMS/ABBREVIATIONS

APACHE II	Acute Physiology and Chronic Health Evaluation-II
BSIs	Bloodstream Infection
CABSI	Catheter-Associated Blood Stream Infection
CAUTI	Catheter-Associated Urinary Tract Infections
CCI	Charlson Comorbidity Index
CD	*Clostridium difficile*
CDC	Centers for Disease Control and Prevention's
CR-BSI	Catheter-Related Blood Stream Infection
CLABSI	Central Line-Associated Bloodstream Infections
HAP	Hospital-Acquired Pneumonia
HCAI	Health Care-Associated Infection
HCAP	Healthcare-Acquired Pneumonia
HFCSUH	Hiwot Fana Comprehensive Specialized University Hospital
ICU	Intensive Care Unit
IDSA	Infectious Disease Society of America
LMICs	Low- and Middle-Income Countries
LRTI	Lower Respiratory Tract Infection
MDR	Multidrug-resistant
NI	Nosocomial Infections
OR	Od Ratio
SSI	Surgical Site Infections
VAP	Ventilator-Associated Pneumonia

ABSTRACT

Background: Hospital-acquired infections are among the most common adverse events in healthcare, causing substantial morbidity, mortality, and financial burden worldwide. These infections are often associated with multidrug-resistant organisms, affecting not only individual patients but also the wider community.

Objective, this study aimed to assess treatment outcomes and associated factors of hospital-acquired infection among adult patients admitted to Hiwot Fana Comprehensive Specialized University Hospital from 1 February 2024 to 30 April 2024.

Method: A prospective longitudinal study was conducted among adult patients admitted to Hiwot Fana Comprehensive Specialized Hospital during the study period. A total of 422 patients were included in the study, selected through systematic random sampling with sampling interval of 2. Data was collected by using organized questioner. Treatment outcomes were classified into two categories: good and poor. Descriptive statistics and bivariate and Multivariable logistic regression analysis was performed, to determine factors associated with poor treatment outcome with results expressed as adjusted odds ratios (AOR) and 95% confidence intervals (CI). Statistical significance was determined at a p-value < 0.05.

Result: Of 422 patients observed in this study, 99 (23.5%) were diagnosed with a hospital-acquired infection. Of most commonly identified hospital acquired infections, bloodstream infections were the most common (37, 37.4%), followed by hospital-acquired pneumonia (35, 35.4%) and urinary tract infections (19, 19.2%). Overall, 50.5% (95% CI: 40.3-60.7) of patients with hospital-acquired infections experienced poor treatment outcomes. Patients with a Charlson comorbidity index score ≥ 3 had higher odds of poor outcomes (AOR = 3.45; 95% CI: 1.02–11.57), bloodstream infection (AOR = 4, 57; 95% CI: 1.06–19.7), prior use of antibiotics before hospital-acquired infection diagnosis (AOR = 3.92; 95% CI: 1.18–13.06), and undergoing an invasive procedure (AOR = 3.69; 95% CI: 1.15–11.9) were all significantly associated with poor treatment outcomes.

Conclusion: This study demonstrated that half of the patients with hospital-acquired infections experienced poor treatment outcomes. Factors significantly associated with adverse outcomes included a Charlson Comorbidity Index (CCI) score ≥3, bloodstream infections, prior antibiotic use before HAI diagnosis, and undergoing invasive procedures. These findings highlight the combined influence of comorbidities, infection type, and treatment practices on patient prognosis, underscoring the urgent need for targeted interventions to reduce mortality and improve recovery among hospitalized adults

Keywords: Hiwot Fana Comprehensive Specialized Hospital, hospital-acquired infections, prospectiev, treatment outcomes, factors affecting poor outcome,

1. INTRODUCTION

1.1 Background

Hospital-associated infections (HCAIs), commonly known as infections acquired in hospital settings, are among the most common illnesses worldwide. Hospital-acquired infections (HAIs) may develop within 48–72 hours after admission, 3–5 days following discharge, or more than 30 days after surgery (Pestaña *et al.,* 2022).

Hospital-associated infections include CLABSI (central line-associated bloodstream infections), CAUTI (catheter-associated urinary tract infections), SSI (surgical site infections), HAP (hospital-acquired pneumonia), VAP (ventilator-associated pneumonia), and CD (Clostridium difficile) infections (Habboush *et al.*, 2023).

The Infectious Diseases Society of America defines hospital-acquired pneumonia (HAP) as pneumonia that appears ≥48 hours after hospitalization and was not incubating at the time of admission (Habboush *et al.*, 2023). Ventilator-associated pneumonia (VAP), a subtype of HAP, arises more than 48 hours after endotracheal intubation and the initiation of mechanical ventilation (Kwa *et al.,* 2007; Ozvatan *et al.*, 2016; Karakuzu *et al.,* 2018).

Hospital-acquired infections (HAIs) have implications not only for individual patients but also for public health, as they are frequently associated with multidrug-resistant pathogens. Clostridium difficile is responsible for C. difficile colitis, while common pathogens causing central line–associated bloodstream infections (CLABSI) include Candida species in adult ICUs, Enterobacteriaceae in adult wards, pediatric ICUs, and cancer units, and *Staphylococcus aureus* across various settings (Weiner-Lastinger *et al.*, 2022)

Effective prevention and control of both HAIs and multidrug-resistant infections require early identification of individuals with relevant risk factors (Cillóniz *et al.,* 2019). Such risk factors include immuncompromised, older, prolonged hospitalization, multiple comorbidities, frequent healthcare facility visits, mechanical ventilation, recent invasive procedures, indwelling medical devices, and admission to intensive care units (ICUs). The source of infection may be hospital staff, other patients, or the healthcare environment (Monegro *et al.,* 2021).

.

this study aimed to assess the prevalence, therapeutic outcomes, and associated factors of HAIs at HFCSUH.

1.2 Statement of the problem

Hospital Acquired Infections increases antibiotic resistance, prolongs hospital stays, generates long-term disability, poses a large financial strain on healthcare systems, raises expenditures for patients and their families, and leads to premature deaths (Srinivasan, 2023). The U.S. Centers for Disease Control and Prevention estimates that, of the 1.7 million patients who develop HAIs annually, approximately 98,000 (about 1 in 17) die as a result (Haque et al., 2018)..

In the United States, HAIs incur annual costs estimated between $28 billion and $45 billion and result in approximately 90,000 deaths, ranking them among the top five causes of mortality (Haque *et al.,* 2018). In low- and middle-income countries, financial data on HAIs are scarce and inconsistent. For instance, in several Argentine ICUs, the additional costs per case were estimated at US$4,888 for CLABSI and US$2,255 for healthcare-associated pneumonia (Srinivasan, 2023).

Globally, healthcare-associated infections affect an estimated 7 out of every 100 hospitalized patients in high-income countries and 10 out of every 100 in low-income countries (Lastinger et al., 2023). Also studies have identified determinants of poor treatment outcomes among patients with HAIs, to include, APACHE II score of >21, a SOFA score of >6, on admission to the ICU, a SOFA score of >6, upon the day of diagnosis, and a low PaO2/FIO2 ratio while on ventilator associated pneumonia (VAP). Also, other characteristics, including BSI, invasive device use, comorbidities, and age, type of HAI, have been found as determinants of in-hospital mortality among HAI patients (Karakuzu *et al.,* 2018)

In low- and middle-income countries, data on HAIs remain limited. Nevertheless, a recent World Health Organization (WHO) report indicates that HAIs are more prevalent in resource-limited settings than in high-income countries (Shahida *et al.*, 2016). A comprehensive review estimated the pooled prevalence of HAIs in Africa at approximately 12.76%, with SSI and bloodstream infections (BSIs) being the most common types (Gidey *et al.*, 2023). Another study stated that across Africa, the number of patients who get HAI and die in 2022 reached 4.8 million and 500,000, respectively (Hutton *et al.*, 2024).

Ethiopia, like many other low-income countries in Africa, faces a high burden of HAIs. A systematic review reported an overall prevalence of 16.96% (Alemu *et al.*, 2020), while a study in Jimma found an incidence of 28.5 cases per 1,000 patient-days (Genaneh *et al.*, 2023). HAIs are associated with increased in-hospital mortality, prolonged hospital stays, and higher healthcare costs.

In Ethiopia, the average direct medical cost for patients with HAIs was 3,033 Ethiopian birr (ETB) higher than for those without HAIs (Gidey et al., 2023). Therefore, effective prevention and management of HAIs require coordinated efforts between healthcare providers and patients. Unfortunately, many countries lack comprehensive surveillance systems for healthcare-associated infections (Pestaña et al., 2022).

1.3 Significance of the study

Hospital acquired infection is currently a big issue for society and healthcare organizations. It also increases the frequency of tests and medicine administrations, increasing the cost of therapy for both patients and medical facilities. Preventing and eliminating nosocomial infections would result in significant financial savings for health care facilities, healthcare providers, and the public. To achieve this , several healthcare facilities should conduct research and projects regarding the prevalence treatment outcomes and factors associated with treatment outcome (Raoofi *et al.*, 2023). Despite this, even though, several studies were undertaken in Ethiopia, focusing on the prevalence and risk factors of specific HAIs. Only, a few studies have been done on outcomes of treatment among patients with HAIs and factors associated with poor treatment outcomes. Therefore, the findings of this study may provide valuable insights to the management and healthcare providers at HFCSUH and Haramaya University regarding the current status of HAIs in the hospital. Help to identify factors that adversely affect treatment outcomes, serve as a data source for developing effective infection control programs, and guide the implementation of strategies to reduce HAI rates, improved treatment approaches, address factors negatively impacting outcomes,. Furthermore, finding may provide high-quality evidence to support future research on related topic.

1.4 Objective

1.4.1. General objective

To assess incident of hospital acquired infection, treatment outcome and factors associated with poor treatment outcome among adult inpatients with hospital acquired infection at Hiwot Fana Comprehensive Specialized Hospital from February 1, 2024, to April 30, 2024.

1.4.2. Specific objectives

- To assess the incident of hospital acquired infection among adult inpatients at to Hiwot Fana Comprehensive Specialized Hospital
- To assess the treatment outcome of HAIs among adult inpatients at Hiwot Fana Comprehensive Specialized Hospital
- To identify factors associated with poor treatment outcomes of HAIs among adult inpatients at Hiwot Fana Comprehensive Specialized Hospital

.

2. LITERATURE REVIEW

2.1 Incident of HAI

Global evidence consistently shows that healthcare-associated infections (HAIs) remain a major challenge to patient safety, despite advances in infection prevention and control. A large systematic review covering publications from 2000–2021 estimated the global prevalence of HAIs at 0.141%, with an annual increasing trend of 0.06% (Id et al., 2023). Although this figure appears low, many country-level studies demonstrate substantially higher rates, underscoring persistent gaps in surveillance and IPC implementation worldwide.

Studies from high-income countries (HICs) generally report lower HAI prevalence and incidence. For instance, In a large cohort of 214,955 hospitalized adults, in US HAIs were identified in 3.1% of admissions(Nickel et al., 2025).And prospective surveillance in Australia identified an incidence of 2.1 per 1000 resident-days (König et al., 2021), while a five-year Polish study documented a prevalence of 3.1% (Rafa et al., 2022). However, HICs are not exempt from high HAI burdens under certain conditions: a cohort study in Thailand among COVID-19 patients reported a 19% HAI prevalence, particularly bloodstream infections (Sathaporn & Khwannimit, 2023). Other studies in Germany, Greece, Italy and China have shown prevalence values ranging from 3.9 episodes per 10,000 admissions to 11.2% (Ott et al., 2013; Kritsotakis et al., 2017;Guarente et al., 2024Zhu et al., 2021).a systematic literature review from Europe find that prevalence of HAI across the region is vary from 4.6% to 49.3% in the general population, depending on the setting and country(*17th WORLD CONGRESS ON PUBLIC HEALTH 2023,MAY 2_6 ROME ETALY* -, n.d.).

Overall, these findings indicate that even robust health systems face HAI challenges, but the burden is more pronounced in low- and middle-income countries (LMICs).

Comparative global analyses demonstrate that LMICs bear disproportionately higher rates of HAIs. For example, pooled results from Southeast Asia reported a prevalence of 21.6% (Wah Goh et al., 2023), while a Brazilian epidemiological study found an incidence of 8 cases per 1000 people-year (Souza et al., 2015). In Africa, the pooled point prevalence was 12.76%, a figure two to three times higher than rates observed in Greece or China (Abubakar, Amir & Rodríguez-Baño, 2022). Also a systematic review and meta _analysis in sub-Saharan Africa state that, The overall pooled prevalence of HAI across all included studies in SSA was estimated at **12.9%** (This finding, demonstrates that approximately one in eight patients admitted in SSA facilities acquires an HAI(Melariri et al., 2024).

- Additional African studies—conducted in Senegal, Botswana, South Africa, and Tunisia—reported HAI prevalence or incidence exceeding 5%, including values such as 11.5%, 13.54%, 7.67%, and 14.5% (Diedhiou et al., 2023; Mpinda-Joseph et al., 2019; Nair et al., 2018; Mahjoub et al., 2015). These consistently elevated rates highlight structural challenges typical of LMIC settings, such as overcrowding, limited resources, insufficient IPC capacity, and inconsistent surveillance.

Across regions, the most common types of HAIs vary. In Senegal, ventilator-associated pneumonia (VAP) was dominant (Diedhiou et al., 2023), whereas a major African review identified surgical site infections (SSIs) as the most frequent, accounting for 41.6% of HAIs (Abubakar, Amir & Rodríguez-Baño, 2022). Conversely, findings from Tunisia indicated that peripheral venous catheter (PVC) infections were the leading type (Mahjoub et al., 2015). These variations reflect contextual differences in case-mix, device use, and quality of infection-prevention practices.

In Ethiopia, consistent with other LMICs, the national HAI burden remains high. A systematic review reported a pooled prevalence of 16.96% (Alemu, Endalamaw & Bayih, 2020). Additional studies from Hawassa, Jimma, Addis Ababa, Adama, and Harar further confirm high prevalence and incidence rates, including 11.9% prevalence, 19.8% prevalence, 6.9% prevalence, and 28.15 per 1000 patient-days incidence (Mengistie, Ashena & Seman, 2022; Genaneh et al., 2023; Tassew et al., 2020; Chernet et al., 2020; Tolera et al., 2018). Surgical site infections (SSIs) remain one of the most significant postoperative complications globally, contributing to increased morbidity, prolonged hospitalization, and elevated healthcare costs. The reviewed study from Harar ,Ethiopia demonstrates that SSIs continue to pose a substantial burden, with a prevalence of **17.1%** (95% CI: 14.6–19.9) among 801 surgical patients(Abdela et al., 2025). findings underscore significant gaps in IPC practices and resource limitations across Ethiopian hospitals.

Regarding causative organisms, Ethiopian studies commonly identify Coagulase-Negative Staphylococci (CoNS) and Escherichia coli as major pathogens associated with HAIs (Mengistie, Ashena & Seman, 2022). These organisms are also globally recognized contributors to device-associated and postoperative infections.

The reviewed literature clearly demonstrates that although HAIs are a universal healthcare problem, their burden is disproportionately high in LMICs—especially in Africa and Ethiopia. The consistently elevated prevalence and incidence rates, along with diverse etiological patterns, highlight the need for context-specific research, targeted IPC interventions, and improved surveillance.

2.2. Treatment outcome of HAIs

Hospital acquired infections can have a significant impact on patients, both at an individual level and at the community level. They can lead to longer hospital stays, increased costs of care, and even death. HAIs can also be linked to the spread of multidrug-resistant infections. (Naj et al., 2024)Studies conducted worldwide demonstrate that HAIs increase the risk of mortality among hospitalized patients. A retrospective study at a tertiary infectious disease hospital in Vietnam, covering January 2011 to December 2013, found a hospital-acquired bloodstream infection (HABSI) case fatality rate of 36.4% (Dat *et al.*, 2017). Similarly. A cross-sectional study conducted at Haukeland University Hospital in Norway (2004–2011, follow-up until 2012) found that patients with HAIs had an adjusted hazard ratio of 1.5 (95% CI: 1.3–1.8) for death within 30 days and 1.4 (95% CI: 1.2–1.5) within one year, compared to those who did not develop HAIs (Koch et al., 2015).in addition to this, a cohort study in Greece reported a 90-day mortality risk of 1.8 (95% CI: 1.3–2.6) for patients with HAIs and 3.3% , 30 days and 6.1% , 90 days mortality following hospital admission. (Kritsotakis et al., 2017). also A six-month survey conducted in South Texas between July and December 2021 reported that the length of stay for patients with catheter-associated urinary tract infections (CA-UTI) ranged from 19 to 59 days (Ambrosini, 2023)

Additionally, a retrospective cohort study in the intensive care unit of Heraklion University Hospital in Greece from October 2012 to April 2015 reported a 34.4% mortality rate among 93 adult patients with VAP (Li *et al.,* 2020). HAIs significantly increased the risk of in-hospital death, need for ICU care, and prolonged hospital stay(Czerniak et al., 2025), The 2019 study conducted in china demonstrates that hospital-acquired infections are a frequent and serious complication after intracranial aneurysm surgery, with poor neurological status, invasive procedures, and prolonged ICU stays being the strongest determinants of risk(Wang et al., 2019)

A large study of over seven million patients admitted to U.S. hospitals reported that SSIs contribute to an additional 2.7 million hospital days annually, increased healthcare costs of approximately US$9.5 billion, and at least 12,000 in-hospital deaths each year (WHO 2016).

A systematic meta-analysis review found that HAI is associated with a high burden of mortality. The estimated pooled mortality resulting from HAI in SSA was a concerning 22.2% (95% CI: 14.2–31.4)(Melariri et al., 2024), suggesting that nearly one-quarter of patients who acquire an HAI may succumb to the infection.

A retrospective cohort study by (Sathaporn and Khwannimit 2023) and a retrospective descriptive epidemiologic study by Souza et al. (2015) reported high mortality rates associated with HAIs, approximately 62.5% and 38.4%, respectively. Additionally, a prospective cohort study conducted in Singapore from June 2015 to February 2016 found that HAIs were linked to an increased length of hospital stay by 1.68 days (95% CI: 1.15–2.21) and a higher risk of in-hospital mortality (adjusted hazard ratio [AHR] = 1.32; 95% CI: 1.09–1.65) (Cai *et al.,* 2020).

A retrospective study from Punjab province similarly demonstrated a significantly higher fatality rate among patients with HAIs compared to those who did not develop HAIs (25.8% vs. 1.2%, $p < 0.001$) (Mustafa *et al.,* 2022).. A one-year retrospective study conducted in the ICU at St. Louis, Senegal, reported a 35% mortality rate among patients with HAIs (iedhiou *et al.*, 2023). Similarly, an observational study in Mauritius found a mortality rate of 50% (Nuckchady, 2021). The literature consistently highlights that Healthcare-Associated Infections (HAIs) in Africa represent a disproportionately high burden, resulting in significantly poorer treatment outcomes compared to developed settings, for instance The pooled mortality rate attributable to HAI in Sub-Saharan Africa is estimated to be approximately 22.2% (95% CI: 14.2–31.4). This rate is a key indicator of poor treatment outcome and underscores the life-threatening nature of these infections in resource-limited settings., (Melariri et al., 2024).

In Ethiopia, limited research has focused specifically on mortality and determinants related to HAIs. A hospital-based longitudinal study in Adama (February to May 2017) reported a 1% mortality rate and an additional 6.3 days of hospital stay among patients with HAIs (Chernet *et al.*, 2020). Similarly, Healthcare-associated infections (HAIs) significantly worsen clinical outcomes, including increased mortality, prolonged hospital stays, and higher rates of intensive care utilization. A longitudinal study from Ethiopia demonstrated that patients who developed HAI had a significantly higher in-hospital mortality rate7.5% and longer lengths of stay than those without infection, with HAI being associated with more than twice the risk of death (AOR = 2.23) and an additional mean hospital stay of over 6 day (Ali et al., 2018)A cohort study at Ayder Hospital in Mekelle, northern Ethiopia, demonstrated that HAIs increased in-hospital mortality to 14.7% and extended hospital stay by 8.3 days compared to patients without HAIs (Gidey et al., 2023).in general, HAIs are not only a clinical challenge but a major source of national loss. In 2022, HAIs were estimated to cause 52,400 deaths annually in Ethiopia, with a case fatality rate ranging from 4\%to 15\%(Yeshambel et al., 2020).

2.3. Factors associated with treatment outcomes of HAIs

According to a retrospective cohort study done in Spain, factors associated with adjusted risk of mortality were age, male sex, Charlson comorbidity index, McCabe severity scale, onset of HAI in the ICU, and BSI(Barrasa-villar et al., 2017) .other Studies also indicate that lower respiratory tract infections (LRTIs), BSIs, and multiple concurrent infections significantly increase the risk of death (Koch *et al.*, 2015; Kritsotakis *et al.*, 2017)..

In a study conducted in the United States, VAEs were associated with higher all-cause ICU mortality and longer hospital or ICU stays. Increased risks for all-cause mortality were also linked to older age, higher APACHE II scores at ICU admission, pneumonia, blood transfusion, use of immunosuppressive drugs, central-line catheter insertion, and the occurrence of two VAEs during the ICU stay (Zhu *et al.*, 2022). Another chohort study conducted in US also concludes that inequities associated with structural racism, resource disinvestment in rural regions, and systemic healthcare imbalances likely contribute to both the incidence of HAIs and the adverse outcomes(Nickel et al., 2025). A retrospective study done in Barnes-Jewish Hospital, from January 1, 2016, to December 31, 2019, detect that dependent predictors of 30-day in hospital mortality to be ,vasopressor use (AOR, 2.34; 95 percent CI, 1.94–2.82), Charlson Comorbidity Index (1-point increments) (AOR, 1.21; 95 percent CI, 1.18–1.24), total antibiotic treatment days(Hayley Motowski, *et al*, 2019). Similarly, another study identified the APACHE II score, advanced age, and the presence of a rapidly lethal underlying disease as independent predictors of 28-day mortality (Tsioutis *et al.,* 2016). a retrospective cohort study conducted in Italy find that invasive procedure is significantly associated with risk of HAI and intern with poor outcome (Guarente et al., 2024)

Similarly, a registry-based longitudinal study conducted in western Iran found that older age, ventilator-associated events (VAEs), BSIs, and fungal infections were strongly associated with in-hospital mortality among patients with HAIs (Iordanou *et al.*, 2017).the other cross-sectional study was conducted at two large hospitals in Kerman province, southeast Iran, from 2020 March 21 to 2021 September 21, over 18 months, Comorbid conditions such as diabetes, renal failure, and a history of surgery have also been shown to exacerbate mortality risk in ICU-acquired infections(Kermani et al., 2025). In a prospective cohort study conducted in the Critical Care Unit of Malaysia from September 2019 to March 2021, several determinants of poor outcome have been identified. Among ,hospital-acquired bloodstream infections (BSIs), advanced age, infection with multidrug-resistant (MDR) organisms, and high severity scores (SOFA) were independently associated with treatment failure and increased 28-day mortality (Rahatul et al., 2024).Also multidrug-resistant bacteria, pneumonia, sepsis, cardiovascular disease, and comorbidities to higher mortality risk (Souza *et al.*, 2015). Similarly a systematic review covering several study conducted across sub-Saharan Africa show that the high mortality burden from HAIs in Africa is a result of a synergistic effect between vulnerable patient populations with complex comorbidities, a hospital environment compromised by inadequate IPC infrastructure and device use, and the widespread presence of multidrug-resistant Gram-negative bacteria(Melariri et al., 2024)

In Ethiopia, a previously cited cohort study reported that ward type particularly admission to the ICU was a significant predictor of hospital mortality (Gidey *et al.,* 2023).also another review confirm that Diabetes mellitus, comorbidities, contaminated wound, history of UTI and history of admission in ICU were statistically significant clinical predictors of HCAIs related poor treatment outcome (Gedefie et al., 2025).

There are several studies conducted on the prevalence and risk factors of HAIs worldwide and various regions of Ethiopia. However there is a scars of comprehensive data on treatment outcome of multiple HAI and associated factors of poor treatment outcome among patient with HAI across multiple ward.

2.4. Conceptual framework

The conceptual framework for this study was developed through a review of relevant literature. It outlines various factors associated with treatment outcomes in patients with HAIs. These factors are primarily categorized into sociodemographic factors, treatment-related factors, clinical factors, and the use of invasive procedures. Additionally, the type of ward is considered as a contributing factor.

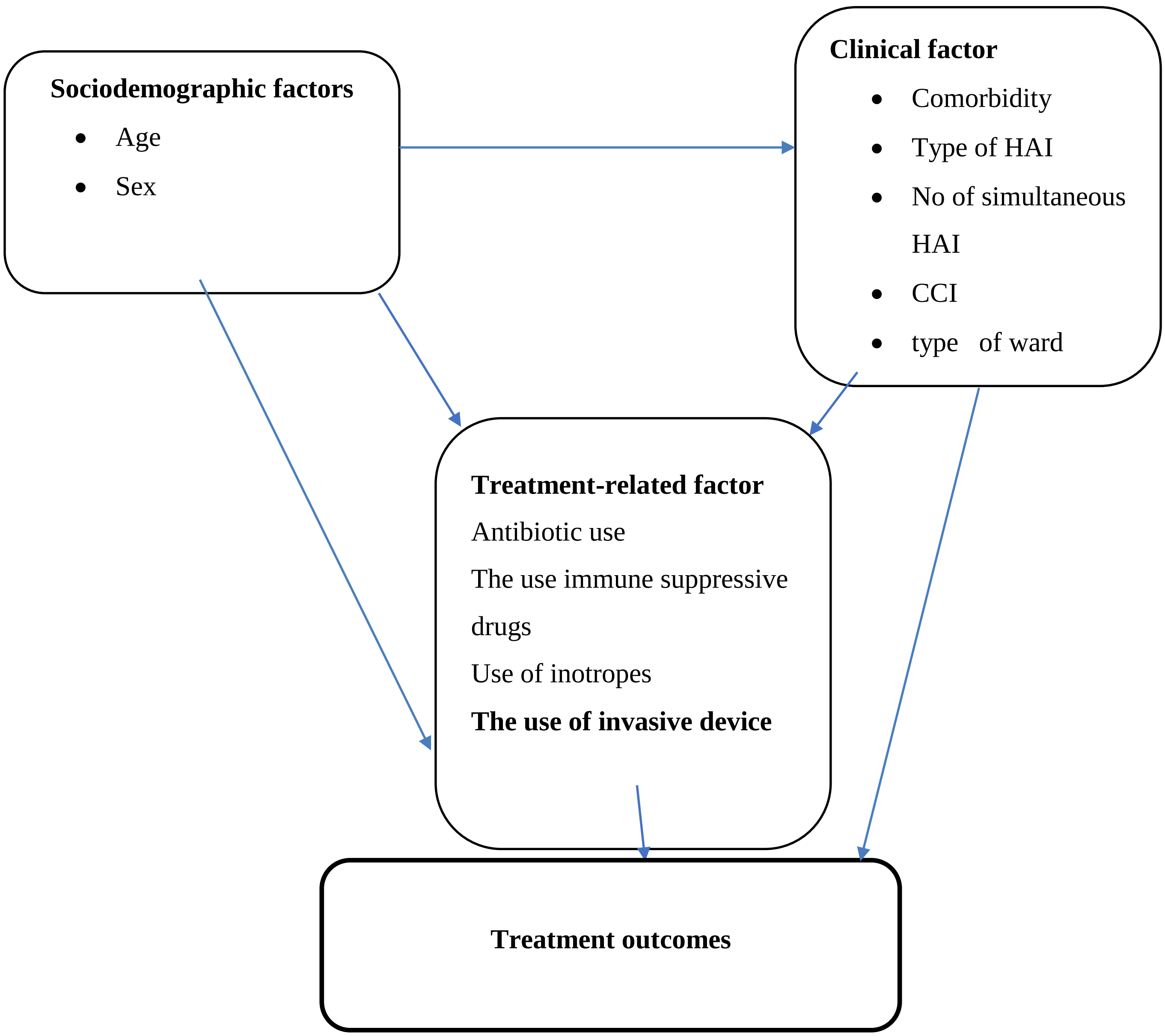

Figure 1: Conceptual framework for treatment outcomes and associated factors among patients with hospital-acquired infections.

3. METHODS AND MATERIALS

3.1. Study area and period

The study was conducted among adult patients hospitalized at Hiwot Fana Comprehensive Specialized University Hospital (HFCSH) in Harar, Eastern Ethiopia. Harar, the capital city of the Harari Region, is located 526 km east of Addis Ababa, the capital of Ethiopia, at an altitude ranging from 1,300 to 2,200 m.

HFCSH is a teaching and public referral hospital affiliated with Haramaya University, serving the entire eastern part of the country. It is the oldest hospital in Ethiopia, originally built during the Italian occupation (1928–1933). The hospital provides services to approximately 370,000–400,000 patients annually and has about 800 beds. It comprises various wards and specialized units, including pediatrics, surgery, gynecology, oncology, psychiatry, and other clinical services (Nigussie *et al.*, 2022). The study was conducted from 1 February 2024 to 30 April 2024.

3.2. Study design

A hospital-based prospective longitudinal study design was employed.

3.3. Population

3.3.1. Source population

All adult patients admitted to HFCSUH between February 1, 2024, and April 30, 2024,

3.3.2. Study population

All adult patients admitted to HFCSUH from February 1, 2024, to April 30, 2024, who met the inclusion criteria were considered for the study.

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria.

All patients hospitalized in the gynecology/obstetrics, medical, or surgical wards who stayed for at least 48 hours, or were readmitted within 30 days of surgery or within 3–5 days, were included.

3.4.2. Exclusion criteria

- Patients who were discharged against medical advice
- Those who were refused to participate /unable to communicate

- Those who were referred to other hospitals

3.5. Sample size determination

Sample sizes for the outcome variable and associated factors were calculated using the single-population proportion formula. For the treatment outcomes, a 50% prevalence of poor treatment outcomes(Nuckchady, 2021), a 5% margin of error, and a 95% confidence interval were considered in determining the sample size

$$n = \frac{Z_{\frac{\alpha}{2}}^{2} P(1-P)}{d^2}$$

Where;

n= sample size

d= margin of error = 0.05

Z = value of the standard normal distribution (Z-statistic) at 95% confidence level (z=1.96).

P = proportion of poor treatment outcome (mortality rate) = 0.5

Using this information, the sample size was calculated as follows:

$$\frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384$$

After adding for a 10% non-response rate, the final sample size was 422.

3.6. Sampling Technique and procedure

Using data from 2015 E.C. from the HMIS unit of HFCSUH, which provided baseline information to estimate the total number of admissions per ward each quarter, the total sample size of 422 was allocated proportionally as follows: gynecology/obstetrics ward (220 patients: 163 from obstetrics and 57 from gynecology), surgery ward (84 patients), and medical ward (118 patients, including 59 from internal medicine). The sampling frame was constructed by using the total number of beds with their respected bed number in each study ward by assuming 80% occupancy rate to determine the number of beds to be followed through ought the study period to achieve the allocated sample size for each ward. Subsequently, a sampling interval of K = 2 calculated from sampling frame. Then after, the first eligible study unit was selected randomly from the first room, irrespective of the study unit. The remaining eligible participants were chosen using systematic random sampling by piking every two eligible patient's bed. If a selected participant was unwilling to participate, the previous eligible patient was included as a replacement.

3.7. Data collection method

3.7.1 Data collection instrument

An organized form of questionnaire was designed based on an earlier related study to be filed by data collectors both by patient interview and and from patient's medical record (Tassew *et al.*, 2020), with all necessary adjustments made.

3.7.2 Data collectors and supervisors

Three nurses from each study ward at HFCSUH collected the data. During the data collection period, one doctor and one senior clinical pharmacist monitored the process.

3.7.3 Data collection procedure

Prior to data collection, written informed consent was obtained from each eligible participant. Data collectors administered the questionnaire using a standardized approach, ensuring that all responses were recorded accurately and completely. Each patient was reviewed from admission and daily throughout their inpatient stay for new medical records. Data entries were checked for accuracy and completeness, and completed questionnaires were securely stored until data entry was finalized.

3.8. Study variables

3.8.1. Dependent variable:

Treatment outcome

3.8.2. Independent variables

Sociodemographic factors: - Age, Sex, Occupation, Marital status, Residences, Educational level

Clinical factors: ward type, presence of chronic disease (comorbidity), length of hospital stay, type of HAI, and Charlson comorbidity index,

Treatment related factors: use of antibiotic, immunosuppressive drugs, and use of inotropes.

Procedure-related factors: exposures to invasive devices (urinary catheter, central intravascular catheter, peripheral intravascular catheter, and mechanical ventilator), patient undergoes surgery, type of surgery

3.9. Operational definition

- **Incident of HAI:** Occurrence of infection after 48 hours of hospitalization in a patient who did not have symptomatic or dormant infection on admission (Horan *et al.,* 2008).
- **BSI:** Presence of any of the following signs and symptoms—fever (>38 °C), chills/rigors, or hypotension—along with at least one positive blood culture not related to contamination.
- **Device-Associated Infections (DAI):** Subset of HAIs that occur in patients with indwelling medical devices. Defined according to CDC/NHSN surveillance criteria:
- **HAP:** Development of respiratory symptoms with at least two signs (e.g., cough, purulent sputum) and a new infiltrate on chest radiograph consistent with infection during hospitalization.
- **Healthcare-Associated Infection (HCAI):** Any infection acquired during the course of receiving healthcare in a hospital setting, including those linked to invasive procedures, medical devices, or prolonged hospitalization. This encompasses both device-associated infections and other nosocomial infections.
- **Invasive Procedure:** Any medical or surgical intervention that involves entering the body, typically by cutting the skin, inserting instruments or devices, or accessing body cavities.
- **SSI:** Development of purulent discharge, abscess, or spreading cellulitis at the surgical site within 30 days after the procedure.
- **Prior antibiotic use:** Prior antibiotic use refers to any systemic antimicrobial therapy administered to an inpatient before the date and time a hospital-acquired infection (HAI) is first clinically suspected or microbiologically confirmed during the current admission.
- **Urinary Tract Infection (UTI):**
    - Mid-stream urine cultures with $\geq 10^5$ CFU/ml, or catheter urine with $\geq 10^2$ CFU/ml, with no more than two species isolated, **OR**
    - Positive dipstick for leukocyte esterase, **OR**
    - Pyuria (≥10 WBCs/high-power field) from clean-catch urine, with or without signs and symptoms, regardless of recent catheterization.

- **Treatment Outcomes of HAI:** Classified as **good** or **poor**.
    - **Good treatment outcome:** Patients with a short hospital stay who were discharged with improvement.
    - **Poor treatment outcome:** Patients who died in-hospital or experienced a prolonged hospital stay.
- **Short Hospital Stay:** Hospital stay equal to or below days $75^{th\ percentile}$ length of stay of the study population(14day) (Mengistie *et al.*, 2022).
- **Prolonged Hospital Stay:** Hospital stay longer than the days 75^{th} percentile length of length of stay of the study population (Mengistie *et al.*, 2022).
- The Charlson Comorbidity Index (CCI) was categorized as mild (1–2) or moderate-to-severe (≥3), with conditions weighted as 1 point for myocardial infarction, heart failure, peripheral or cerebrovascular disease, dementia, chronic pulmonary or connective tissue disease, ulcer disease, diabetes without end-organ damage, or prior seropositive rheumatic disease; 2 points for diabetes with end-organ damage, renal disease, any non-metastatic tumor, or mild liver disease; 3 points for hemiplegia, moderate/severe renal disease, or AIDS; and 6 points for metastatic solid tumor, moderate/severe liver disease, leukemia, lymphoma, or metastatic cancer (Wei et al., 2023).

3.10. Data quality control

Before data collection, data collectors and supervisors received comprehensive training on the study protocol, data collection tools, ethical considerations, interview techniques, and data quality control procedures was given for two consecutive days . A pre-test was conducted on 5% of the calculated sample size at Jugal General Hospital, and necessary adjustments like, removing variables which is not valuable to meet objective and those complete data cannot be occurred were made based on the findings. The principal investigator and designated supervisors regularly monitored and supervised data collection activities. Data collectors were available for consultation and clarification of any questions or issues throughout the study period.

3.11. Data processing and analysis

The collected data were coded and cleaned using Epi Info version 7.2.5, then exported to SPSS version 27 for analysis. Quantitative variables were summarized using means and standard deviations (SD), while categorical variables were presented as proportions and percentages. Bivariate and multivariable logistic regression analyses were performed to identify factors associated with HAIs. Variables with a p-value <0.25 in the bivariate analysis were included in the multivariable model. The Hosmer-Lemeshow test was used to assess model goodness-of-fit, and results indicated a good fit ($p > 0.05$). Multicollinearity among independent variables was assessed using the Variance Inflation Factor (VIF), with no variables exceeding a VIF of 5. The strength of associations between the outcome and independent variables was expressed as odds ratios (OR) with 95% confidence intervals (CI). Variables with a p-value <0.05 in the multivariable analysis were considered statistically significant."

3.12. Ethical consideration

Ethical approval was obtained from the Haramaya University, College of Health and Medical Sciences Institutional Health Research Ethics Review Committee (IHRERC; Ref. No. IHRERC/005/2024). An official letter of cooperation was submitted to the HFCSUH medical director to obtain access to patient medical records and facilitate other research activities. Written informed consent was obtained from each participant after explaining the study's purpose, benefits, and potential risks. Confidentiality was maintained by removing names and other identifiers from data collection tools and using unique codes. Data were stored securely and used solely for the purposes of this study.

3.13. Information dissemination plan

This study will be accessible to HFCSUH, Haramaya University's School of Pharmacy, and other students or researchers for educational and research purposes. Findings are also planned to be published in peer-reviewed international journals to maximize accessibility.

4. RESULT

4.1 Socio-demographic characteristics of patients

A total of 422 patients participated, of whom 314 (74.4%) were female. 168 (39.8%) of the participants were between the ages of 18 and 30, with a mean age of (37.18) ±14.515.220.(52.1%)of participant were from Gyni/OBS ward .**(Table 2).**

Table 1: Socio-demographic characteristics of patients admitted to HFCSUH from February 1, to30 April 2024.

Variables	Category	Frequency	Percentage (%)
Sex	Male	108	25.6
	Female	314	74.4
Age (in years)	18-30	168	39.8
	31-40	113	26.8
	41-50	70	16.6
	51-60	29	6.90
	>60	42	10.0
	Gyn/OBS	220	52.1
Admitted wards	ICU	55	13.0
	Medical	63	14.9
	Surgical	84	19.9

4.2 Clinical characteristics of patients

The mean duration of hospitalization among the study population was 11.00 ± 5.023 days. The urinary catheter was inserted in 94 (22.3%) of the patients, a nasogastric tube in 31(7.30%) of the participants, and only 22 (5.20%) of the participants were on mechanical ventilation. Around 45(10.7%) of the participants had a history of use of inotropes, and 126 (29.9%) received immunosuppressive agents. Regarding comorbid conditions, 90 (21.3 %) of participants had Charlson Comorbidity Index (CCI) ≥ 3, and nearly one-fourth, 110 (26.1%) of participants had a known chronic comorbid condition. Only 29 (6.90 %) participants had two or more comorbid conditions. Chronic heart failure 44 (10.4 %), diabetes mellitus (DM) 37 (8.80 %), and hypertension 29 (6.9 %) were the predominant comorbidities (Figure 2).

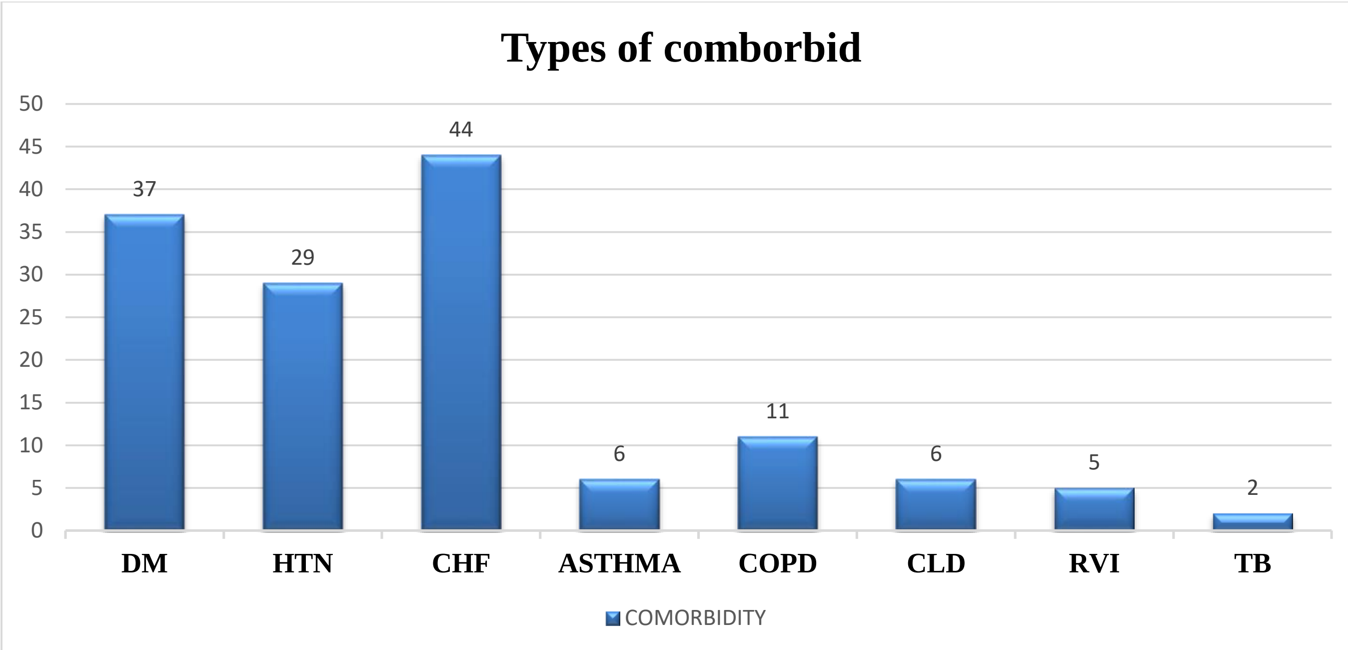

Figure 2: Comorbid conditions of patients admitted to HFCSUH from February 1, 2024, to April 30, 2024,

4.3 Prescribed medications

Around 288 (68.2%) of participants received antibiotics before a diagnosis of HAI. Metronidazole was the most frequent antibiotic received by 229 (54.3 %) of participants, which was followed by Ceftriaxone 222 (52.6 %) and Ceftazidime 91 (21.6%) (Table 3).

Table 2: Antibiotics given before the diagnosis of HAI for patients admitted to HFCSUH in Harar, eastern Ethiopia.from February 1, 2024, to April 30, 2024,

Type of antibiotics	Frequency	Percentage (%)
Metronidazole	229	54.3
Ceftriaxone	222	52.6
Ceftazidime	91	21.6
Vancomycin	66	15.6
Ampicillin	20	4.7
Cefepime	8	1.9

Others*	40	9.5

Others*: azithromycin, doxycycline, ciprofloxacin, carbapenium cephalexin

4.4 Incidence and identified types of HAIs

Out of 422 individuals, 99 (23.5%) were diagnosed with a HIA during their stay at the hospital. BSI was the most frequent HAI, accounting for 37 (37.4%) of all HAIs, followed by HAP 35 (35.4%), and UTI 19 (19.2%). Only 8(8.1%) were developed SSI **(Figure 3).**

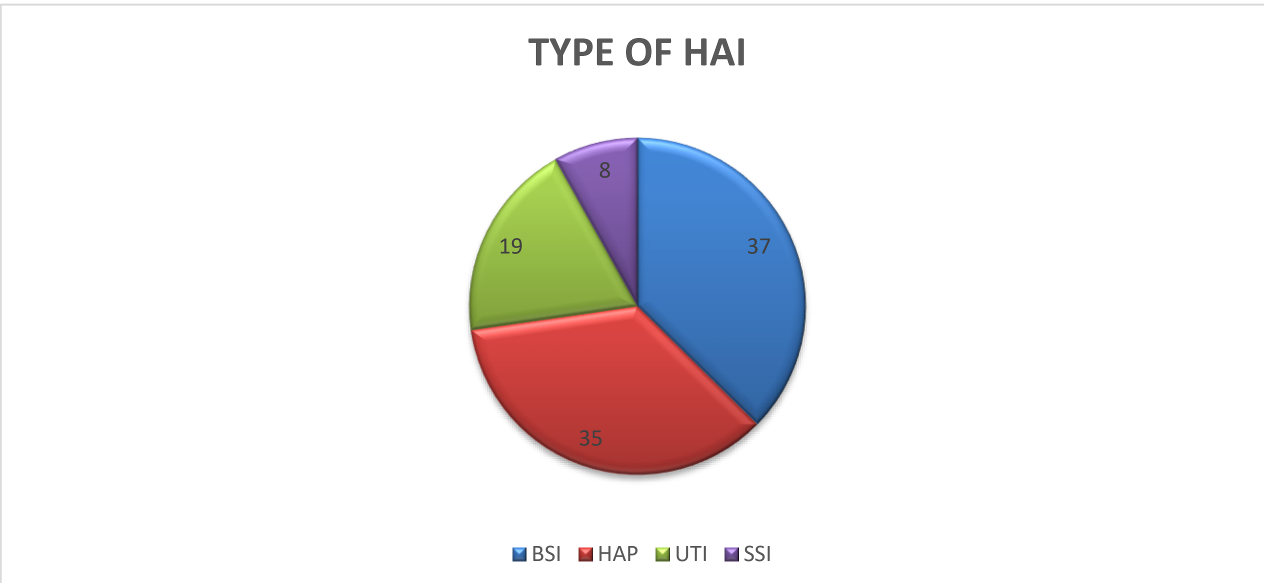

Figure 3: The type of HAI identified among patients admitted to HFCSUH from February 1, 2024, to April 30, 2024, in Harar, eastern Ethiopia.

4.5 Treatment outcomes of study participant

Of 422,participant 89 (21.1%) patients experienced poor treatment outcomes. Among the 99 patients diagnosed with HAIs, 50.5% (95% CI: 40.3-60.7) had poor outcomes. The overall in-hospital mortality rate was 19 (4.5%), however, it is as high as 8 (8.1%) among patients who developed HAIs (Figure 4). The mean duration of hospitalization identified to be 10.36 ±4.996 and 13.09±4.540 days among patient without HAI and patient with HAI respectively. (Table 4).

Table 3: Treatment outcome of participants with HAI among patients admitted to HFCSUH in Harar, Eastern Ethiopia, from February 1, 2024, to April 30, 2024.

Variables	Frequency	Percent
Hospital mortality	19	4.5
Hospital mortality among those who develope HAIs	8	8.1
Mean duration of hospitalization among patients who don't developed HIAs (Mean and SD)	10.36 ±4.996	
duration of hospitalization among patientswho developed HAIs (Mean and SD)	13.09±4.540	

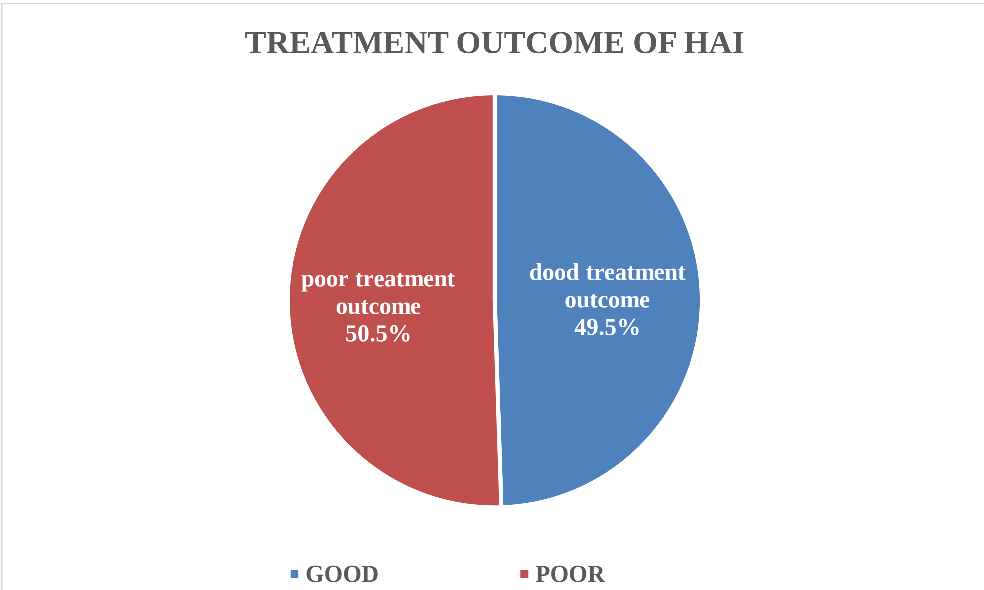

Figure 4: Treatment outcome of HAI among those patients admitted to HFCSUH, in Harar, Eastern Ethiopia from February 1, 2024, to April 30, 2024.

4.6 Factors associated with treatment outcomes of HAIs

4.6.1 Bivariate analysis

Bivariate logistic regression was performed for all independent variables, and those variable with a p-value < 0.25 were included in the multivariate logistic regression. The variables selected for multivariate analysis were use of immunosuppressive therapy, CCI ≥ 3, type of HAI, use of antibiotics prior to HAI diagnosis, and undergoing an invasive procedure **(Table 5).**

4.6.2 Multivariate analysis

Multivariate logistic regression showed that a CCI score ≥ 3 (AOR = 3.45; 95% CI: 1.02–11.57), bloodstream infection (AOR 4.57(1.06, 19.7)*), use of antibiotics before HAI diagnosis (AOR = 3.92; 95% CI: 1.18–13.06), and undergoing an invasive procedure (AOR, 3.69(1.15, 11.9)*) were significantly associated with poor treatment outcomes **(Table 5).**

Table 4: bivariate and multi variant logistic regression for factors associated with the treatment outcome of participants with HAI among patients admitted to HFCSUH in Harar, Eastern Ethiopia, from February 1, 2024, to April 30, 2024.

Variables		**Treatment outcomes of HAIs**		**COR**	**AOR**	**P-value**
		Good	**Poor**			
CCI	< 3	24	7	1	1	0.045
	≥ 3	25	43	5.90(2.22, 15.64)**	3.45(1.02, 11.6)*	
Type of HAIs	UTI	13	6	1	1	
	HAP	24	11	0.99(0.30, 3.30)	1.02(0.24, 4.304)	0.982
	SSI	4	4	2.17(0.40, 11.74)	4.1(0.50, 33.03)	0.190
	BSI	8	29	7.85(2.26, 27.26)*	4.57(1.06, 19.7)*	0.042
Use of immunosuppressive therapy	No	31	25	1	1	
	Yes	18	25	1.72(0.77, 3.84)	1.49(0.52, 4.33)	0.46
Use of antibiotics before diagnosis	No	42	29	1	1	0.026
	Yes	7	21	7.04 (2.66, 16.66)*	3.92(1.28, 13.1)*	
Performed invasive procedures	No	42	23	1	1	0.029
	Yes	7	27	7.04 (2.66, 16.7)**	3.69(1.15, 11.9)*	

Hosmer-Lemeshow goodness of fit test model was fitted with a P-value of; 0.886 *P <0.05, **P<0.001, AOR: adjusted odds ratio, CC: Charlson comorbidity index, COR: crude odds ratio, BSI: bloodstream infection, HAP: hospital-acquired pneumonia, SSI: surgical site infections, UTI: urinary tract infections

5. DISCUSSION

This study assessed treatment outcomes and associated factors among adult patients with hospital-acquired infections at HFCSUH. Nearly 25% of patients admitted to four HFCSUH units in the present study developed HAI, and 50.5% (95% CI: 40.3-60.7) of patients who did so experienced poor treatment outcomes. Antibiotic use before HAI diagnosis, invasive procedures, BSI, and CCI ≥ 3 are statistically significant factors associated with poor treatment outcomes.

This study found that 50.5% of participants with HAI had a poor treatment outcome, a higher proportion than reported in studies from Norway(4.7%) (Koch et al., 2015) and Greece (3.3%)(Kritsotakis et al., 2017). Several factors may explain this disparity,both previous studies were conducted in high-income countries, while this study was conducted in a low-income country, where weaker healthcare systems and limited access to advanced treatment options contribute to a higher burden of communicable disease–related deaths (Africa CDC, 2024).

8.1% mortality rate observed in current study among patients who developed HAIs is somehow higher than the study conducted in Ethiopia at Adama Hospital Medical College (1%) (Chernet et al., 2020). However, it was lower than studies done in Ethiopia at Tigray (14.7%) (Gidey et al., 2023), and in Saudi Arabia (33.3%) (Badger-Emeka et al., 2023). Variation in type of in comorbidities, antimicrobial resistance patterns, and sample size difference may also have contributed to the observed variation.

A higher CCI CCI score ≥ 3) score was a strong predictor of poor outcomes. With 3.45 AOR,in the current study and This finding was aligns with previous studies: at Washington University, mortality from ventilator-associated pneumonia increased with each 1-unit increment in CCI (Motowski et al., 2019); in Spain, CCI scores of 3–4 (AHR = 3.09, 95% CI: 1.24–7.24) and >5 (AHR = 4.02, 95% CI: 1.68–9.60) were significantly associated with poor outcomes (Barrasa-Villar et al., 2017); and in Australia, higher CCI scores were also associated to increased risk (COR = 1.83, 95% CI: 1.47–2.28) (Tabah et al., 2023). The cumulative burden of comorbidities including their number, type, and severity has consistently been shown to influence mortality risk (Dhakal et al., 2020; Divo et al., 2017). Age further compounds this risk, as patients ≥ 50 years receive additional CCI points; in the present study, half of those with CCI ≥ 3 were aged ≥ 51 years, reinforcing the established evidence that mortality is higher among older adults.

BSI was also found increased the odds of poor outcomes by 4.57-fold. This finding is consistent with studies done in Norway (Koch et al., 2015), in Iran (Iordanou et al., 2017), and Spain, where BSI was associated with poor outcomes (AHR = 2.49, 95% CI: 1.64–3.81) (Barrasa-Villar et al., 2017). The high mortality risk associated with BSI is largely explained by its complications, severe sepsis and septic shock, which can progress to multiple organ failure and are reported to carry mortality rates of 50–60% among elderly patients.

The study found that patients who underwent an invasive procedure (AOR = 3.69; 95% CI: 1.15–11.9) were 3.69 times more likely to experience poor treatment outcomes. This finding is consistent with evidence from Serbia, where intubation was strongly associated with poor outcomes (OR = 6.7; 95% CI: 2.74–16.37; $p < .001$) (Despotovic et al., 2020), as well as studies conducted in Pakistan (Mustafa et al., 2020), (and the United States (Zhu et al., 2022). The use of invasive devices facilitates the transmission of healthcare-associated infections, particularly those caused by resistant organisms. Mortality in patients with invasive devices has been reported to be up to four times higher compared to those without such devices (Nuckchady et al., 2021), and infections with resistant pathogens may further double the risk of death (Navasardyan et al., 2016).

In this study, prior antibiotic use (AOR = 3.92; 95% CI: 1.18–13.06) was another significant factor, with affected patients being nearly four times more likely to experience poor outcomes. Similar findings were reported at Washington University, where mortality from ventilator-associated pneumonia increased with each additional day of prior antibiotic exposure (Motowski et al., 2019), and in Italy, where receipt of empirical antibiotic therapy before HAI diagnosis (OR = 6.4; 95% CI: 2.3–17.6) was independently associated with poor outcomes (Mario et al., 2015). This association may be explained by the emergence of resistant pathogens following prior antibiotic exposure, which complicates treatment and reduces available therapeutic options.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study demonstrated that half of the patients with hospital-acquired infections experienced poor treatment outcomes. Factors significantly associated with adverse outcomes included a Charlson Comorbidity Index (CCI) score ≥3, bloodstream infections, prior antibiotic use before HAI diagnosis, and undergoing invasive procedures. These findings highlight the combined influence of comorbidities, infection type, and treatment practices on patient prognosis, underscoring the urgent need for targeted interventions to reduce mortality and improve recovery among hospitalized adults.

6.2 Recommendation

Based on the present findings, targeted interventions should focus on patients with identified risk factors for poor treatment outcomes, including those with high CCI scores, bloodstream infections, invasive procedures, and prior antibiotic exposure.

- **Enhanced screening and monitoring of high-risk patients** – Patients with CCI ≥ 3 and older adults should undergo closer clinical monitoring and early intervention to prevent poor outcomes. Comprehensive management of comorbidities may reduce complication rates and improve outcomes.
- **Strengthened infection prevention and control (IPC) measures** – To reduce the risk of bloodstream infections and device-related complications, especially in gynecology/OBS ward where devise associated infection is common, strict adherence to aseptic techniques during invasive procedures is essential. Routine assessment of device necessity and prompt removal when no longer indicated should be standard practice.
- **Optimized antibiotic stewardship** – Rational antibiotic prescribing is critical to prevent the emergence of resistant pathogens. This includes adherence to hospital antibiotic guidelines, culture-based therapy, and regular review of antibiotic regimens to minimize unnecessary exposure.

- **Early diagnosis and aggressive management of sepsis** – Given the high mortality associated with BSI-related sepsis, rapid diagnostic testing and timely initiation of evidence-based sepsis management protocols should be prioritized.
- **Capacity building in healthcare systems** – Improving diagnostic capacity, ensuring access to essential antimicrobials, and strengthening staff training in IPC and antimicrobial stewardship can substantially improve patient outcomes.

7. STRENGTHS AND LIMITATIONS

The single-center design at HFCSUH may limit the generalizability of the findings to other hospitals or regions in Ethiopia. And a prospective study make difficult to detect causal relationships between risk factors and poor treatment outcomes. Fifth, limited microbiological data prevented detailed characterization of pathogens and resistance patterns. Finally, socioeconomic factors and other contextual issues were not addressed and warrant further study. Despite these limitations, this study included all types of HAIs across multiple wards, providing a comprehensive assessment of treatment.

8. REFERENCES

17th WORLD CONGRESS ON PUBLIC HEALTH 2023,MAY 2_6 ROME ETALY -. (n.d.).

Abdela, J., Yusuf, M., Adem, F., Amin, A., Mohammedsani, B., Abdurke, M., Mehadi, A., Abdu, A., & Mohammed, H. (2025). *Incidence , predictors , bacterial isolate , antibiotic susceptibility pattern and treatment outcomes among patients who underwent major surgery in public hospitals in Eastern Ethiopia : a prospective multicenter cohort study*. *April*. https://doi.org/10.3389/fbrio.2025.1552671

Alemu, A. Y., Endalamaw, A., & Bayih, W. A. (2020). The burden of healthcare-associated infection in Ethiopia: A systematic review and meta-analysis. *Tropical Medicine and Health*, *48*(1). https://doi.org/10.1186/s41182-020-00263-2

Ali, S., Birhane, M., Bekele, S., Kibru, G., Teshager, L., Yilma, Y., Ahmed, Y., Fentahun, N., Assefa, H., Gashaw, M., & Gudina, E. K. (2018). Healthcare associated infection and its risk factors among patients admitted to a tertiary hospital in Ethiopia: longitudinal study. *Antimicrobial Resistance and Infection Control*, *7*(1), 1–9. https://doi.org/10.1186/s13756-017-0298-5

Ambrosini, K. A. (2023). *ScholarWorks @ UTRGV Catheter-associated urinary tract infections : patient characteristics , treatment , and clinical outcomes in one South Texas acute care hospital*.

Barrasa-villar, J. I., Aibar-remón, C., Prieto-andrés, P., Mareca-doñate, R., & Moliner-lahoz, J. (2017). *Impact on Morbidity , Mortality , and Length of Stay of Hospital-Acquired Infections by Resistant Microorganisms*. *65*, 644–652.

Cai, Y., Lo, J. J.-M., Venkatachalam, I., Kwa, A. L., Tambyah, P. A., Hsu, L. Y., Barnett, A., Marimuthu, K., & Graves, N. (2020). The impact of healthcare associated infections on mortality and length of stay in Singapore-A time-varying analysis. *Infection Control and Hospital Epidemiology*, *41*(11), 1315–1320. https://doi.org/10.1017/ice.2020.304

Chernet, A. Z., Dasta, K., Belachew, F., Zewdu, B., Melese, M., & Ali, M. M. (2020). Burden of healthcare-associated infections and associated risk factors at Adama hospital medical college, Adama, Oromia, Ethiopia. *Drug, Healthcare and Patient Safety*, *12*, 177–185. https://doi.org/10.2147/DHPS.S251827

Cillóniz, C., Dominedò, C., & Torres, A. (2019). An overview of guidelines for the management of hospital-acquired and ventilator-associated pneumonia caused by multidrug-resistant Gram-negative bacteria. In *Current Opinion in Infectious Diseases*. Lippincott Williams and Wilkins. https://doi.org/10.1097/QCO.0000000000000596

Czerniak, B., Banaś, W., & Budzyński, J. (2025). *HEALTHCARE-ASSOCIATED INFECTION AND UNFAVOURABLE OUTCOMES DURING A ONE-YEAR FOLLOW-UP AFTER DISCHARGE : A SINGLE-CENTER STUDY*. *38*(2), 179–189.

Dat, V. Q., Vu, H. N., Nguyen The, H., Nguyen, H. T., Hoang, L. B., Vu Tien Viet, D., Bui, C. L., Van Nguyen, K., Nguyen, T. V., Trinh, D. T., Torre, A., van Doorn, H. R., Nadjm, B., & Wertheim, H. F. L. (2017). Bacterial bloodstream infections in a tertiary infectious diseases hospital in Northern Vietnam: Aetiology, drug resistance, and treatment outcome. *BMC Infectious Diseases*, *17*(1), 1–11. https://doi.org/10.1186/s12879-017-2582-7

Diedhiou, M., Sarr, N., Dieye, A., Lo, S., Ba, E. B., Barboza, D., Dia, A. D., Dia, N. M., & Fall, M. L. (2023). Nosocomial Infections in the Intensive Care Unit of Saint Louis Regional Hospital: Status Report and Prognostic Factors of Mortality. *EAS Journal of Anaesthesiology and Critical Care*, *5*(03), 38–44. https://doi.org/10.36349/easjacc.2023.v05i03.001

Gedefie, A., Yeshanew, F., Fekadeselassie, A., Getaneh, B., Ayres, A., & Muche, A. (2025). *Magnitude of Health Care Associated Infections and its Clinical Predictors in Ethiopia : A Systematic Review and Meta-Analysis*. *8*, 1–16.

Genaneh, W., Sibhat, M., Techane, T., & Legesse, T. G. (2023). Health care-associated infections and associated factors among adult patients admitted to intensive care units of selected public hospitals, Addis Ababa, Ethiopia. *International Journal of Africa Nursing Sciences*, *18*. https://doi.org/10.1016/j.ijans.2023.100570

Gidey, K., Gidey, M. T., Hailu, B. Y., Gebreamlak, Z. B., & Niriayo, Y. L. (2023). Clinical and economic burden of healthcare-associated infections: A prospective cohort study. *PLoS ONE*, *18*(2 February), 1–11. https://doi.org/10.1371/journal.pone.0282141

Guarente, L., Mosconi, C., Cicala, M., Santo, C. De, Ciccacci, F., Carestia, M., Emberti, L., Palombi, L., Quintavalle, G., Di, D., Buonomo, E., Moramarco, S., Riccardi, F., & Orlando, S. (2024). Infection Prevention in Practice Device associated healthcare associated infection (DA- HAI): a detailed analysis of risk factors and outcomes in a university hospital in Rome , Italy. *Infection Prevention in Practice*, *6*(4), 100391. https://doi.org/10.1016/j.infpip.2024.100391

Habboush, Y., Yarrarapu, S. N. S., & Guzman, N. (2023). *Infection Control.*

Haque, M., Sartelli, M., Mckimm, J., & Bakar, M. A. (2018). *Health care-associated infections – an overview Health care-associated infections – an overview*. https://doi.org/10.2147/IDR.S177247

Hayley Motowski, MD1 Daniel Ilges, PharmD2 Nicholas Hampton, PharmD3 Marin H. Kollef, MD4 Scott T. Micek, P. (2019). *Determinants of Mortality for Ventilated Hospital-Acquired Pneumonia and Ventilator- Associated Pneumonia*. 1–10. https://doi.org/10.1097/CCE.0000000000000867

Horan, T. C., Andrus, M., & Dudeck, M. A. (2008). CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. *American Journal of Infection Control*, *36*(5), 309–332. https://doi.org/10.1016/j.ajic.2008.03.002

Hutton, G., Chase, C., Kennedy-walker, R., & Hamilton, H. (2024). Financial and economic costs of healthcare-associated infections in Africa. *Journal of Hospital Infection*, *150*, 1–8. https://doi.org/10.1016/j.jhin.2024.04.015

Iordanou, S., Middleton, N., Papathanassoglou, E., & Raftopoulos, V. (2017). Surveillance of device associated infections and mortality in a major intensive care unit in the Republic of Cyprus. *BMC Infectious Diseases*, *17*(1). https://doi.org/10.1186/s12879-017-2704-2

Karakuzu, Z., Iscimen, R., Akalin, H., Girgin, N. K., Kahveci, F., & Sinirtas, M. (2018). Prognostic risk factors in ventilator-associated pneumonia. *Medical Science Monitor*, *24*, 1321–1328. https://doi.org/10.12659/MSM.905919

Kermani, M. S., Pouradeli, S., Sadeghian, R., & Abadi, Z. M. (2025). *Exploring the impact of comorbidities and drug resistance on mortality in ICU- acquired bloodstream infections*.

Koch, A. M., Nilsen, R. M., Eriksen, H. M., Cox, R. J., & Harthug, S. (2015). Mortality related to hospital-associated infections in a tertiary hospital; repeated cross-sectional studies between 2004-2011. *Antimicrobial Resistance and Infection Control*, *4*(1). https://doi.org/10.1186/s13756-015-0097-9

Kritsotakis, E. I., Kontopidou, F., Astrinaki, E., Roumbelaki, M., Ioannidou, E., & Gikas, A. (2017). Prevalence, incidence burden, and clinical impact of healthcare-associated infections and antimicrobial resistance: A national prevalent cohort study in acute care hospitals in Greece. *Infection and Drug Resistance*, *10*, 317–328. https://doi.org/10.2147/IDR.S147459

Lastinger, L. M., Alvarez, C. R., Kofman, A., Konnor, R. Y., Kuhar, D. T., Nkwata, A., Patel, P. R., Pattabiraman, V., Xu, S. Y., & Dudeck, M. A. (2023). Continued increases in the incidence of healthcare-associated infection (HAI) during the second year of the coronavirus disease 2019 (COVID-19) pandemic. *Infection Control and Hospital Epidemiology*, *44*(6), 997–1001. https://doi.org/10.1017/ice.2022.116

Li, Y., Liu, C., Xiao, W., Song, T., & Wang, S. (2020). Incidence, Risk Factors, and Outcomes of Ventilator-Associated Pneumonia in Traumatic Brain Injury: A Meta-analysis. *Neurocritical Care*, *32*(1), 272–285. https://doi.org/10.1007/s12028-019-00773-w

Melariri, H., Freercks, R., Merwe, E. Van Der, Ham-baloyi, W. Ten, Oyedele, O., & Murphy, R. A. (2024). *Articles The burden of hospital-acquired infections (HAI) in sub-Saharan Africa : a systematic review and meta-analysis*. *71*(April), 1–16. https://doi.org/10.1016/j.eclinm.2024.102571

Mengistie, E., Ashena, T., & Seman, B. (2022). *Prevalence of Hospital Acquired Infection and Associated Factors Among Patients Admitted , at Hawassa University Comprehensive Specialized Hospital Getachew Melakie 1 , Embialle Mengistie2 , University Dep*.

Monegro, A. F., Muppidi, V., & Regunath, H. (2021). Hospital Acquired Infections.[Updated 2020 Sep 3]. *StatPearls [Internet]*. *StatPearls Publishing, Treasure Island, FL*.

Mustafa, Z. U., Tariq, S., Iftikhar, Z., Meyer, J. C., Salman, M., Mallhi, T. H., Khan, Y. H., Godman, B., & Seaton, R. A. (2022). Predictors and Outcomes of Healthcare-Associated Infections among Patients with COVID-19 Admitted to Intensive Care Units in Punjab, Pakistan; Findings and Implications. *Antibiotics*, *11*(12). https://doi.org/10.3390/antibiotics11121806

Naj, Z., Singh, A. K., & Mishra, P. K. (2024). *THE IMPACT OF HOSPITAL-ACQUIRED INFECTIONS ON PATIENT OUTCOMES*. *26*(2), 249–252.

Nickel, K. B., Kinzer, H., Butler, A. M., Maddox, K. E. J., & Fraser, V. J. (2025). *Intersection of Race and Rurality With Health Care – Associated Infections and Subsequent Outcomes*. *8*(2), 1–12. https://doi.org/10.1001/jamanetworkopen.2024.53993

Nigussie, S., Demeke, F., Getachew, M., & Amare, F. (2022). Treatment outcome and associated factors among patients admitted with acute poisoning in a tertiary hospital in Eastern Ethiopia: A cross-sectional study. *SAGE Open Medicine*, *10*. https://doi.org/10.1177/20503121221078155

Nuckchady, D. C. (2021). Incidence, Risk Factors, and Mortality From Hospital-Acquired Infections at a Hospital in Mauritius. *Cureus*. https://doi.org/10.7759/cureus.19962

Pestaña, M. Í., Pérez-García, A., & Abad, R. F. (2022). Healthcare-associated infections. *Medicine (Spain)*, *13*(56), 3267–3276. https://doi.org/10.1016/j.med.2022.05.010

Rahatul, N., Ilyani, M., & Kamalrujan, S. (2024). *The Outcome of Hospital-Acquired Bloodstream Infection and Its Associated Factors in Critical Care Unit*. *31*(6), 160–177.

Raoofi, S., Kan, F. P., Rafiei, S., Hosseinipalangi, Z., Mejareh, Z. N., Khani, S., Abdollahi, B., Talab, F. S., Sanaei, M., Zarabi, F., Dolati, Y., Ahmadi, N., Raoofi, N., Sarhadi, Y., Masoumi, M., Hosseini, B. sadat, Vali, N., Gholamali, N., Asadi, S., … Ghashghaee, A. (2023). Global prevalence of nosocomial infection: A systematic review and meta-analysis. *PLoS ONE*, *18*(1 January). https://doi.org/10.1371/journal.pone.0274248

Shahida, S. M., Islam, A., Dey, B. R., Islam, F., Venkatesh, K., & Goodman, A. (2016). Hospital Acquired Infections in Low and Middle Income Countries: Root Cause Analysis and the Development of Infection Control Practices in Bangladesh. *Open Journal of Obstetrics and Gynecology*, *06*(01), 28–39. https://doi.org/10.4236/ojog.2016.61004

Souza, E. S., Belei, R. A., Carrilho, C. M. D. de M., Matsuo, T., Yamada-Ogatta, S. F., Andrade, G., Perugini, M. R. E., Pieri, F. M., Dessunti, E. M., & Kerbauy, G. (2015). Mortality and risks related to healthcare-associated infection. *Texto e Contexto Enfermagem*, *24*(1), 220–228. https://doi.org/10.1590/0104-07072015002940013

Srinivasan, L. (2023). Healthcare-Associated Infections. *Avery's Diseases of the Newborn*, 519-533.e8. https://doi.org/10.1016/B978-0-323-82823-9.00037-4

Tassew, S. G., Woldu, M. A., Degu, W. A., & Shibeshi, W. (2020). Management of hospital-acquired infections among patients hospitalized at Zewditu memorial hospital, Addis Ababa, Ethiopia: A prospective cross-sectional study. *PLoS ONE*, *15*(4). https://doi.org/10.1371/journal.pone.0231949

Tsioutis, C., Kritsotakis, E. I., Karageorgos, S. A., Stratakou, S., Psarologakis, C., Kokkini, S., & Gikas, A. (2016). Clinical epidemiology, treatment and prognostic factors of extensively drug-resistant Acinetobacter baumannii ventilator-associated pneumonia in critically ill patients. *International Journal of Antimicrobial Agents*, *48*(5), 492–497.

Wang, J., Ji, Y., Jiang, L., Zhao, X., Guan, S., Yang, P., Yu, J., & Liu, Y. (2019). *Analysis of factors influencing hospital- acquired infection in postoperative patients with intracranial aneurysm*. 1–8.

Weiner-Lastinger, L. M., Haass, K., Gross, C., Leaptrot, D., Wong, E., Wu, H., & Dudeck, M. A. (2022). Pathogens attributed to central line-associated bloodstream infections in US acute care hospitals during the first year of the COVID-19 pandemic. *Infection Control and Hospital Epidemiology*, 1–4. https://doi.org/10.1017/ice.2022.16

WHO Surgical Site Infection Prevention Guidelines Web Appendix 3 Summary of a systematic review on decolonization with mupirocin ointment with or without chlorhexidine gluconate body wash for the prevention of Staphylococcus aureus infection in nasal carr. (n.d.).

Yeshambel, A., Id, A., Endalamaw, A., & Belay, D. M. (2020). *Healthcare-associated infection and its determinants in Ethiopia : A systematic review and meta-analysis*. 1–15.

https://doi.org/10.1371/journal.pone.0241073

Zhu, S., Wang, W., Kang, Y., He, Q., Zhang, H., Deng, Y., Cai, L., Zhang, R., Sun, X., & Zong, Z. (2022). Clinical outcomes and risk factors for mortality from ventilator-associated events: a registry-based cohort study among 30,830 intensive care unit patients. *Infection Control & Hospital Epidemiology*, *43*(1), 48–55.

ANNEX I: Questionnaires

S. No	Variables	Response	Skip/Remark
Part 1: Socio-demographic factors			
1	Sex	A. Male B. Female	
2	Age (yrs)		
3	Residence	A. Urban B. Rural	
PART III: -CLINICAL CHARACTERISTICS OF PATIENT			
11	Underlying diseases (more than one answer is possible)	A. Diabetes mellitus B. Cardiac disorders C. Chronic renal failure D. Severe malnutrition E. Hypertension F. TB G. Chronic liver disease H. Cancer I. HIV/AIDS J. Others (specify)	
12	Charlson comorbidity index	A. 0 B. 1 C. 2 D. 3 E. >4	
PART IV: Treatment outcomes			
13	Outcomes	A. Discharge with improvement B. Died	
PART V: Type of site-specific HAI			
14	Site of infection	A. Pneumonia B. Urinary tract infection C. Surgical site infections D. Antibiotic induced Diarrhea	

		E. Joint and bone infection F. Blood stream infection (Sepsis, Meningitis) G. Other, specify___________________	
PART VI: Treatment related factors			
15	Antibiotic given (full regimen) pes		
16	Change of antibiotics after diagnosis of HAI. (Full regimen)		
17	Use of steroids	A. Yes B. No	
18	Use of chemotherapy	A. Yes B. No	
19	Use of anti-retroviral drugs	A. Yes B. No	
20	Patient starts inotropic	A. Yes B. No	

ANNEX II: CURRICULUM VITAE

1. Personal Information

Name:-Fedila Shukrala Reshid

Date of birth: - 18/10/81 E.C

Place of birth: - Addis Ababa

Sex: - Female

Telephones: - 0910097913

Address: - Harar

Nationality: - Ethiopian

2. **Education Background**

Medhaniyalem primary school Addis Ababa Ethiopia 1-8

Medhaniyalem Secondary School Addis Ababa, Ethiopia from grade 9-12

Graduated from Haramaya University with B.SC Degree In Clinical pharmacy on 6th July, 2013 G.C

Cumulative GPA: I had scored 3.01 in Bachler of degree in clinical pharmacy

3. Work Experience

I have 8 years of work experience, 3, years in DilChora Referal Hospital, Dire Dewa Ethiopia as clinical pharmacist and 5 Year in Harar Health Science College Harar as assistant graduate two for one year, then as assistant lecturer for four years.

Research experience:-I have done and published research on, DOVE PRESS with a title, **Assessment of, prescribing and dispensing pattern of anti-hypertensive drugs in Hiwot Fana Specialized University Hospital (HFSUH)**

Trainings. and certifications

- ✓ *Basic ART: by CDC*
- ✓ *Family planning: by DKT.*
- ✓ *Management of drug resistant tuberculosis*: organized by Dire Dewa administration Health Bureau/TBGF
- ✓ *Health commodity management information system -Facility Edition (Dagu):* organized by Ministry Of Health, the Ethiopian pharmaceutical Supplies Agency and JSIAIDS.

Interest and hobbies

- ✓ Reading educational and religious books
- ✓ Participating in teaching and training activity
- ✓ Caring for family

4 Language skill

Language	Speak	Listen	Read	Write
Amharic	Yes	Yes	Yes	Yes
English	Yes	Yes	Yes	Yes
Oromifa	Yes	Yes	No	No

Computer Skill

Basic computer skill and Mendeley, good at browsing internet, typing, etc

Social skill: out going, working in team, organizational and motivational skill, good communication skill and eager to help others**.**

ANNEX III: APPROVAL SHEETS

HARAMAYA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Treatment Outcomes and associated factors of hospital-acquired infection among Adult Patients admitted to Hiwot Fana Comprehensive Specialized University Hospital, Harar, Ethiopia.

Submitted by: Fedila Shukrala ________ ____/___/2024

Name of student Signature Date Approved by:

Mr. Kirubel Minsamo ________ ____/___/2024

Major Advisor Signature Date

Mr. Jemal Abdela __________ ____/___/20234

Co-Advisor Signature Date

_____________________ __________ ____/___/20234

Research Thematic Area Leader Signature Date

____________________________ ___________ ___/___/2024

Chairman, DGC/SGC Signature Date

__________________________ ________________ ____/___/2024

PGPD Signature Date