ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE

DEPARTMENT OF EMERGENCY MEDICINE AND CRITICAL CARE

ASSESSMENT OF THE INCIDENCE AND PATTERN OF BACTERIAL BLOODSTREAM INFECTIONS IN INTENSIVE CARE UNITS AT TIKUR ANBESSA SPECIALIZED HOSPITAL AND ZEWDITU MEMORIAL HOSPITAL, ADDIS ABABA, ETHIOPIA: 2024

A RESEARCH THESIS SUBMITTED TO THE COLLEGE OF HEALTH SCIENCES, DEPARTMENT OF EMERGENCY AND CRITICAL CARE MEDICINE, PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR A SPECIALTY CERTIFICATE IN EMERGENCY AND CRITICAL CARE MEDICINE

INVESTIGATOR**:** DR WASSIE TSEGAYE **(**MD, ECCM PGY-3**)**

ADVISERS: DR. TEMESGEN BEYENE (MD, MPH, IHI FELLOW, CONSULTANT ECCM, ASSOCIATE PROFESSOR OF EM)

DR. FINOT DEBEBE (MD, MSC, ASSOCIATE PROFESSOR OF ECCM, INTENSIVIST)

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Principal Investigator	Dr. Wassie Tsegaye
Advisor's Name	Dr. Temesgen B (MD, MPH, IHI Fellow, Consultant ECCM, Associate professor of EM) Dr. Finot D (MD, MSC, Associate Professor of ECCM, Intensivist)
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Address of investigator	Tell 251911727516 Email: wassietsegaye07@gmail.com

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
AMR	antimicrobial resistance
ARDS	Acute respiratory distress syndrome
BSI	Bloodstream infections
CHS	College of Health Sciences
CONS	Coagulase-negative Staphylococci
ICU	intensive care unit
ER	Emergency room
MW	Medical ward
OR	Operation room
TASH	Tikur Anbesa Specialized Hospital
TBI	Traumatic brain injury
SW	Surgical ward
ZMH	Zewditu Memorial Hospital

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Abstract

Background: Bloodstream infections, particularly culture-positive bacteremia, are a significant complication for patients hospitalized in intensive care units. These infections considerably contribute to increased morbidity and death, longer hospital stays, and higher healthcare expenses. Understanding the epidemiology of bacteremia in intensive care units is critical for adopting effective prevention measures and enhancing treatment techniques.

Objective: This study aimed to determine the incidence and patterns of Bacterial Bloodstream Infections in Intensive Care Units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia.

Methodology: A retrospective chart review was conducted among 167 patients admitted to TASH and ZMH ICU from January to June 2024. Data were collected from the patient's medical records, charts, and microbiological laboratory. Descriptive statistics were used to summarize the findings, and binary logistic regression analysis was used to assess the association between the variables of interest.

Results: 167 participants underwent blood culture testing, and 51 yielded positive results. This corresponds to a cumulative incidence of 30.5% and an incidence density of 610 cases per 1,000 person-years. Blood cultures collected before antibiotic initiation (AOR 31.66, 95% CI:12.01, 83.43) and fever (AOR 2.77,95% CI:1.093,7.02) were more likely to have higher odds of a positive blood culture. Patients with retro-viral infections (RVI) (AOR 8.85, 95% CI:3.01,26.01), sepsis, and septic shock (AOR 4.5, 95% CI:1.48,13.65) and mechanical ventilation 14 days and above (AOR 26.85, 95% CI:5.48,131.5) had higher odds of death outcome.

Conclusion and recommendation: The study found a significant burden of bacterial bloodstream infections (BSIs) in the intensive care units (ICUs) of Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital. Increase infection prevention measures, encourage prudent antibiotic use, and establish routine antimicrobial resistance surveillance. The leading pathogens were Klebsiella pneumonia and Acinetobacter spp. Early blood culture collection and fever were significant predictors of BSIs. Patients with retroviral infections, sepsis, and prolonged mechanical ventilation had worse outcomes.

1. Introduction

1.1. Background

Bacterial Bloodstream Infections (BSIs) are a major cause of morbidity and mortality in Intensive Care Units (ICUs) worldwide. Patients in ICUs are particularly susceptible due to weakened immune systems, invasive procedures, and catheter use. Understanding the incidence and pattern of BSIs in ICUs is crucial for implementing effective prevention and treatment strategies.

Bacterial Bloodstream Infections (BSIs) occur when bacteria invade the bloodstream, triggering an inflammatory response with altered vital signs and blood tests, confirmed by positive blood cultures (1). Hospital-acquired infections (HAIs) are the most common complication experienced by patients worldwide during their stay in the hospital.(2) Among these HAIs, bloodstream infections (BSIs) are particularly prevalent, accounting for roughly 15-20% of all hospital-acquired infections and affecting about 1% of all hospitalized patients (3). Having a bloodstream infection significantly increased the risk of death, with 17.0% of patients passing away within 30 days.(4) The clinical consequences of antimicrobial resistance (AMR) encompass the development of more severe infections, a rise in morbidity (illness), treatment failure, and increased mortality (death). In an observational, cross-sectional, 24-hour point prevalence study done at Belgium in 2017, 54% of ICU patients globally were suspected or verified to be infected. Hospital mortality was 30% in patients with confirmed or suspected infection.(5) In a meta-analysis of sub-Saharan countries, Salmonella enterica was the most common cause of non-malaria bloodstream infections, accounting for 58.4% of all cases. Streptococcus pneumoniae, the most common isolate in children, accounted for 18.3%. (6)

1.2. Statement of the problem

Bacterial bloodstream infections (BSIs) are a major complication for patients in intensive care units (ICUs), leading to increased morbidity and mortality. Limited data exists on the current burden and characteristics of BSIs in ICUs of Addis Ababa, Ethiopia. This study aims to address this gap by investigating the incidence and pattern of BSIs in adult ICUs at

Zewditu Memorial Hospital and Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia during the year 2024.

1.3. Significance of the study

This study has important implications because Ethiopian ICUs lack data on how widespread BSIs are. This study will provide a clear picture. Doctors can make more informed decisions about antibiotics by knowing which bacteria cause most BSIs, improving patient results. The study uncovered how resistant these bacteria are to antibiotics, helping to fight this growing issue. A better understanding of BSIs was allow for targeted measures like improved infection control, ultimately saving lives. The findings can be used nationwide to develop strategies for preventing and controlling infections in Ethiopian hospitals. This study's impact extends beyond the two hospitals involved, potentially improving care in all Ethiopian ICUs. It was lay the groundwork for understanding BSIs in these critical settings, ultimately leading to better patient care and advancements in Ethiopian healthcare on a national scale.

2. Literature review

A large correlational study involving over 15,000 ICU patients across 88 countries revealed a critical issue: more than half had infections, with a concerning portion acquired during their ICU stay. This highlights the alarming prevalence of ICU infections worldwide. Among a worldwide sample of patients in ICUs in 2017, the prevalence of suspected or proven infection was 54%. The situation is further worsened by the fact that infected patients had a 30% mortality rate, and certain antibiotic-resistant bacteria posed an even greater risk of death.(7)

A major international study done in Germany in 2020 on expert statements involving over 1,100 patients found that most ICU-acquired bloodstream infections stemmed from catheters (21%), pneumonia within the hospital (21%), and abdominal infections (12%). Notably, in a quarter of cases (24%), the exact source of the infection couldn't be determined.(8)

A cross-sectional study was done on outcomes of hospital-acquired bloodstream infections (HABSI) in critically ill patients. The increasing resistance of bacteria, especially gram-negative types, to antibiotics is linked to higher death rates within 28 days of infection. Two factors worsened outcomes: not giving the right antibiotics and not addressing the source of the infection. This highlights the need for better ways to prevent HABSI, control the spread of resistant bacteria, and develop new antibiotics for these tough infections.(9)

Population-based study done worldwide Bloodstream infections (BSI) are a major health concern, with E. coli, Staphylococcus aureus, and Streptococcus pneumoniae being the top culprits. These infections strike at different rates: E. coli around 35 per 100,000 people, S. aureus at 25, and S. pneumoniae at 10. The reason for these variations likely comes down to how often blood cultures are done, a region's demographics, and the types of risk factors present in different areas. Understanding how common BSI is helps guide healthcare priorities, research, and evaluate efforts to prevent them.(10) A large European cohort study involving nearly 120,000 ICU patients revealed a critical outcome: healthcare-associated bloodstream infections and pneumonia significantly increased mortality rates. Additionally, pneumonia led to longer ICU stays. While the most common types of antibiotic resistance played a role, their impact was less pronounced compared to the infections themselves..(11)

A 20-year global study spanning from the SENTRY Antimicrobial Surveillance Program was done Between 1997 and 2016 nearly 265,000 bloodstream infections investigated the leading culprits. Staphylococcus aureus reigned as the most common pathogen until 2004, followed closely by Escherichia coli. However, after 2005, E. coli surpassed S. aureus as the predominant cause of bloodstream infections.(12)

A study done in Belgium Intensive care units (ICUs) faces a particular challenge from antibiotic-resistant bacteria. Among germs with positive gram stains, the biggest threats are methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE). For gram-negative bacteria, the main concern is a rapid rise in resistance. This includes extended-spectrum beta-lactamases (ESBLs) in Klebsiella pneumonia, E.coli, and Proteus species. Additionally, Enterobacter and Citrobacter species are showing high levels of resistance to powerful third-generation cephalosporin antibiotics. Finally, Pseudomonas aeruginosa and Acinetobacter species are becoming multidrug-resistant, meaning they are resistant to many different antibiotics.(13)

Researchers conducted a comprehensive review of existing studies (meta-analysis) to understand how common healthcare-associated infections (HAIs) are in Southeast Asia. They analyzed 41 studies out of a much larger pool (14,089). Their analysis suggests that overall, about 9% of patients (with a range of 7.2% to 10.8%) get an HAI in Southeast Asian hospitals. Additionally, they found an average of 20 HAI cases per 1,000 days spent in intensive care units (ICUs).(5)

A systematic review and meta-analysis were done There wasn't much existing information about bloodstream infections people get outside of hospitals (community-acquired) in Africa. To fill this gap, researchers looked through 3 databases for studies that tracked patients admitted to hospitals who had a blood culture test done. They found 22 relevant studies with data on over 58,000 patients. Out of these, over 5,500 (almost 10%) had bloodstream infections. Adults were more likely to have infections caused by Salmonella enterica (especially non-typhoidal types), while children more often had Streptococcus pneumoniae infections.(6)

a surveillance study done at a large urban hospital in Malawi on Trends in antimicrobial resistance in bloodstream infection isolates from 1998–2016.Nearly 30,000 pathogens were

identified from almost 200,000 blood tests. Over half (51%) of the bacteria causing infections were resistant to several common antibiotics used in Malawi as first-line treatments.

This resistance was much more frequent in gram-negative bacteria (almost 70%) compared to gram-positive ones (under 7%). There was a significant rise in bacteria resistant to two specific types of antibiotics: extended-spectrum beta-lactamase (ESBL) and fluoroquinolones. This increase was particularly sharp after 2003, reaching over 60% by 2016. On a positive note, most common gram-positive bacteria remained susceptible to at least one of the first-line antibiotics. Methicillin-resistant Staphylococcus aureus (MRSA), a type of staph bacteria resistant to a common antibiotic, showed an increase over time, from nearly 8% in 1998 to almost 18% in 2016.(14)

A systematic review analysis was done that was published between 1990 and 2019 to understand the prevalence of bacteria causing bloodstream infections in sub-Saharan Africa. It specifically focused on three common bacteria: E. coli, Klebsiella, and Salmonella, and their resistance to three powerful antibiotics: ceftriaxone, cefotaxime, and ceftazidime. The review identified 40 relevant studies, with 7 delving deeper into death rates associated with these infections. Key findings revealed a concerning trend: A significant portion of bacteria showed resistance to the three antibiotics: E. coli: Nearly 1 in 5 cases (18.4%) across 20 studies exhibited resistance. Klebsiella spp.: Over half of the cases (54.4%) based on 28 studies were resistant. Salmonella showed lower resistance, with only 1.9% of cases resistant in 12 studies. This review highlights a worrying prevalence of antibiotic resistance among common bacteria causing bloodstream infections in sub-Saharan Africa, potentially leading to more severe and potentially fatal infections.(15)

A Retrospective Study, conducted at St. Dominic Hospital in Ghana, examined bloodstream infections and antibiotic resistance patterns over nine years. The study found a relatively high rate of bloodstream infections, with over 51 positive cultures per 100,000 hospital visits. Staphylococcus aureus was the primary culprit for the first six years, but coagulase-negative staphylococcus (CoNS) became the most common cause in the final three years. Worryingly, the bacteria showed significant resistance to several antibiotics, particularly tetracyclines, penicillin's, and sulphonamides. (16)

A prospective observational study was conducted from March 2017 to February 2018 in four selected ICUs in Addis Ababa Ethiopia on Prevalence and outcome of sepsis and septic shock in intensive care units This study found that out of every 100 patients admitted to the ICU, 26.5 (or over a quarter) developed sepsis or septic shock. A total of 275 patients were diagnosed with these conditions. Respiratory infections were the most frequent culprit, causing sepsis or septic shock in over half (53.1%) of the cases. Patients typically stayed in the ICU for 5 days (with a range of 2 to 8 days), and the most commonly identified bacteria was Pseudomonas aeruginosa (present in 34.5% of cases).(17)

A cross-sectional study conducted at the University of Gondar, Ethiopia from February to May 2018 revealed a concerning rate of bloodstream infections, with a quarter (25%) of participants having positive cultures. Worryingly, nearly 70% were caused by gram-negative bacteria, which showed significant resistance to many commonly used antibiotics. Thankfully, some effectiveness remained with stronger antibiotics like amikacin, meropenem, and ciprofloxacin. The situation is particularly alarming for Staphylococcus aureus, as over half (57.1%) were resistant to methicillin (MRSA), making them highly challenging to treat. Additionally, nearly 80% of gram-negative bacteria produced enzymes (ESBL) that render many antibiotics ineffective.(18) A facility-based longitudinal study was conducted on 278 patients admitted to the adult intensive care unit of Ayder Comprehensive Specialized Hospital in Northern Ethiopia from October 2016 to October 2017. Of the total patients, 60 (21.6%) developed nosocomial sepsis. Adult ICU patients who developed nosocomial sepsis had a roughly two-fold increased risk of mortality compared to individuals who did not.(19)

prospective cross-sectional study was conducted at Arsho Advanced Medical Laboratory, Addis Ababa, Ethiopia, from January 2019 until July 2020 This research identified bacteria in over half (156) of the samples studied. Gram-negative bacteria were slightly more common, making up just over half (50.6%) of the isolates. Among the gram-negative bacteria, Klebsiella pneumoniae was the most frequently isolated (14.1%), followed by E. coli (9.0%) and Acinetobacter lwoffii (5.8%).(20)

2.1. Conceptual Fra

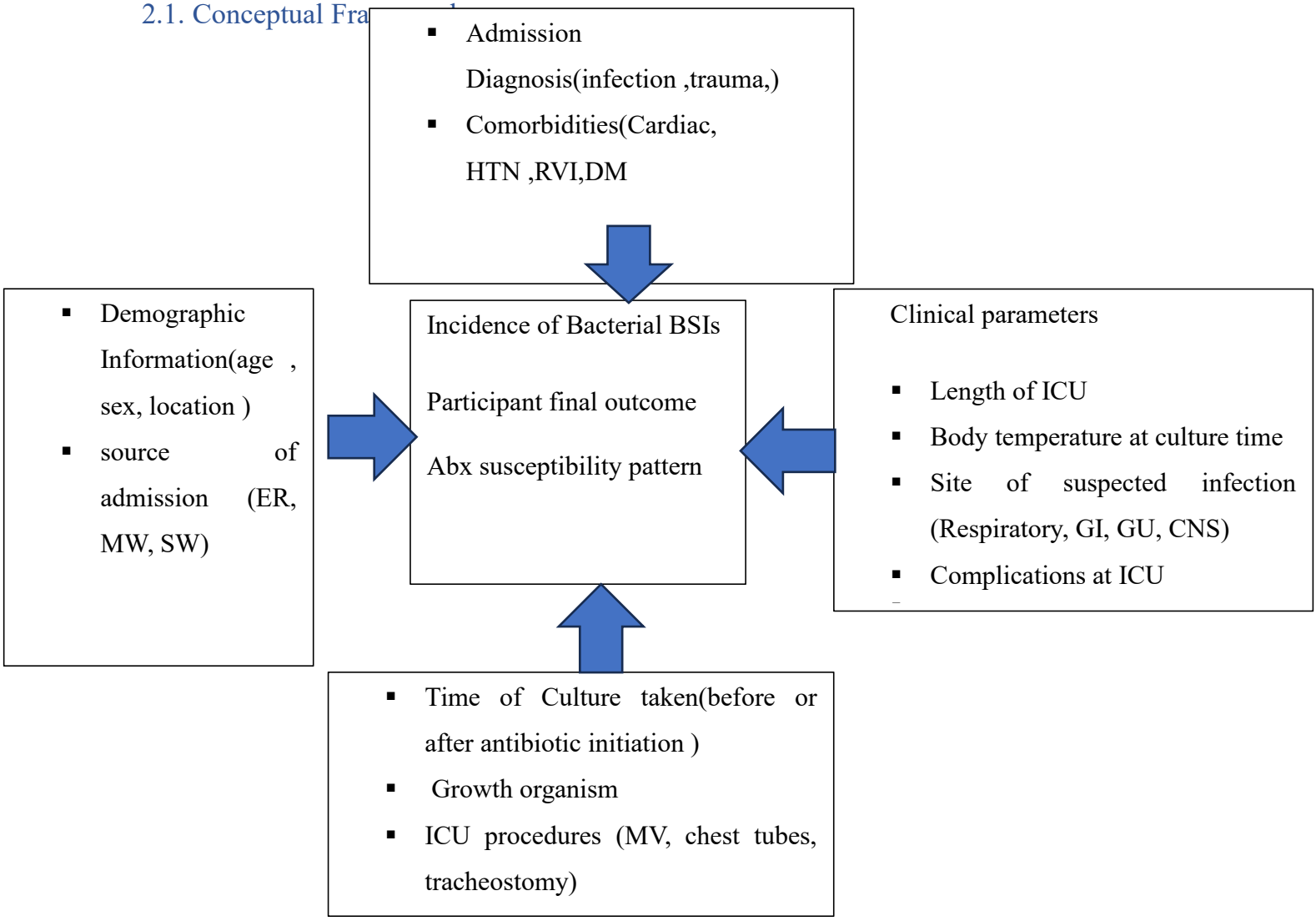


Figure 1: Conceptual Framework of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at Tikur Anbessa specialized hospital and Zewditu memorial hospital, Addis ababa, Ethiopia, Addis Ababa, Ethiopia, 2024 G.c, (n= 167) developed from related litterateurs

3. Objective of the study

3.1. General objective

To investigate the incidence and pattern of Bacterial Bloodstream Infections (BSIs) in patients admitted to Intensive Care Units (ICUs) at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital in Addis Ababa, Ethiopia during the year 2024.

3.2. Specific objective

To determine the incidence of bacterial bloodstream infections among ICU patients at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, in 2024.

To identify factors associated with bacterial bloodstream infections among ICU patients at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, in 2024.

To evaluate the antimicrobial susceptibility patterns of bacterial isolates from ICU patients at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, in 2024.

4.Methods

4.1. Study setting

Tikur Anbessa Specialized Hospital is Ethiopia's largest referral hospital and the primary teaching hospital for Addis Ababa University's School of Medicine. It was founded in 1972 and has since played a critical role in providing comprehensive healthcare services to Ethiopians. Tikur Anbessa Specialized Hospital is the largest referral hospital in the country, with 700 beds, 200 doctors, 379 nurses, and 115 other health professionals dedicated to providing health care services. There is one main ICU, Constitutes of six medical, four PICU, and six surgical ICU beds. Blood culture media commonly used in clinical laboratories include Brain Heart Infusion (BHI) broth and, to a lesser extent, Tryptone Soya Broth (TSB) and Thioglycolate broth.

ZMH one of the government hospital located in Addis Ababa open 1976. One of largest referral hospital under Addis Ababa regional health beauro. Providing different health services including emergency, ICU, medical and surgical wards. there is one main ICU for medical, surgical, pediatrics and gynecology obstetrics patients. It has 10 beds with 8 functional mechanical ventilators. The emergency and ICU service is under 3 staff emergency critical care consultants with affiliation of Tikur Anbesa emergency and critical care residents. Blood culture media commonly used in clinical laboratories include Brain Heart Infusion (BHI) broth, McConkey agar, and Chocolate agar

4.2. Study design and methods

This study was a retrospective chart review of medical records, and laboratory review conducted at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, from January 1 to June 30, 2024.

4.3 Sampling technique

This study used an institutional-based cross-sectional study design and was conducted at the ICUs of Tikur Anbessa Specialized Hospital (TASH) and Zewditu Memorial Hospital (ZMH), Addis Ababa, in August 2024.

4.4. Population

4.4.1 Target Population

All patients admitted to the intensive care unit in Ethiopia from January 1, 2024, to June 30, 2024

4.4.2 Source population

All patient admitted to intensive care unit at ZMH and TASH in Ethiopia from January 1, 2024 to June 30, 2024

4.4.3 Study population

All patients admitted to the intensive care unit and samples taken for blood culture, at TASH and ZMH in Ethiopia from January 1, 2024, to June 30, 2024

4.4.4 Sampling frame

List of patients in the intensive care unit during study period, at TASH and ZMH in Ethiopia from January 1, 2024, to June 30, 2024

4.5. Sample size

To calculate the sample size for an analytical cross-sectional study we used the expected prevalence of BSI was 28.06% from a study done in Ethiopian Tikur Anbessa Specialized Hospital, Addis Ababa in 2022.(21)

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

Where: n = sample size

Zα/2 = the standard normal deviate (set at 1.96 for a 95% level of precision)

P = the expected prevalence (set at 28.06% for this)

d = the acceptable margin of error (set at 3% for this example)

Therefore, the sample size would be: n = (1.96^2 * 0.2806 * (1 - 0.2806)) / 0.03^2 = 861.64

Rounded up to the nearest whole number, the estimated sample size would be 862

Since the sample frame is less than 10000, we use the adjustment formula, nadj. = n/ ((1+ (n/N)). Where nadj. = Adjusted sample size, n = calculated sample size, n = 862 and N = study population, N=**150**, nadj. = 862/ (1+862/150) ≈ 150, Considering the 10 % missing chart rate sample size was 167. A one-month pilot study was conducted at two hospitals to estimate the sample size. Data on patient admissions and samples for culture were collected. A statistical method was used to calculate the required sample size. To ensure fair representation, two-thirds of the sample was drawn from ZMH and TASH.

4.5. Eligibility criteria

4.5.1. Inclusion criteria

1. All patients admitted to ICU & samples taken for blood culture

4.5.2. Exclusion criteria

Patients admitted to ICU who had incomplete data are excluded

4.6. Study variables

4.6.1. Dependent variables

Incidence of Bacterial Bloodstream Infections (BSIs)

The final outcome of the participants

Antibiotic susceptibility pattern

4.6.2 Independent variables

- demography: age, gender
- comorbidity illness
- length of ICU stay

- procedure undergone
- Use of invasive devices (e.g., mechanical ventilation)
- Hospital: Zewditu Memorial Hospital or Tikur Anbessa Specialized Hospital

4. 7. Data collection and procedure

The research material was created by adapting and building upon a previous study, reviewing the old questionnaire, selecting relevant questions, and modifying them to fit the current study's objectives. New questions were added to cover specific aspects of the current research. The revised questionnaire was thoroughly reviewed to ensure it was clear, relevant, and complete. And this study involved a retrospective analysis of medical records and chart reviews from patients admitted to the ICUs at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital in Addis Ababa during the year 2024. Medical Records: Electronic medical records (EMRs) and paper charts of ICU patients admitted in 2024 were reviewed. Microbiology Laboratory Records: Data on blood cultures, including positive cultures with identification of bacterial isolates and their antimicrobial susceptibility testing results, were obtained from the respective hospital laboratories. Data was collected using a structured questionnaire on the Kobo Toolbox.

4.8. Data quality assurance

The data collectors were trained on how to collect and use the tool to gather data from patient charts and medical records. Daily supervision was carried out to ensure adherence to the data collection process. The completion of the questionnaires and the information recorded at the end of each data collection day were examined to verify data accuracy. Any errors identified were corrected immediately.

4. 9. Statistical analysis and procedure

The collected data was exported from the Kobo toolbox, it was exported to SPSS version 27 for cleaning and analysis by the principal investigator. Descriptive statistics, proportion, mean, and chi-square tests were calculated using tables and charts to characterize the study population using

socio-demographic and background characteristics. The association between each independent variable and the dependent variable was assessed in a Bi-variate logistic regression analysis

4.10. Operational definition

Incidence: The number of new cases of bloodstream infections with culture growth identified in the ICU population over the study period (six months), expressed per 1,000 person-years.

Cumulative incidence: The proportion of new bloodstream infection cases among the total number of ICU admissions during the study period, expressed as a percentage (number of new cases per 100 admissions) (5)

Pattern: The distribution of identified microorganisms, their antibiotic resistance profiles, and the clinical outcomes associated with bloodstream infections, including risk factors and trends observed.

Survived: means for this study, if they were discharged from the ICU with improved condition or transferred to a general ward from the ICU.

Common Antibiotics: Antibiotics frequently used as first- or second-line treatments in ICU settings, such as penicillins (ampicillin), cephalosporins (ceftriaxone, cefepime,ceftazidium), fluoroquinolones (ciprofloxacin), vancomycin, aminoglycosides (gentamicin, amikacin), carbapenems (meropenem), and macrolides (clindamycin).

Antimicrobial susceptibility: The sensitivity or resistance of bacterial isolates to specific antibiotics, determined by laboratory testing, indicating the effectiveness of these antibiotics in treating bloodstream infections.

4.11. Ethical consideration

A formal letter was taken from Addis Ababa University College of Health Sciences, Department of Emergency and Critical Care Medicine got approval to conduct this study. the study was conducted after obtaining ethical clearance from the department ethics committee

and Addis Ababa Health Bureau. Then, data were collected after getting an official letter of permission.

5. Results

5.1. Socio-demographic characteristics of the study participants

A total of 167 participants were included in the study with a response rate of 100%. The majority of participants were male 62.3% and the rest were females. 41.3% of the participants were aged between 40 and 60 years followed by those aged between 20 and 40 years around 38.9%. One hundred eight (64.7%) of the participants were recruited from Zewditu Memorial Hospital (ZMH), and the others were from Tikur Anbessa Specialized Hospital (TASH).

Table 1: socio-demographic characteristics of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, Addis Ababa, Ethiopia,

Variables	Category	Frequency	Percent
Sex	Male	104	62.3
	Female	63	37.7
Age in Years	<20	10	6
	20-40	65	38.9
	41-60	69	41.3
	>60	23	13.8
Hospitals	TASH	59	35.3
	ZMH	108	64.7

5.2. Source of admission, admission diagnosis and comorbidities related characteristics of the study participants

Of the total 167 participants, 87 (52.1%) were admitted to the emergency department, 51 (30.5%) to medical wards, 13 (7.8%) to surgical wards, 7 (4.2%) to the operating room, 5 (3%) to the gynecology/obstetrics ward, and 4 (2.4%) to the pediatric ward. The most common admission diagnoses were sepsis and septic shock (n = 68, 40.7%), stroke (n = 22, 13.2%), traumatic brain injury (TBI) (n = 19, 11.4%), followed by congestive heart failure, acute respiratory distress

syndrome (ARDS). The commonest comorbidities, were hypertension 26.9% cases, cardiac 25.1%) cases followed with RVI and DM, and 24.6% had no reported comorbidities.

Table 2: source of admission, admission diagnosis, and comorbidities related characteristics of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital (n=167)

Variables	categories	frequency	percent (%)
Source of Admission	ER	87	52.1
	MW	51	30.5
	SW	13	7.8
	OR	7	4.2
	GNY/OBS	5	3
	Pediatrics	4	2.4
Admission Dx	Sepsis &sptic shock	68	40.7
	TBI	19	11.4
	Stroke	22	13.2
	Congestive heart failure	16	9.6
	ARDS	12	7.2
	Sever pneumonia	11	6.6
	PTE	10	6
	GBS	10	6
	DKA	8	4.8
	General Surgical	8	4.8
	Myocardial infarction	7	4.2
	Trauma(not tbi)	3	1.8
Comorbidities	RVI	38	22.8
	HTN	45	26.9
	Cardiac	42	25.1
	DM	16	9.6
	Renal	13	7.8
	Liver	3	1.8
	Malignancy	3	1.8
	No comorbidity	42	24.6

5.3. Length of ICU stay, Duration on MV, Complication at ICU, Body T0 at time of culture taken

More than half of the participants (50.9%) had a moderate length of ICU stay (7-14 days), while 27.5% had a prolonged ICU stay (>14 days). Nearly half (47.9%) required mechanical ventilation, with most on it for less than 14 days. The most common complications were hospital-acquired infections (HAIs, 31.7%) followed by ventilator-associated pneumonia (VAP,

12.6%) and the least common reported complication was pneumothorax in around 0.6%. Around 36.5% of patients had a fever at culture collection, of them 26 participants had a fever of 38.3°C and above.

Table 3:determinants of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: Addis Ababa, Ethiopia, 2024 G.C, (n =167).

Variables	categories	frequency	percent (%)
Length of ICU stay in days	<7	36	21.6
	7-14	85	50.9
	>=14	46	27.5
On MV	Yes	80	47.9
	No	87	52.1
Duration on MV in days	<14	50	29.9
	>=14	29	17.4
Complication at ICU	HAI	53	31.7
	VAP	21	12.6
	Arrhythmia	4	2.4
	pneumothorax	1	0.6
Body Temperature at time of culture taken	<36.5	10	6
	36.5-37.5	104	62.5
	37.6-38.3	35	21
	=>38.3	26	15.5

Table 4: growth organism on the culture of the assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: Addis Ababa, Ethiopia, 2024 g.c, (n =167).

The most common organisms isolated from positive blood cultures were *Klebsiella* spp. (K. pneumonia n = 13, 7.8%; K. oxytoca n = 1, 0.6%), followed by *Acinetobacter* spp. (n = 11, 6.6%), Coagulase-negative Staphylococci (CoNS) (n = 10, 6%), *Pseudomonas aeruginosa* (n = 7, 4.2%), *Escherichia coli* (n = 4, 2.4%), *Staphylococcus aureus*, and *Enterobacter* spp. (n = 2, 1.2% each).

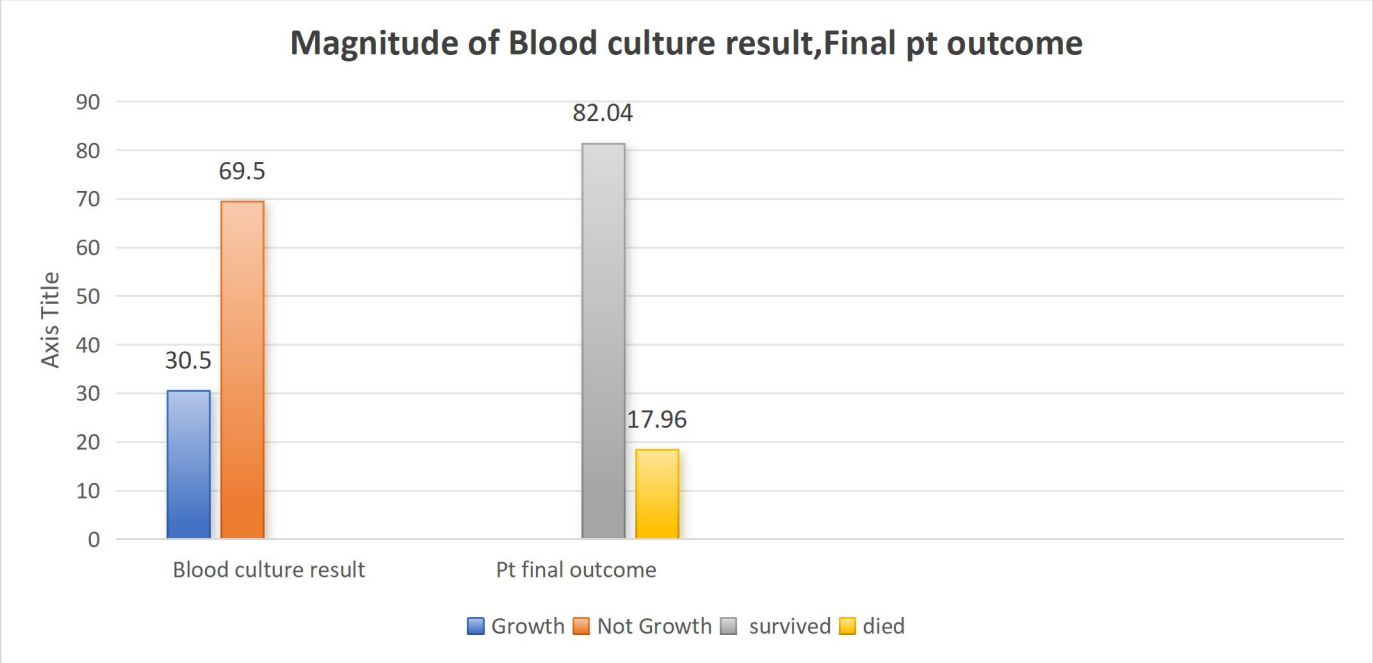
Growth organism on culture	Frequency	Percentage
No growth	116	69.5

K. pneumonia	13	7.8
Acitnobacter spp	10	6.0
Pseudomonas	7	4.2
CONS	10	6.0
Enterobacter	1	0.6
E.coli	4	2.4
S. aurus	2	1.2
K.oxytoce	1	0.6
G +ve cocci	1	0.6
Mixed growth	1	0.6
Enterobacter cloacae	1	0.6

5.4. Magnitude of Blood culture result and participant final outcome

Among the 167 participants, blood culture growth was observed in 51 cases, corresponding to a cumulative incidence of 30.5% and an incidence rate of approximately 610 cases per 1,000 person-years. Of the 51 positive blood cultures, 39 were Gram-negative bacteria, accounting for 76.5% of the total positive cultures. The remaining 12 were Gram-positive bacteria, representing 23.5% of the total positive cultures. Regarding patient outcomes, a significant majority of 137 participants (82.04%) reported as survive. Conversely, 30 participants (17.96%) were reported as died, from this 4.8% were culture positive.

Figure 2: Magnitude of Blood culture result, and final patient outcome in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: Addis Ababa, Ethiopia, 2024 G.c, (n =167)



5.5. Antibiotic susceptibility pattern

The susceptibility of various bacteria reveals that Meropenem and Amikacin were the most effective antibiotics against a wide range of organisms, including K. pneumoniae, Acinetobacter, Pseudomonas, Enterobacter, E. coli, and K. oxytoca. However, concerning levels of multidrug resistance were observed, particularly among Pseudomonas and Acinetobacter. Different types of bacteria respond differently to β-lactam antibiotics like ceftriaxone, cefepime, and ceftazidime. While some bacteria, such as *K. pneumoniae*, are highly resistant to these drugs, others, like *E. coli*, are more susceptible. Many bacteria, especially Gram-negative ones like *K. pneumoniae* and *P. aeruginosa*, are resistant to multiple antibiotics. Additionally, we've seen cases coagulase negative staphylococcus bacteria that are resistant to vancomycin. Other antibiotics, such as aminoglycosides, fluoroquinolones, and clindamycin, also have varying effectiveness against different bacteria.

Table 5:determinants of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units at tikur anbessa specialized hospital and zewditu memorial hospital, addis ababa, ethiopia: addis ababa, ethiopia, 2024 g.c, (n =167).

Bacterial isolate (Total no.)	Susceptibility	Antibiotics tested											
		Ceftiaxone	Metronidazole	Cefipime	Vancomycin	Ceftazidime	CAF	Ampicillin	Meropenem	Ciprofloxacin	Gentamycin	clindamycin	Amikacin
K. Pneumonia (n= 13)	Sensitive	2	4	4	1	1	3	3	**6**	1	4	2	6
	Resistant	7	1	7	5	8		**1**	**3**				2
Actinobacterium (n=10)	Sensitive	2	0	2	0	1	3	2	3	2	2	0	5
	Resistant	8	5	6	6	7		3	**1**				2
Pseudomonas (n= 7)	Sensitive	2	3	3	0	0	**2**	**0**	**6**	2	3	0	5
	Resistant	5	4	3	5	5		**2**	**1**				1
CONS (n=10)	Sensitive	2	4	4	1	0	**2**	**1**	**5**	1	0	1	4
	Resistant	3	2	0	**1**	1		**1**	**0**				0
Enterobacter (n=2)	Sensitive	0	2	0	0	0	**1**	**0**	**1**	0	1	1	1
	Resistant	1	0	1	1	0		**0**	**0**				0
E. coli (n= 4)	Sensitive	1	0	1	0	1	**1**	**0**	**1**	0	0	0	2
	Resistant	1	1	1	1	2		**2**	**1**				0
S. aures (n=)	Sensitive	1	2	0	2	0	**1**	**0**	**0**	0	1	0	0
	Resistant	1	0	1	0	0		**0**	**0**				0
K. Oxytoca (n= 1)	Sensitive	0	0	0	0	0	**0**	**0**	**1**	1	0	0	1
	Resistant	1	0	1	1	1		**1**	**0**				0
Gram positive cocci (n=1)	Sensitive	0	0	1	0	0	**0**	**0**	**1**	0	0	0	1
	Resistant	1	1	0	0	0		**0**	**0**				0
Mixed growth (n= 1)	Sensitive	0	1	0	1	0	**0**	**1**	1	0	1	0	1
	Resistant	1	0	1	0	1		**0**	0				0

Summary: K. pneumonia, Acinetobacter, pseudomonas and K. Oxytoca showed sig. resistance to commonly used antibiotics. There was one vancomycin resistant CONS identified

Carbapenem resistance was noted in K. pneumonia, Acinetobacter, and pseudomonas

To assess the relationship between multiple variables and a binary outcome, a multi-variable binary logistic regression analysis was conducted. Prior to this, univariate linear regression analyses were performed to evaluate the individual associations between each predictor variable and the outcome. The goodness-of-fit of the final multivariate logistic regression model was assessed using the Hosmer-Lemeshow test. The model's output included crude odds ratios (CORs) and their corresponding p-values. A p-value less than 0.05 was considered statistically significant, indicating a significant association between the predictor variable and the outcome. Additionally, 95% confidence intervals were calculated to provide a range of plausible values for the true effect size of each predictor variable.

5.6. Multi-variable logistic regression analysis predictors of assessment of the incidence and pattern of bacterial bloodstream infections in intensive care units

5.6.1 bivariable and multivariable logistics regression analysis predictors of blood culture result in ICU

The logistic regression analysis identified several significant predictors of positive blood culture results. Early blood culture collection before antibiotic initiation is crucial for accurate diagnosis of bloodstream infections. It is strongly associated with a positive blood culture result, as indicated by a high adjusted odds ratio and significant p-value. Blood culture collected before antibiotic initiation was associated with 31.66 times higher odds of growth compared to cultures collected after antibiotic initiation. Fever can also be a useful clinical indicator for identifying patients at risk of bloodstream infections. patients with fever are approximately 2.77 times more likely to have a positive blood culture compared to those without fever.

Table 6: bivariable and multivariable logistics regression analysis predictors of blood culture result in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: Addis Ababa, Ethiopia, 2024 G.c, (n =167).

Predictors	Blood Culture Result		COR (CI)	P-value	AOR (CI)	P-value
	Growth	No Growth				
Hospital-acquired infection after ICU admission						

Yes	22	31	2.08(1.043,4.15)	0.038	1.33(0.52,3.43)	0.552
No	29	85	1		**1**	
When was the blood culture taken?						
Before antibiotic initiation	44	18	34.22(13.33, 87.84)	<0.001	31.66(12.01,83.43)	<0.001
After antibiotic initiation	7	98	1		**1**	
Fever time of culture taken						
Yes	28	23	3.06(1.546,6.064)	0.001	2.77(1.093,7.021)	0.032
NO	33	83	1		1	

5.6.2 bivariable and multivariable logistics regression analysis predictors of participants' final outcome in intensive care units

The logistic regression analysis revealed several factors significantly associated with patient outcomes in the ICU. Patients with retroviral infections (RVI) were 8.85 times more likely to die compared to those without RVI. Patients with sepsis and septic shock had 4.5 times the odds of dying than those with no sepsis and sepsis and septic shock. Finally, patients on mechanical ventilation for more than 14 days and above had a 26.85 times higher likelihood of dying compared to those on ventilation for less than 14 days.

Table 7:bivariable and multivariable logistics regression analysis predictors of participant's final outcome in intensive care units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: Addis Ababa, Ethiopia, 2024 G.c, (n =167)

Predictors	Participant final outcome		COR (CI)	P-value	AOR (CI)	P-value
	Died	Survived				
RVI						
YES	17	21	7.22(3.06,17.05	<0.001	8.85(3.01,26.01)	<0.001
No	13	116			1	
TBI						
Yes	6	13	2.38(0.83,6.89	0.109	3.86(0.78,18.9)	0.098

No	24	124	1		1	
Sepsis and septic shock						
YES	18	50	2.61(1.16,5.86)	0.02	4.5(1.48,13.65)	**0.008**
No	12	87	1		1	
Cardioversion/defibrillation						
YES	5	6	4.37(1.24,15.42	0.022	4.49(0.76,26.5)	0.098
No	25	131	1		1	
Duration of mechanical ventilation						
<14days	3	47	1		1	
14 days &above	16	13	19.28(4.86,76.46)	<0.001	26.85(5.48,131.5)	<0.001
Not on MV	11	77	2.24(0.6,8.44)	0.227	4.84(1.08,21.69)	0.039

6. DISCUSSION

Bloodstream infections (BSIs) remain a significant challenge in intensive care units (ICUs), contributing to increased morbidity, mortality, and healthcare costs. Among the 167 participants, blood culture growth was observed in 51 cases, corresponding to a cumulative incidence of 30.5% and an incidence rate of approximately 610 cases per 1,000 person-years. Of the 51 positive blood cultures, 39 were Gram-negative bacteria, accounting for 76.5% of the total positive cultures. A study was conducted to investigate bloodstream infections (BSIs) in a hospital laboratory. the study population was predominantly male, with a significant proportion aged between 40 and 60 years. This demographic profile aligns with the general population trends in Ethiopia. The majority of patients were admitted to the ICU through the emergency department, Common admission diagnoses included sepsis and septic shock, stroke, followed by traumatic brain injury and heart failure. Hypertension and cardiac conditions were the most prevalent comorbidities among the participants highlighting the critical role of early diagnosis and intervention in managing severe infections. majority of patients had moderate-length ICU stays and required mechanical ventilation. Common complications included hospital-acquired pneumonia and ventilator-associated pneumonia. These findings are consistent with previous studies that have shown a high prevalence of hospital-acquired infections, particularly pneumonia, in ICU patients.(5) The association between prolonged ICU stays, mechanical ventilation, and increased risk of infection is well-established. early detection and prompt intervention may be important for preventing and managing infections in ICU patients. While it's difficult to directly compare our findings with previous studies due to different reporting methods, other studies in West Africa and other countries have reported similar or higher rates of BSIs. However, some studies have shown different patterns of bacterial infections, with Gram-positive bacteria being more common in some cases. (6) It is worth mentioning that it was not plausible to draw a direct comparison of our findings to similar studies undertaken previously in Ghana and other West African countries. we found the male gender to be more susceptible to bloodstream infections in the present study. Thus, more males 35 recorded bacteremia compared to their female counterparts 16. Our results add to a growing body of knowledge where male preponderance to bloodstream infections has been reported in previous studies. (14) Blood culture collection and fever at the time of culture taken were associated with a higher risk of

BSIs. this finding is nearly comparable to that study done with a systematic review on community-acquired bloodstream infections that is associated to fever. (6) The most common organisms isolated from blood cultures were Gram-negative bacteria, particularly K. pneumoniae, Acinetobacter spp, and coagulase-negative staphylococcus aures followed by P. aeruginosa. These findings are consistent with previous studies that were done in different countries in the world in Asia, and sub-Saharan Africa including Ethiopia but that was different in the United States of America and Canada where gram-positive organisms were predominant. (12). our findings showed the significance of taking a blood culture before antibiotic initiation was associated with a high yield of positive culture results. This is because antibiotics can kill or inhibit the growth of microorganisms in the blood, making it more difficult to isolate and identify them in a blood culture. In our study, 25.5 % (13/51) revealed Klebsiella pneumonia as the leading causative agent of bacteremia followed by *accitnobacter* (10/51 (19.6%). this is also a comparable finding that was done in Egypt that shows Klepsela the leading.(2) In contrast, however, our results contradict the findings of Labi et al. , Obeng-Nkrumah et al. , Opota et al. and in Canada (10) who reported *Escherichia coli* as the leading cause of bloodstream infections. The study demonstrated a significant association between various factors and patient outcomes. Patients with retroviral infections who require prolonged mechanical ventilation and those diagnosed with sepsis or septic shock have a significantly higher risk of adverse outcomes. possible explanation are HIV, can significantly compromise the immune system, rendering individuals more vulnerable to opportunistic infections, including those that can lead to sepsis. A weakened immune response can impair the body's ability to effectively combat infections, resulting in more severe disease and prolonged illness. Sepsis and septic shock, characterized by a systemic inflammatory response, can further exacerbate organ injury and lead to multiple organ failure. In individuals with weakened immune systems, infections may be less apparent and progress more rapidly, leading to delayed diagnosis and treatment. Prolonged mechanical ventilation, a common intervention in critically ill patients, increases the risk of ventilator-associated pneumonia and other secondary infections. This finding was comparable in a previous study done in Addis Ababa on the Prevalence and outcome of sepsis and septic shock in intensive care units that sepsis with septic shock immunocompromised patients with retroviral infections was associated with increased mortality. (17) A significant majority of participants (82.04%) demonstrated clinical improvement. Conversely, participants (17.96%) recorded as

died and Pseudomonas exhibits high resistance to most antibiotics, with some sensitivity to Meropenem, Ciprofloxacin, and Gentamicin, CONS Shows moderate resistance to most antibiotics, with some sensitivity to Meropenem and Amikacin. It highlights a concerning level of multidrug resistance. The antibiotic susceptibility testing revealed high rates of resistance to commonly used antibiotics, particularly among Gram-negative bacteria. This is also consistent with the previous study done in in Ethiopia on resistance of cefalosporins to gram negatives.(21) Meropenem and amikacin were identified as the most effective antibiotics against a wide range of organisms in this study, which was similar to the previous study. (22) Our findings also show K. pneumonia, Acinetobacter, Pseudomonas, and K. oxytoca demonstrated significant resistance to commonly prescribed antibiotics. A single instance of vancomycin-resistant Coagulase-Negative Staphylococcus (CoNS) was identified. Notably, carbapenem resistance was observed in K. pneumonia, Acinetobacter, and Pseudomonas species. the increasing prevalence of multidrug-resistant organisms necessitates the prudent use of these agents and the development of new antimicrobial therapies. Early diagnosis, prompt initiation of appropriate antimicrobial therapy, and effective infection control measures are crucial for improving patient outcomes and mitigating the impact of BSIs in ICU settings.

Limitation

This study has several limitations. Conducted in two hospitals in Addis Ababa, its findings may not be generalizable to other settings in Ethiopia. The retrospective design relied on medical records, which may have included incomplete or inconsistent data, and the small sample size limited statistical power. The six-month study period may not capture seasonal variations or long-term trends. Missing data on comorbidities and treatments could have influenced the results, while the lack of molecular analysis prevented detailed understanding of resistance mechanisms.

7. Conclusion and Recommendation

7.1. Conclusion

The study revealed a significant burden of bacterial bloodstream infections (BSI) in intensive care units (ICUs) in Addis Ababa, Ethiopia. Early blood culture collection before antibiotic initiation and fever were identified as significant risk factors for BSI development. Patients with retroviral infections, prolonged ICU stays, sepsis, and septic shock,& prolonged mechanical ventilation, were associated with poorer clinical outcomes. Gram-negative bacteria, particularly K. pneumoniae, Acinetobacter spp., and P. aeruginosa, and CONS were the most common causative agents. These organisms exhibited high levels of antibiotic resistance, emphasizing the urgent need for effective infection control measures and judicious antibiotic use. To address this critical issue, comprehensive antimicrobial stewardship programs, the development of rapid diagnostic tests, and investments in research for novel antimicrobial agents are imperative.

7.2. Recommendation

To address the significant burden of bloodstream infections (BSIs) in intensive care units (ICUs) in the study area, coordinated efforts are needed across multiple stakeholders.

Hospital Administrators

Implement robust infection prevention and control programs, including strict hygiene practices, regular equipment sterilization, and early isolation of infected patients.

Upgrade ICU infrastructure and laboratory facilities to support advanced diagnostic tests and antimicrobial susceptibility testing.

Establish data surveillance systems to monitor infection rates and resistance patterns.

ICU Healthcare Professionals

Prioritize early diagnosis by collecting blood cultures before initiating antibiotics and closely monitor high-risk patients, such as those with prolonged ICU stays ,RVI or sepsis.

Adhere to antibiotic stewardship programs to prevent misuse and minimize antimicrobial resistance.

Communicate with patients and families about infection risks and prevention strategies.

Policy Makers and Public Health Authorities

Develop a national antimicrobial resistance (AMR) surveillance system to track infection trends and resistance patterns.

Support public awareness campaigns promoting the judicious use of antibiotics and infection prevention measures.

Invest in research and development of novel antimicrobial therapies and diagnostics, ensuring alignment with global AMR strategies.

International Organizations and Collaborators

Provide technical assistance for capacity building, workforce training, and resource mobilization. Collaborate on the development of cost-effective antimicrobial solutions and ensure Ethiopian participation in global AMR surveillance efforts.

Researchers

Focus on local epidemiology by conducting studies on BSIs and resistance patterns in diverse settings.

A collective approach emphasizing infection prevention, judicious antibiotic use, and robust surveillance is critical to reducing the impact of BSIs and improving patient outcomes in Ethiopian ICUs.

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9. ANNEXES

Annex1. information

Dear Participant,

My name is Dr. Wassie Tsegaye and I am a 3rd year Emergency Medicine & Critical Care resident. I am currently doing my research on "Assessment of the incidence and pattern of Bacterial Bloodstream Infections in Intensive Care Units at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia: A 2024". The purpose of this study is to assess the incidence and pattern of Bacterial Bloodstream Infections (BSI) in Intensive Care Units (ICUs) at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital in Addis Ababa, Ethiopia.

The data collected will only be used for the purpose of this study. Confidentiality will be strictly protected and none of your response will affect you in any way. Your participation will significantly help to increase the body of knowledge in this area and vital for the success of this study but is purely voluntary. You may decline to participate in the study at any point if you choose to do so. I would like to thank you in advance for your participation. If you have any questions or need to get in touch with the researcher, please use the following contact information.

Respectfully,

Dr. Wassie Tsegaye

+251-911727516

E-mail; wassietsegaye07@gmail.com

Annex 2 : Consent form

I declare that the purpose, procedure as wells as, risks, and benefits of the study has been explained to me and I have understood. I hereby agree to take part in the study

Annex 3: Questionnaires (5)

Section 1: Demographic Information	
1.1. Participant ID:	
1.2. Age:	
1.3. Gender:	
1.4. Location (hospital)	

Section 2: source of admission
2.1 Emergency department
2.2 Medical ward
2.3 surgical ward
2.4 operational theater
2.5 gynecology/obstetrics
2.6 Pediatrics

Section 3: admission diagnosis
1. myocardial infarction

Section 3: admission diagnosis
2. congestive heart failure
3. septic shock
4. sever pneumonia
5. ARDS
6. Pulmonary embolism
7. Diabetic ketoacidosis
8. Stroke
9. Head trauma
10. General surgical
11. PTE
12. GBS
13. Sever pneumonia
14. Acute kidney injury
15. SEPSIS AND SEPTIC SHOCK
16 trauma other than TBI
Section 4: length of ICU stay (days)
1.

Section 5: comorbidities
1. RVI
2. HTN
3. CARDIAC
4. RENAL
5. Lung disease
6. NEUROLOGIC
7. DM
8. Liver disease
Section 7 site of suspected infection
1.respiratory
2.gastrointestinal
3.CNS
4.Genito-urinary
5.skin
6.unknown focus

Section 6: Procedures and related questions	**Yes**	**No**
mechanical ventilation		
Chest tube		
Central catheter		
Pleural tap		
Tracheostomy		
Cardioversion and defibrillation		
Ascetic tab		
Lumbar puncture		

Pericardiocentesis		
6.2 length of stay in the ICU in days		
6.3 duration on MV in days		
6.4 When was the sample collection	Before antibiotic initiation	After antibiotic initiation

Section 7:1 culture result	**Growth**	**No growth**
7.2growth organism on culture		
7.3 body temperature at time of culture taken		
Section 8. Previous exposure to antibiotic		
8.1Was taking antibiotics in the past 3 months		

Abx susceptibility	Ceftriaxone	Metronidazole	Vancomycin	Cefepime	Ceftazidime	Meropenem	Ciprofloxacin	Clindamycin	gentamycin	Ampicillin	CAF	CPT	All
Sensitive													
Intermediate													
resistant													

Section 10: complication after ICU admission	HA infection	VAP	Pneumothorax	Arrythmia	Catheter associated infection	None

Section 11: Final Participant Outcome	Improved and discharged	Transferred to ward	Died