ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
DEPARTMENT OF EMERGENCY AND CRITICAL CARE MEDICINE

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HOSPITAL-ACQUIRED INFECTION AND ASSOCIATED FACTORS IN EMERGENCY DEPARTMENT: CASE-CONTROL STUDY AMONG PATIENTS ADMITTED FOR MORE THAN 48 HOURS IN GOVERNMENT TERTIARY TEACHING HOSPITAL

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Declaration

I hereby declare that this thesis titled "Hospital-Acquired Infection and Associated Factors in Emergency Department: Case-Control Study Among Patients Admitted for More Than 48 Hours in a Government Tertiary Teaching Hospital" is my own original work and has not been presented for any degree or diploma at any other university or institution. I have properly credited all the sources of information utilized in this work and have secured any required permissions.

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Abbreviations/Acronym

AAU:_____Addis Ababa University

AMR:_____Anti-microbial resistance

AOR:_____Adjusted odd ratio

CAUTI:_____Catheter-associated urinary tract infection

CDC: _____Center for Disease Control and Prevention

CLABSI:_____Central Line-associated bloodstream infection

CI: _____Confidence interval

COPD:_____Chronic obstructive pulmonary disease

DM:_____Diabetes mellitus

ECDC:_____European Center for Disease Prevention and control

EEA:_____European Economic Area

ER:_____Emergency Room

ETB:_____Ethiopian Birr

EU:_____European Union

HAI:_____Hospital-acquired infection

HAP:_____Hospital-acquired pneumonia

HCAI:_____Healthcare-associated infection

HIC:_____High-income countries

HIV:_____Human immunodeficiency virus

HTN:_____Hypertension

IPC:_____Infection prevention and control

KHC:_____Kimberley Hospital Complex

LMIC:_____Low- and middle-income countries

NEDOCS:___National Emergency department overcrowding scale

SD:_____Standard deviation

SPSS:_____Statistical package for social sciences

SSI:_____Surgical site infection

TASH:_____Tikur Anbessa Specialized Hospital

USA:_____United States of America

USCDC:___United States Centers for Disease Control and Prevention

UTI:_____Urinary tract infection

VAP:_____Ventilator-associated pneumonia

WHO:_____World Health Organization

Abstract

Background

“Hospital-acquired infections (HAIs)” pose a considerable obstacle in healthcare settings, particularly in emergency departments where patient turnover is high and conditions may be chaotic. This sought to investigate “the risk factors associated with HAIs among patients admitted to Tikur Anbesa Specialized Hospital for more than 48 hours”.

Methods:

An unmatched case-control study design was employed, involving 73 cases of HAIs and 144 controls from June to October 2024. “Data were collected using structured questionnaires and analyzed using SPSS software”.

Results:

The results indicated that invasive procedures were the strongest predictor of HAIs (AOR with 95% CI of 11.593(3.833,35.067), p<0.001), followed by culture collection (AOR with 95% CI of 11.288(1.017,125.272), p=0.048) and being in the red zone (AOR with 95% CI of 7.462(1.170,47.595), p=0.033). Conversely, previous hospital admissions were associated with a decreased risk of HAIs (AOR with 95% CI of 0.267(0.071,0.999), p=0.05).

“Conclusion and recommendation”

This study highlights the significant prevalence of HAIs in the ED setting at TASH. The identified risk factors emphasize the necessity for focused strategies in infection prevention and control, particularly in high-risk areas like the red zone and for patients undergoing invasive procedures.

Keywords: Hospital-acquired infections (HAIs), Nosocomial infection, Tikur Anbesa Specialized Hospital, Emergency room, unmatched case-control.

1. INTRODUCTION

1.1. Background

“Hospital-acquired infections (HAIs)” represent a critical challenge in modern healthcare, impacting millions of patients around the globe and leading to increased morbidity, extended hospital stays, and significant healthcare costs([1]). Defined as “infections acquired after 48 hours of admission, within three days of discharge, or within a month following surgery”([2]), HAIs are often caused by multidrug-resistant microorganisms that complicate treatment efforts([1],[2]). At Tikur Anbesa Specialized Hospital (TASH), an alarming trend has emerged: prolonged emergency department (ED) stays exceeding 48 hours are becoming increasingly common. This situation raises urgent concerns, as patients in these circumstances are at heightened risk for acquiring HAIs due to various factors, including overcrowding and limited access to timely medical interventions. The research sought to investigate the specific risk factors associated with HAIs in this unique setting, ultimately seeking to enhance patient outcomes and inform strategies for infection prevention within the ED.

Despite advances in medical care, “hospital-acquired infections (HAIs) remain a leading cause of morbidity and mortality worldwide”, affecting millions annually([1]). While every hospitalized patient is at risk of developing an HAI, numerous international studies have identified various contributing factors across all settings—high, middle, and low-income countries. Key risk factors include “inappropriate use of invasive devices and antibiotics, high-risk diagnostic or therapeutic procedures, immunosuppression, severe underlying illnesses, and conditions affecting newborns and older adults”([3]). In resource-limited settings, additional challenges such as “poor water quality, sanitation issues, waste management deficiencies, environmental cleaning inadequacies, insufficient equipment, understaffing, overcrowding, and inadequate knowledge of infection prevention and control (IPC) measures” exacerbate the situation ([3]). Understanding these risk factors is crucial for developing effective prevention strategies, particularly in high-traffic areas like emergency departments. This study seeks to address the specific risk factors contributing to HAIs in emergency departments through an unmatched case-control study design.

Despite the critical nature of this issue, there is a significant absence of research particularly concentrating on the emergency room (ER) setting in “low- and middle-income countries” like “Ethiopia”. Much existing research has been conducted in developed nations, primarily concentrating on inpatient populations, leaving a significant gap in understanding HAIs in high-traffic areas like emergency departments. This study seeks to address these gaps by investigating the “risk factors associated” with HAIs among ER patients at “Tikur Anbesa Specialized Hospital (TASH)”, ultimately aiming to inform better infection prevention strategies and improve patient outcomes.

Understanding the specific causes of HAIs in this context is essential for developing targeted interventions that can reduce infection rates and improve patient outcomes while optimizing healthcare resource utilization. The findings from this study may also interest researchers, educators, and the general public. Ultimately, this research aims to add to the current body of knowledge regarding HAIs and raise awareness about this pressing issue.

This study employed a quantitative research method using an unmatched case-control design among ER patients admitted to TASH over five months. The primary objectives are:(1) to describe the various “types of hospital-acquired infections” prevalent among emergency room patients at TASH; and (2) to identify the associated “risk factors for HAIs” among these “patients” with a focus on patient-related factors, environmental conditions, and healthcare personnel practices.

The findings of this study will significantly enhance our understanding of the risk factors of HAIs in the ER environment at TASH and inform the development of evidence-based infection prevention and control strategies. Ultimately, this research aims to support local, regional, national, and international initiatives aimed at reducing HAIs and improving patient safety in healthcare settings.

1.2. Statement of the problem

Each year, “hundreds of millions of peoples” are impacted by “HAIs”, many of which are preventable([1]). In “high-income countries (HICs)”, approximately 7 out of every 100 admitted “patients” will “develop at least one HAI”, while this rate is even higher in “low- and middle-income countries (LMICs)”, where it reaches 15 out of every 100 patients([4]). Ethiopia, classified as an LMIC, faces a particularly high burden of infectious diseases compounded by limited healthcare resources. “The prevalence of HAIs in Ethiopia has been reported to be as high as 16.96%”, with certain wards experiencing even greater rates([14]). Despite this alarming statistic, “there is a notable lack of research specifically focusing on the risk factors associated with HAIs among ER patients in Ethiopia”. Previous studies have primarily concentrated on inpatient populations and surgical wards, often overlooking the unique challenges faced in emergency settings([4],[14]). This research sought to fill this critical gap by investigating the “risk factors of HAIs” among ER patients at “Tikur Anbessa Specialized Hospital in Addis Ababa”. The findings will be instrumental in developing targeted interventions and policies to mitigate the spread of HAIs, ultimately improving patient outcomes in “Ethiopia”.

1.3. Significance of the study

The study on “the risk factors of hospital-acquired infections (HAIs) among emergency room (ER) patients at Tikur Anbessa Specialized Hospital (TASH)” is significant for several reasons. First, it aims to identify specific factors contributing to HAIs in ER patients, who are particularly vulnerable due to compromised immune systems and underlying medical conditions. Existing research indicates that older age and comorbidities significantly increase HAI risk, highlighting the need for targeted investigation in this population. By focusing on ER patients in Ethiopia, this study addresses a critical gap in literature, as most prior research has concentrated on inpatient populations and surgical wards. The findings will inform healthcare providers about effective prevention and control measures tailored to the unique challenges of ER settings. “This information can lead to the development of evidence-based policies and guidelines for infection control, ultimately improving patient outcomes and reducing healthcare costs associated with treating HAIs”.

2. LITERATURE REVIEW

2.1. INTRODUCTION

Despite variations in the study settings, study types, and study populations, the disease burden and "risk factors of hospital-acquired infections" have been discussed in various literature for hospitalized patients. However, research done in the area is very scarce and resources for emergency room patients are constrained hence, this research tries to look into the literature from the limited studies.

2.2. Socio-demographics

A study was conducted at the "emergency department" of Rush University Medical Center in Chicago, Illinois, USA, to investigate the prevalence and "risk factors associated" with "multidrug-resistant Enterobacteriaceae" responsible for "urinary tract infections". As per the study, 431 patients with UTIs caused by Enterobacteriaceae participated in the process. The majority of patients were female (81%), followed by men (19%), with African Americans (52%), Caucasians (22%), Hispanics (22%), and Asians (1%) having the lowest demographics. The median age was 44 years (range: 14–101 years), and the majority of patients were female (81%) ([4]).

In addition to that a retrospective and predictive study was done "at the emergency department of surgery at Linköping University, Linköping, Sweden, on the incidence and potential risk factors for hospital-acquired pneumonia Among 4961 patients" with a hospital stay of over 48 hours, pneumonia was diagnosed in 1.8% of the patients. In the HAP group, there was a notably higher number of men compared to women (P = 0.025). However, no significant difference in mean age was observed between the HAP group and the reference group (P = 0.61). Among the patients aged over 85, 21 individuals were in the HAP group (23.3%), while the reference group had 18 patients (24.0%) ([5]).

Similarly, an investigation on "the incidence and risk factors for hospital-acquired infections was conducted at eight university-affiliated hospitals in Shiraz, Iran". In total, 323 HAIs were found among 3450 patients during the 4-point prevalence survey

periods (9.4%). “A total of 1701 male and 1742 (50.6%) female patients had their HAI status checked”. Patients' ages ranged as young as a month to 90 years old (median = 32 years). The average age of the males was 35.3 22.7% years, compared to 33.2 20.4% years for the females. Between the four analyzed seasons, no statistically significant seasonal changes in prevalence were found ([6]).

In the emergency room of a tertiary care university-affiliated hospital in Seoul, Korea, a retrospective cohort study was carried out. In the study, which ran from March 2013 to February 2015, 2532 patients were found to be eligible. They examined the data for 2189 patients after eliminating 343 patients who were either transferred from other hospitals with central line insertions or passed away in the ER. The median age of the patients was 65 (with a range of 54 to 74 years), and 58.8% of them were male ([7]).

“At the Kimberley Hospital Complex (KHC), in the Northern Cape Province of South Africa”, a point prevalence survey was carried out to determine the prevalence of healthcare-associated infections. There were 326 patients in the study. 53.4% of the patients, or 174 individuals, were female. All of the patients who were surveyed ranged in age from 28 days to 91 years, with a median age of 46. Patients aged 0 to 5 made up the largest percentage of patients (27.0%), followed by those aged 51 to 70 (23.9%) ([8]).

A matched-case control study was conducted at two teaching hospitals, “the University of Gondar and Felege-Hiwot Medical Teaching Hospitals, located in the Amhara Regional State of Ethiopia”, to investigate risk factors associated with hospital-acquired infections. The study included a total of 545 patients, comprising 109 cases and 436 controls. The median age for both cases and controls was 25 years, with interquartile ranges of 16–35 for cases and 16–36 for controls. Patients had an average hospital stay of 8 days, with an interquartile range of 4–15 days; specifically, the median length of stay was 7 days for cases and 8 days for controls. ([9]).

To identify the risk factors of “hospital-acquired infections, a longitudinal study was carried out in all wards of the Jimma University Medical Centre” from May to September 2016. The final analysis included 992 participants in total. The percentage of female participants was about 55%. The median age was 34.12 years (SD: 16.86). A majority of the participants were under 30 years old (49.20%) ([10]).

At Tikur Anbessa Specialized Hospital, the prevalence of nosocomial infections was examined among 1,006 surgical patients admitted to the surgical wards between April 1983 and January 1984. There were 273 women and 733 (72.9%) men among them. Most of the patients roughly 76% were 45 years of age or younger. The hospital stays of the patients ranged from 1 day to 509 days, with a mean of 71 days ([11]).

The disease burden of Hospital-acquired infection

The European Centre for Disease Prevention and Control (ECDC) estimated that there were 4.5 million cases of healthcare-associated infections (HAIs) annually among patients admitted to acute care hospitals in the EU and EEA, based on data from 2016 to 2017. According to the United States Centers for Disease Control and Prevention (USCDC), on any given day, one in 31 hospital patients and one in 43 nursing home residents are affected by a healthcare-associated infection. The spread of AMR and the issue of infection do not disregard long-term care facilities.4.4 million cases of healthcare-associated infections, according to the ECDC, are reported every year in EU and EEA nations. Similar to this, according to the CDC, 43 out of every 100 nursing home residents have HAIs on any given day ([3]).

To determine the "prevalence of endemic healthcare-associated infections in developing countries, a systematic review and meta-analysis" were conducted. The occurrence of healthcare-associated infections (HAIs) was significantly higher than the rates reported in Europe and the USA, which stand at 15 per 100 patients (95% CI: 126-189) based on high-quality studies. The overall density of HAIs in adult intensive care units was at least three times greater than that reported in the USA, with a combined density of 479 per 1000 patient days (95% CI 367-591). The most prevalent type of infection in hospitals was surgical site infections, with a pooled cumulative incidence of 56 per 100 surgical procedures, which is considerably higher than the rates seen in developed countries ([12]).

To estimate the extent of "healthcare-associated infections in Ethiopia" in 2020, "a systematic review and meta-analysis" were carried out. The analysis encompassed 13,821 patients across 18 studies, contributing to the overall estimation of prevalence. The pooled prevalence of healthcare-associated infections was found to be 16.96% (95% CI: 14.10-19.82). The most common types of healthcare-associated infections

included surgical site infections (39.66%), urinary tract infections (27.69%), bloodstream infections (19.9%), dual infections (surgical site and urinary tract infections) at 14.01%, and respiratory tract infections at 13.51%. Subgroup analysis revealed that the surgical, gynecology, and obstetrics wards had the highest overall prevalence, recorded at 22.42% ([13]).

2.3. Determinants of Hospital-acquired infection

The WHO report on healthcare without avoidable infections highlights the essential role of infection prevention and control (IPC). It identifies several factors contributing to hospital-acquired infections in developed countries, including inappropriate use of invasive devices and antibiotics, high-risk diagnostic or therapeutic procedures, immunosuppression, severe underlying conditions affecting newborns and the elderly, and inadequate implementation of IPC measures ([2]).

“A systematic review of the available literature on healthcare-associated infection (HAI) in Africa to better understand the burden of HAI in the region” and identify strategies for prevention and control. They found different risk factors, which in general include: limited resources and weaker infrastructures in some settings; overcrowding and understaffing in healthcare facilities; lack of adherence to infection prevention and control measures; high prevalence of antibiotic resistance; and limited availability of diagnostic tools and laboratory capacity ([14]).

“In a systematic review and meta-analysis that examines the prevalence and determinants of healthcare-associated infections (HCAIs) in Ethiopia”. The article discusses several “risk factors for healthcare-associated infections in Ethiopia”. These include underlying non-communicable diseases, prolonged hospital stays, invasive procedures, the use of invasive devices, poor infection prevention and control practices, and antibiotic misuse ([15]).

2.4. Conceptual framework

This conceptual framework illustrates the multifaceted nature of hospital-acquired infections (HAIs). The central element, HAI, is affected by a variety of factors, including the characteristics of the patients. (age, gender, occupation, etc.), clinical variables (severity of illness, reason for admission, previous hospitalizations, antibiotic use), process of care variables (hand hygiene compliance, environmental cleaning, adherence to protocols), and organizational factors (staffing levels, resource availability, workload).

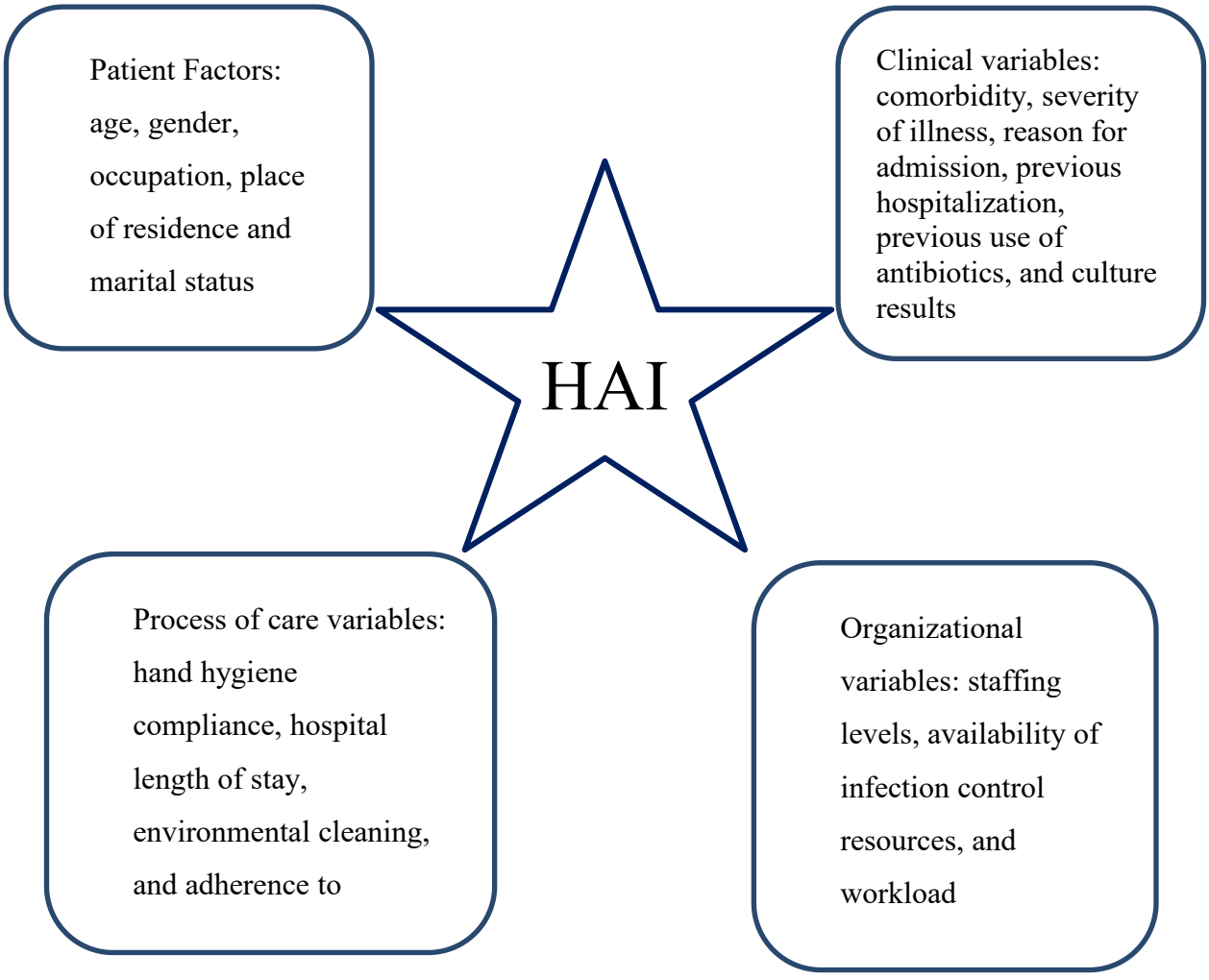

Figure 1 Conceptual Framework showing factors associated with HAI

Adapted from various litterateurs (4 - 6, 9)

3. OBJECTIVES OF THE STUDY

3.1. General objective

To describe “hospital-acquired infection and associated factors among emergency room patients at Tikur Anbessa Specialized Hospital”.

3.2. Specific objectives:

I. To describe the different types of “hospital-acquired infections prevalent among patients” who are kept for more than 48 hours in the “emergency room of Tikur Anbessa Specialized Hospital”.
II. “To identify the risk factors associated” with “hospital-acquired infection among patients” who are kept for more than 48 hours in the “emergency room of Tikur Anbessa Specialized Hospital”.

4. RESEARCH METHODOLOGY

4.1. Study setting

TASH, the largest specialized hospital in Ethiopia, serves a diverse and high-volume patient population from across the country([17]). With over 700 beds and a focus on emergency care, TASH provides a unique setting to investigate hospital-acquired infections (HAIs) in a high-risk group([17]). Given Ethiopia's high infectious disease burden and limited healthcare resources, insights from this study have the potential to inform infection prevention strategies both locally and nationally.

4.2. Study Design and Period

“An unmatched case-control study design” was employed to investigate the “risk factors associated with hospital-acquired infections (HAIs)” among 73 cases (patients with “hospital-acquired infections”) and 144 controls (“patients without hospital-acquired infections”) kept at “emergency department (ED) at Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, Ethiopia” between June 1 and October 31, 2024.

4.3. Sampling Technique

For this study the researcher used Convenience sampling technique.

4.4. Population

4.4.1. **Source Population**:

The study's source population consists of all patients who were admitted to the Emergency Department of Tikur Anbesa Specialized Hospital (TASH) for more than 48 hours during the defined study period, which spans from June 1 to October 31, 2024.

4.4.2. **Sample Population**:

The unit of analysis for this study was the individual patient, including both cases (patients with hospital-acquired infections) and controls (patients without hospital-acquired infections).

4.5. Sample size

"The sample size for this study was determined using a sample size calculator for an unmatched case-control study design based on Kelsey et al.'s" (2007) methods in observational epidemiology. Using a previously done study in inpatient setup from Ethiopia(18) the odd ratio for various significant risk factors was computed as shown in table 1 below and the highest sample size 365 participants (73 cases and 292 controls) was chosen as a final sample size. However, due to the short duration of the study period, only 217 participants (73 cases and 144 controls) were ultimately enrolled.

Table 1 Sample size calculation

Factors	**Power**	**Ratio**	**Proportion of exposures Among controls**	**CI**	**OR**	**Proportions of exposure among cases**	**Case**	**Control**	**Total**
Immune-suppression	80	1:4	21.1	95%	2.34	38.49	61	241	302
Antibiotics use	80	1:4	67.4	95%	8.63	94.69	27	105	132
Invasive procedures (central line)	**80**	**1:4**	**0.9**	**95%**	**6.92**	**5.91**	**73**	**292**	**365**
Surgery	80	1:4	33.5	95%	2.35	54.21	54	215	269

4.6. Eligibility Criteria

4.6.1. Inclusion Criteria:

- Patients presenting to the "emergency room at Tikur Anbessa Specialized Hospital"
- Patients over the age of 13 years

4.6.2. Exclusion Criteria:

- Patients receiving prophylactic antibiotics
- "Patients admitted to hospital for more than 48 hours" before ER presentation

- Prisioner
- Pregnant women

4.7. Study Variables

4.7.1. Dependent Variable

"Hospital-acquired infection"

4.7.2. Independent Variables

- Demographic Variables: Age, gender, occupation, and marital status
- Process of Care Variables: Hand hygiene compliance, hospital length of stay, environmental cleaning practices, and adherence to infection prevention guidelines
- Organizational Variables: Staffing levels, availability of infection control resources, and workload
- Clinical Variables: Commodities, the severity of illness, reason for admission,
- previous hospitalization, previous antibiotic use, and blood culture results

4.8. Data collection tool and procedure

"The data collection tool" was adapted from previously conducted research studies ([18], [19], [20], [21]). Data collection was performed using KoboToolbox, an open-source data collection platform. Trained data collectors, including nurses, interns, and residents, utilized a structured questionnaire to gather demographic information, process of care variables, and organizational variables through interviews with patients or their caregivers. Additionally, responses regarding clinical variables were triangulated with the patients' medical records to ensure accuracy and reliability.

4.9. Data quality assurance

A pilot test was conducted with 5% of the sample size one week prior to the actual data collection. Feedback from both study participants and data collectors indicated no significant concerns regarding the questionnaire used, aside from some minor rearrangements of questions to improve its structure. Data collectors received training on the use of KoboToolbox, and daily supervision was conducted to ensure data quality.

The accuracy of the collected data was verified through regular reviews of completed questionnaires. Any errors or inconsistencies identified were corrected promptly.

4.10. Statistical analysis and procedure

Data collected using KoboToolbox was exported “to SPSS version 26 for Windows”. Descriptive statistics (frequencies and percentages) were used to summarize categorical variables. “Binary logistic regression was used to identify” predictors of hospital-acquired infections (HAIs). “Variables with a p-value of less than 0.2 in binary logistic regression analysis” were included in the “multivariable logistic regression model”. Model fit was assessed using the “Hosmer-Lemeshow goodness-of-fit test”. A p-value less than 0.05 was considered statistically significant.

4.10.1. Operational definitions

These definitions were used to ensure consistency and accuracy in the research:

- “Hospital-Acquired Infection (HAI)”: An infection acquired during a hospital stay, typically diagnosed 48 hours or more after admission, within three days of discharge, or one month post-operatively. These include:

    - ✓ “Catheter-Associated Urinary Tract Infection (CAUTI): A urinary tract infection that develops in a patient who has a urinary catheter”.
    - ✓ “Central Line-Associated Bloodstream Infection (CLABSI): A bloodstream infection that occurs in a patient who has a central line”.
    - ✓ “Surgical Site Infection (SSI): An infection that occurs at the surgical site within 30 days of surgery”.
    - ✓ “Ventilator-Associated Pneumonia (VAP): A type of pneumonia that develops in a patient who is on a ventilator”.

- Adult: Individuals aged 13 years and older.
- Case: a patient with hospital acquired infection.
- Control: a patient without hospital acquired infection.

4.11. Ethical consideration

Before data collection, ethical approval was obtained from the “Emergency Medicine Department at Tikur Anbessa Specialized Hospital and the Institutional Review Board of the School of Medicine at Addis Ababa University”. “Informed consent was obtained from all participants. Participants were assured of their right to withdraw from the study at any time”. A brief explanation of the study's objectives was provided to each participant before the data collection instruments. To ensure confidentiality, personal identifiers were removed from the data, and access to the data was restricted to authorized personnel.

5. RESULTS

5.1. Demographics of the participants

The study included a total of 217 participants, comprising 94 females (43.3%) and 123 males (56.7%). Among the 73 cases, there were 32 females (43.8%) and 41 males (56.2%), while the control group consisted of 144 individuals, including 62 females (43.1%) and 82 males (56.9%). The age distribution revealed that the largest group of participants fell within the 35-54 years category, accounting for 39.2% of the total, whereas the smallest group was aged between 13 and 17 years, comprising only 2.8%. Marital status data indicated that the majority of participants were married (77.4%), followed by single individuals (15.7%), with a small proportion being widowed (4.6%) or divorced (2.3%). In terms of occupation, government employees represented the largest group at 29.5%, followed closely by housewives at 24%. Regarding residence, a significant majority of participants lived in urban areas (72.8%), with similar trends observed among both cases (80.8% urban) and controls (68.8% urban).

Table 2 Socio-demographics characteristics of participants admitted to TASH of "Addis Ababa, Ethiopia" emergency room from June 1 - October 31, 2024 (n=217)

Varriables		Cases		Controls	
		frequency	percent	frequency	percent
Gender	female	32	43.8%	62	43.1%
	male	41	56.2%	82	56.9%
Age	13-17	2	2.7%	4	2.8%
	18-34	14	19.2%	46	31.9%
	35-54	32	43.8%	53	36.8%
	55-64	12	16.4%	26	18.1%
	65-74	8	11.0%	9	6.3%
	75 years and above	5	6.8%	6	4.2%
Marital status	divorced	2	2.7%	3	2.1%
	married	57	78.1%	111	77.1%
	single	9	12.3%	25	17.4%
	widowed	5	6.8%	5	3.5%
Occupation	driver	3	4.1%	5	3.5%
	farmer	5	6.8%	18	12.5%
	government_employee	17	23.3%	47	32.6%
	house_wife	21	28.8%	31	21.5%
	laborer	1	1.4%	1	.7%
	others	5	6.8%	1	.7%
	privet_job	9	12.3%	18	12.5%
	student	9	12.3%	17	11.8%
	unemployed	3	4.1%	6	4.2%
Place of residence	rural	14	19.2%	45	31.3%

Varriables		Cases		Controls	
	urban	59	80.8%	99	68.8%

5.2. Distribution of Hospital-Acquired Infections Among Emergency Room Patients

As shown in Table 3, the majority of participants were female (41.1%). “Hospital-acquired pneumonia (HAP)” was the most common infection, affecting 67.1% of patients. While females had a higher prevalence of CLABSI, the overall distribution of HAI types was similar between genders.

The 35-54 age group was the most prevalent, accounting for 43.8% of all patients and 65.3% of all HAIs. Younger age groups (13-17 and 18-34) had a higher prevalence of CAUTI, while older age groups (65-74 and 75 years and above) had a higher incidence of other HAI types.

Married individuals represented the largest group of patients with hospital-acquired infections (HAIs), comprising 54.7% of the total. They primarily experienced HAP (54.7%) and CAUTI (21.9%). Single individuals presented a more diverse range of HAI types, including HAP (5.4%), CAUTI (2.7%), combined HAP and CAUTI (1.3%), and CLABSI (2.7%). Widowed individuals were primarily affected by HAP (4.1%) and CAUTI (2.7%). Divorced individuals primarily experienced HAP (2.7%). While married individuals had the highest number of HAIs, the distribution of HAI types was relatively consistent across all marital statuses. HAP remained the most prevalent type of infection, followed by CAUTI.

The data reveals that housewives and government employees constituted the largest occupational groups among the 73 patients with HAIs. HAP was the most prevalent type of HAI, accounting for 54.8% of all cases. While certain occupations, like students, exhibited a wider range of HAI types, HAP remained the most prevalent infection across all occupational groups.

Urban residents constituted the majority of patients (cases), accounting for 59 out of 73 (80.8%). From Urban patients, 40 (67.8%) had HAP followed by CAUTI 18 (30.5%) and 1 (1.7%) patient had both HAP+CAUTI. And from patients from the rural areas

HAP is still the most common taking 9 (64.3%) followed by CLABSI and CAUTI each 2(14.3%) and 1(7.1%) had both HAP and CAUTI. While urban residents were more numerous, the distribution of HAI types was relatively similar between rural and urban populations. HAP remained the most common type of infection in both groups.

As shown from Table 3 the short-stay ward had the highest number of patients (65), accounting for 89.0% of all patients (cases). HAP was the most prevalent type of HAI, accounting for 67.1% (49/73) of all infections.

Table 3 Distribution of different types of HAIs among cases admitted to TASH of Addis Ababa, Ethiopia emergency room from June 1 - October 31, 2024 (n=73)

Variable		Types of HAIs							
		CAUTI		CLABSI		HAP		HAP+CAUTI	
		frequency	percent	frequency	percent	frequency	percent	frequency	percent
Gender	Female	10	13.69%	2	2.7%	19	26%	1	1.3%
	Male	10	13.69 %	0	0 %	30	41 %	1	1.3%
Age	13-17	1	1.3%	0	0%	0	0%	1	1.3%
	18-34	2	2.7%	2	2.7%	10	13.69%	0	0%
	35-54	9	12.3%	0	0%	23	31.5%	0	0%
	55-64	4	5.4%	0	0%	8	10.9%	0	0%
	65-74	3	4.1%	0	0%	4	5.4%	1	1.3%
	≥ 75	1	1.3&	0	0%	4	5.4%	0	0%
Marital status	Divorced	0	0%	0	0%	2	2.7%	0	0%
	Married	16	21.9%	0	0%	40	54.8%	1	1.3%
	Single	2	2.7%	2	2.7%	4	5.4%	1	1.3%
	Widowed	2	2.7%	0	0%	3	4.1%	0	0%
Occupation	Driver	1	1.3%	0	0%	2	2.7%	0	0%
	Farmer	0	0%	0	0%	5	6.8%	0	0%
	Government employee	7	9.6%	0	0%	9	12.3%	1	1.3%
	House-wife	7	9.6%	0	0%	14	19.1%	0	0%
	Laborer	0	0%	0	0%	1	1.3%	0	0%
	Privet-job	2	2.7%	0	0%	7	9.6%	0	0%
	Student	2	2.7%	2	2.7%	4	5.4%	1	1.3%
	Un-employed	0	0%	0	0%	3	4.1%	0	0%
	Under pension	1	1.3%	0	0%	3	4.1%	0	0%
	Out of job due to health	0	0%	0	0%	1	1.3%	0	0%

Place of residence	Rural	2	2.7%	2	2.7%	9	12.3%	1	1.3%
	Urban	18	24.6%	0	0%	40	54.8%	1	1.3%
Ward	Red	3	4.1%	0	0%	4	5.4%	0	0%
	Short stay ward	17	23.2%	2	2.7%	45	61.64%	1	1.3%
	Waiting	0	0%	0	0%	0	0%	1	1.3%

5.3. Factors Associated with Hospital-Acquired Infections among Emergency Room Patients

Table 4 Multivariate analysis result

Variables	AOR with (95% CI)	P-value
Previous hospital admission	0.267(0.71,0.999)	0.050
Culture taken	11.288(1.017,125.272)	0.048
Invasive procedure	11.593(3.833,35.067)	0.000
Ward		
Red	7.462(1.170,47.595)	0.033
Waiting	0.069(0.009,0.549)	0.011

As shown in Table 4, four of the independent variables made a unique statistically significant contribution to the model: invasive procedures, previous hospital admission, culture taken, and ward. The strongest predictor of hospital-acquired infection (HAI) was invasive procedure, with an odds ratio of 11.593 (95% CI: 3.833 - 35.067, $p < 0.001$). This indicated that patients who underwent an invasive procedure were over 11 times more likely to develop HAI compared to those who did not, controlling for all other factors in the model.

Patients in the red zone were also at significantly increased risk of HAI, with an odds ratio of 7.462 (95% CI: 1.170 - 47.595, $p = 0.033$). Conversely, patients in the waiting room had a significantly decreased risk of HAI, with an odds ratio of 0.069 (95% CI: 0.009 - 0.549, $p = 0.011$).

Previous hospital admission and culture taken were also associated with increased risk of HAI, though to a lesser extent. Previous hospital admission was also associated with an increased risk of HAI, with an odds ratio of 0.267 (95% CI: 0.071 - 0.999, p = 0.050). Similarly, culture taken was associated with an increased risk of HAI, with an odds ratio of 11.288 (95% CI: 1.017 - 125.272, p = 0.048).

6. Discussion

The findings from this study underscore the multifaceted nature of hospital-acquired infections (HAIs) in emergency department patients, revealing that invasive procedures are the most significant predictor of HAI risk, with an odds ratio of 11.593 (95% CI: 3.833 - 35.067, p < 0.001), indicating that patients undergoing such procedures were over eleven times more likely to develop an HAI compared to those who did not. This aligns with existing literature that consistently identifies invasive interventions as critical points for potential infection due to breaches in sterile technique and increased exposure to pathogens(30,31,32). Notably, patients in high-acuity settings, such as the red zone, faced heightened risks for HAIs, with an odds ratio of 7.462 (95% CI: 1.170 - 47.595, p = 0.033), likely reflecting the complexities and urgent nature of their medical conditions(28). Those waiting for care demonstrated a significantly lower risk (OR 0.069; 95% CI: 0.009 - 0.549, p = 0.011), suggesting that reduced exposure to invasive procedures may mitigate infection rates. Additionally, the association between previous hospital admissions and decreased HAI risk (OR 0.267; 95% CI: 0.071 - 0.999, p = 0.050) highlights the importance of patient familiarity with healthcare environments in enhancing infection prevention practices(30). These insights emphasize the need for tailored infection control strategies that address specific procedural risks and patient demographics within emergency departments.

The study population included a relatively balanced distribution of males and females. The majority of participants were middle-aged adults, with the 35-54 age group was most affected by hospital-acquired infections (HAIs), particularly hospital-acquired pneumonia (HAP) at a rate of 65.3%. Younger age groups were more likely to experience catheter-associated urinary tract infections (CAUTI), while older age groups were more prone to HAP. This aligns with previous research highlighting the vulnerability of older adults to respiratory infections, as adults aged 65 and older are

significantly more likely to be hospitalized with HAP due to various risk factors including age, pre-existing lung diseases, and prolonged hospitalization[24,25].

In a study examining HAI across different age groups, it was found that the incidence of HAP was notably higher in older patients, with those over 70 years old exhibiting the highest rates[25]. Furthermore, older adults are at a greater risk for sepsis and related infections, which complicate their recovery and increase mortality rates[24]. This emphasizes the need for targeted infection prevention strategies in healthcare settings, particularly for older populations who are disproportionately affected by these conditions[24].

Married individuals had the highest incidence of HAI, with HAP being the most common type (54.7%). This suggests that marital status may not significantly influence specific infection types but reflects broader patterns of healthcare utilization and this finding goes against the study in which single marital status is associated with increased risk of HAP and hospitalization([26]). Housewives and government employees were the most affected occupational groups, with HAP as the primary infection type. Urban residents had a higher prevalence of hospital-acquired infections (HAIs) at 80.8%, with hospital-acquired pneumonia (HAP) being the dominant infection type in both urban and rural areas. This aligns with previous research suggesting that urban environments may contribute to higher infection rates. A systematic review highlighted that the prevalence of HAIs, “including lower respiratory tract infections, is significantly higher in urban settings” compared to rural ones due to factors such as higher patient turnover and more complex healthcare needs in urban populations([27]).

The short-stay ward and the red zone had the highest incidence of hospital-acquired infections (HAIs), particularly hospital-acquired pneumonia (HAP). This suggests that these areas may pose higher infection risks due to factors such as patient acuity and turnover rates. Research indicates that emergency departments, characterized by high patient turnover and acute illness severity, are associated with increased rates of HAIs([28]). Emergency department staff face significant risks for HAIs due to the complexity of care and rapid patient flow, which can hinder adherence to infection control practices. Furthermore, the prevalence of HAP is notably higher in environments where patients are critically ill and require immediate attention, reinforcing the need for targeted infection prevention strategies in these settings[29].

There is a paucity of data from the scientific community as the concept of HAIs in emergency rooms is emerging, indicating a need for further research to better understand these dynamics.

The strongest predictor of hospital-acquired infections (HAIs) was undergoing an invasive procedure, with an odds ratio of 11.593 (95% CI: 3.833 - 35.067, $p < 0.001$). This finding indicates that patients who underwent invasive procedures were over eleven times more likely to develop an HAI compared to those who did not, controlling for all other factors in the model. This aligns with existing literature that consistently identifies invasive procedures as a critical risk factor for HAIs due to potential breaches in sterile technique and increased exposure to pathogens during such interventions. A systematic review highlighted that surgical procedures significantly increase the risk of HAIs, with invasive techniques being particularly associated with higher rates of infections like pneumonia and surgical site infections[30,31].

Additionally, another study found that the presence of indwelling devices and prolonged hospital stays further exacerbated the risk of developing HAIs among patients undergoing invasive procedures([32]). These findings underscore the importance of stringent infection control practices in settings where invasive procedures are performed.

Patients in the red zone exhibited a significantly increased risk of hospital-acquired infections (HAIs), with an odds ratio of 7.462 (95% CI: 1.170 - 47.595, $p = 0.033$). This suggests that patients requiring urgent care are at higher risk, possibly due to the nature of their conditions and the rapid pace of care delivery in high-acuity settings[28]. Conversely, patients in the waiting room had a significantly decreased risk of HAI, with an odds ratio of 0.069 (95% CI: 0.009 - 0.549, $p = 0.011$). This counterintuitive finding may reflect lower exposure to invasive procedures or a lesser degree of clinical intervention while waiting for care. Research supports these observations; a systematic review found that emergency department settings, particularly the red zone where critically ill patients are treated, are associated with elevated HAI rates due to high patient turnover and the complexity of care required for acute conditions[30,33].

The analysis indicated that previous hospital admission was associated with a decreased risk of hospital-acquired infections (HAIs), with an odds ratio of 0.267 (95% CI: 0.071 - 0.999, $p = 0.050$). This result suggests that patients with a history of hospitalization

have 73.3% less risk of acquiring HAI in the emergency department compared to those who do not. This may be due to individuals who have had previous hospital admissions having a better understanding of the hospital environment and taking necessary precautions to prevent HAIs, but further study is required to explore this association. Research supports this finding; a longitudinal study found that patients with prior hospital admissions exhibited lower rates of HAIs, potentially due to increased awareness of infection prevention practices and familiarity with healthcare settings [30]. Conversely, certain patient populations, particularly those with multiple comorbidities or prolonged hospital stays, may still be at risk for HAIs despite previous admissions[34]. Additionally, having a culture taken was associated with an increased risk of hospital-acquired infections (HAIs), with an odds ratio of 11.288 (95% CI: 1.017 - 125.272, p = 0.048). This may reflect both the severity of the patient's condition necessitating culture tests and the potential for contamination during sample collection. Research indicates that cultures taken in high-acuity settings, such as emergency departments, can lead to increased rates of contamination, which subsequently raises the risk of HAIs[35]. A study found that blood culture contamination is a common complication in emergency care, leading to increased diagnostic uncertainty and a higher likelihood of nosocomial infections due to potential mismanagement based on false-positive results[35]. Furthermore, another investigation highlighted that the technical challenges and procedural lapses during sample collection contribute significantly to contamination rates, underscoring the need for stringent protocols to minimize infection risks during diagnostic procedures[36].

6.1. Limitations of the Study

- Single-Center Study: “The research was conducted at Tikur Anbesa Specialized Hospital”, which may limit the applicability of the results to other healthcare settings. Different hospitals may have varying infection control practices, patient demographics, and healthcare delivery models that could influence HAI rates.
- Limited Monitoring of Post-Discharge Infections: The study did not monitor infections that may have occurred after patients were discharged from the emergency department. This lack of follow-up means that potential infections developing post-discharge were not captured in the research process and this also

could lead to an underestimation of the true incidence of HAIs associated with emergency care.

- Quantitative Focus: The study was exclusively quantitative, which may limit the depth of understanding of factors contributing to hospital-acquired infections (HAIs). Incorporating qualitative research methods, such as interviews or focus groups with healthcare providers and patients, could provide richer insights into the experiences and perceptions surrounding HAIs in the emergency department.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

This study aimed to investigate the risk factors associated with hospital-acquired infections (HAIs) among patients admitted to the emergency department for more than 48 hours at Tikur Anbesa Specialized Hospital. The findings revealed that invasive procedures were the most significant predictor of HAI development, followed by red zone and culture collection. Notably, previous hospital admissions were associated with a decreased risk of HAIs, suggesting that familiarity with healthcare settings may play a protective role.

7.2. Recommendations

Based on the findings of this study, several recommendations can be made:

- Enhance Infection Control Protocols: Implement stringent infection control measures during invasive procedures and culture collection to minimize contamination risks. This includes proper training for healthcare staff on best practices for sample collection and disinfection techniques.
- Regular Audits and Monitoring: Conduct regular audits of infection control practices within the emergency department to identify areas for improvement and ensure compliance with established protocols.
- Patient Education: Develop educational programs for patients regarding the importance of infection prevention measures to reinforce safe practices during their care.

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Annex I. Information Sheet and Consent Form Informed Consent

Research Project: Hospital Acquired Infection and Associated Factors in the Emergency Department: Unmatched Case-Control Study among Patients Admitted for More Than 48 Hours in a Government Tertiary Teaching Hospital.

Name and address of Principal Investigator:

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Introduction

This consent form will provide you with information about the study so that you can make an informed decision about your participation. Your participation is voluntary, and you are free to withdraw at any time without penalty.

Purpose of the Study

The purpose of this study is to investigate the factors associated with hospital-acquired infections in the emergency department to improve patient care and outcomes.

Procedures

If you agree to participate, you will be asked to provide information about your health and treatment during your stay in the emergency department. This information will be used to identify factors that may contribute to the risk of acquiring infections in the hospital setting.

Risks and Benefits

There are minimal risks associated with participating in this study, which may include discomfort from discussing personal health information. However, the potential benefits include contributing to a greater understanding of hospital-acquired infections, which may lead to improved patient safety and care.

Confidentiality

Your privacy and confidentiality will be respected throughout the study. All data will be stored securely, and only the research team will have access to it. Results will be reported in aggregate form only, and no individual participant will be identifiable.

Consent

I have read the above information, and I understand the purpose and procedures of the study. I have had the opportunity to ask questions and have them answered to my satisfaction. By signing below, I consent to participate in the study.

Participant's Name: _____

Participant's Signature: _____

Date: _____

Please keep a copy of this consent form for your records. If you have any further questions about the study, please contact Dr. Besufekad Tesfu using the information provided above.

Thank you for considering participation in this important study.

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Annex II. English version questioner

This questionnaire was adapted from previously researched areas in Ethiopia([18], [19], [20], [21]).

Table 6 English version questionnaire

Patient identification	Participants' response to keyword (s) in patient identification
1. Demographic Variables: (please choose one response only)	
1.1. Sex	1. Male 2. Female
1.2. Age	1. 13-17 years 2. 18-34 Years 3. 35-54 Years 4. 55-64 Years 5. 65-74 years 6. 75 years and above
1.3. Marital status	1. Single 2. Married 3. Widowed 4. Divorced
1.4. Occupation	1. Student 2. Government employee 3. Privet job 4. Driver 5. Farmer 6. Laborer 7. Maid/Servant 8. Merchant 9. Un employed 10. Housewife 11. Others, specify_____
1.5. Place of residence	1. Urban 2. Rural 3. Unknown
1.6. Date of hospital admission	DD/MM/YY
2. Process of Care Variables: (please choose one response only)	
2.1. Ward	1. Red 2. Short stay ward 3. Waiting 4. Isolation
2.2. Have you observed healthcare workers	1. Yes 2. No

consistently practice hand hygiene? Like alcohol hand rub/ sanitizers before and after examining you or giving treatment	3. Sometimes 4. I don't recall
2.3. Are hospital facilities such as the patient rooms, bathrooms, and public areas properly and regularly cleaned?	1. Yes, regularly 2. Yes but not sufficiently /needs improvement 3. Sometimes 4. I never seen any
2.4. Was the bed/ chair properly cleaned before you were examined?	1. Yes 2. No 3. Sometimes 4. I don't recall
2.5. Do healthcare workers wear gloves?	1. Yes 2. No 3. Sometimes 4. I don't recall
2.6. Do healthcare workers wear masks?	1. Yes 2. No 3. Sometimes 4. I don't recall
2.7. Do you think the ward is clean?	1. yes 2. No
2.8. Do you think the room is well-ventilated?	1. yes 2. No
3. Organizational Variables: (please choose one response only)	
3.1 Do you think that there are enough staff members to provide quality care?	1. Yes 2. No 3. I am not sure
3.2 Have you seen healthcare workers struggling with a shortage of gloves?	1. Yes 2. No 3. Sometimes 4. I don't recall
3.3 Have you seen healthcare workers struggling with a shortage of masks?	1. Yes 2. No 3. Sometimes 4. I don't recall
3.4 Have you seen healthcare workers struggling with a shortage of alcohol hand rub/sanitizer?	1. Yes 2. No 3. Sometimes 4. I don't recall
3.5 Do you think healthcare workers have an increased	1. Yes 2. No

workload?	3. Sometimes 4. I don't recall
3.6 NEDOCS score	----------
4. Clinical Variables: (please choose one response only)	
4.1 Do you have a hospital-acquired infection	1. Yes 2. No
4.2. If yes, what type? (please choose one or more than one response)	1. HAP 2. CAUTI 3. CLABSI 4. SSI 5. VAP
4.3. Have you undergone surgery before?	1. Yes 2. No
4.4. if yes why was the surgery done?	Please specify_____?
4.5. if yes when was it done?	1. _____in days
4.6. Have you received any immunosuppressive treatments such as chemotherapy or radiation therapy? Before the current admission	1. Yes 2. No 3. I don't recall
4.7. Do you have any chronic medical conditions?	1. Yes 2. No 3. I never got tested 4. I don't know
4.8. If yes….. (please choose one or more than one response)	1. Hypertension 2. Diabetes 3. HIV 4. Cardiovascular disease 5. Asthma 6. COPD 7. Renal disease 8. Malignancy
4.9. Have you ever had a hospital-acquired infection before?	1. Yes 2. No 3. I don't recall
4.10. If yes what type of HAI was it? (please choose one or more than one response)	1. HAP 2. CAUTI 3. CLABSI 4. SSI 5. VAP
4.11. Have you been admitted to a hospital in the past?	1. Yes 2. No
4.12. if yes, when?	----------in days

4.13. Have you recently taken any antibiotics?	1. Yes 2. No 3. I don't know
4.14. If yes can you tell me the drug/s? (please choose one or more than one response)	1. Generic name only 2. Generic name only 3. Generic name only 4. Generic name only
4.15. Were culture tests done?	1. Yes 2. No 3. I don't recall 4. I was not told
4.16. If yes what was the result? you can check the result in the I care	1. ----------
4.17. Did you receive any invasive procedures during your hospitalization, such as insertion of a urinary catheter, central venous catheter, plural tab, or LP?	1. Yes 2. No 3. I don't recall
4.18. If yes can you specify the type of procedure(multiple entries are acceptable)	1. ……. 2. ……..
4.19. How long did you stay in this hospital for the current admission	1. _____in days