



**HOSPITAL ACQUIRED INFECTIONS AND INFECTION
PREVENTION PRACTICES IN TEACHING HOSPITALS IN
THE AMHARA REGIONAL STATE, ETHIOPIA**

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**DISSERTATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
(PhD)
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**ADDIS ABABA UNIVERSITY, SCHOOL OF GRADUATE
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AMHARA REGIONAL STATE, ETHIOPIA**

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PHILOSOPHY (PhD) IN PUBLIC HEALTH**

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ORIGINAL PAPERS

This dissertation is mainly based on the following four papers

- I. Yallew WW, Kumie A, Yehuala FM. The point prevalence of hospital-acquired infections in two teaching hospitals of Amhara Region in Ethiopia. *Drug Healthc. Patient Saf.* 2016; 8:71–6.
- II. Yallew WW, Kumie A, Yehuala FM. Risk factors for hospital acquired infections in teaching hospitals of the Amhara Regional State, Ethiopia: matched case control study
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- III. Yallew WW, Kumie A, Yehuala FM. Healthcare worker’s practice of infection prevention and control of hospital acquired infection in Amhara Region teaching hospitals, Ethiopia.
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- IV. Yallew WW, Kumie A, Yehuala FM. Barriers to Infection prevention practice among Amhara region teaching hospitals in Ethiopia: Qualitative study
(Submitted to BMC Nursing NURS-D-17-00027)

ACRONYMS AND ABBREVIATIONS

AIDSTAR	AIDS Support and Technical Assistance Resources
AOR	Adjusted Odds Ratio
APACHE	Physiological Score Chronic Health Evaluation
ASA	American Society of Anesthesiology
BAP	Blood Agar Plate
BSI	Blood Stream Infection
CAP	Chocolate Agar Plate
CAIs	Community Acquired Infections
CAUTI	Catheter Associated Urinary Tract Infection
CDC	Centers for Disease Control and Prevention
CHS	College of Health Science
CI	Confidence Interval
CLABSI	Central Line-Associated Bloodstream Infections
CLIPs	Central Line Insertion Practices
CR-BSI	Catheter-Related Bloodstream Infection
CSA	Central Statistical Agency of Ethiopia
CV	Coefficient of Variation
CVCs	Central Venous/Vascular Catheters
DA	Devise Associated
DI	Depth Interview
ECDC	European Centre for Disease Prevention and Control
ESCMID	European Society for Clinical Microbiology and Infectious Diseases
HAI	Hospital Acquired Infection
HAP	Hospital-acquired pneumonia

HA-UTI	Hospital-acquired Urinary Tract Infection
HBV	Hepatitis B virus
HBC	Hepatitis C Virus
HCAI	Health Care Associated Infection
HCWs	Health Care Workers
HIV/AIDS	Human Immune Virus /Acquired Immune deficient syndrome
HIV	Human Immune Virus
HPA	Health Protection Agency
FHH	Felege-Hiwot Hospital
FGD	Focus Group Discussion
FMOHE	Federal Ministry of Health Ethiopia
ICC	Interclass Correlation Coefficient
ICU	Intensive Care Unit
IPPS	Infection Prevention and Patient Safety
IVC	Intravascular Catheters
LRTI	Lower Respiratory Tract Infection
LOS	Length of Stay
NAUTIs	Nosocomial Urinary Tract Infections
NCCLS	National Committee for Clinical Laboratory Standards
NHSN	National Healthcare Safety Network
NHS	National Health Service
NICU	Neonatal Intensive Care Unit
NIS	Nosocomial Infections Surveillance
NNIS	National Nosocomial Infections Surveillance
MDROs	Multi-Drug Resistant Organismes
MRSA	Methicilin-Resistant Staphylococcus Aureus
PEAP	Pan Euro Asian Prevalence
POA	Present On Admission

PPS	Point Prevalence Survey
PVC	Peripheral Vascular Catheter
OR	Odds Ratio
SSI	Surgical Site Infection
UC	Urinary Catheter
UK	United Kingdom
UOG	University of Gondar
URT	Upper Respiratory Tract Infection
USA	United States of America
UTI	Urinary Tract Infection
VAP	Ventilator Associated Pneumonia
VIF	Variance Inflation Factor
WHO	World Health Organization

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ABSTRACT

Background: Hospital acquired infections are major public health concerns throughout the world, contributing to increased morbidity, mortality, and health cost. Hospitals are the main sources for the risk of acquiring infection during health care delivery. There is little evidence concerning the burden of unsafe care in developing countries, where the risk of harm to patients is likely to be greater, due to low infrastructure, technologies, and human resources. Limited researches to specific infections show that a significant number of inpatients acquire infections in hospital set ups in Ethiopia. There is limited information that indicate magnitude, barriers and factors for prevention and control practice of hospital acquired infections in teaching hospitals.

Objective: The overall objective of this study was to assess the magnitude and risk factors of hospital acquired infections and barriers and health care workers practice of infection prevention and control in Amhara Regional state teaching Hospitals, Ethiopia.

Methods: Mix of quantitative and qualitative methods were employed. A repeated cross-sectional and matched case control study designs were employed between April and July 2015 at the University of Gondar and Felege-Hiwot medical teaching hospitals. All eligible inpatients admitted for at least 48 hours on the day of the survey were included. Trained physicians and nurses collected data according to the Centers for Disease Control and Prevention(CDC) definitions of hospital acquired infections. A total of 908 patients for the prevalence survey, 545 patients, 109 cases and 436 controls for the matched case control study and 422 health care workers for the practice of infection prevention and control were included in this study. The collected data were cleaned, coded and entered into Epi-Info software version 3.5.3 and analysis was done using STATA 13. Univariate and multivariable Conditional logistic regression were used for the analysis. Odds ratios with the corresponding 95% confidence intervals were estimated and p values were determined. Variables with $P < 0.05$ in the multivariable conditional logistic regression analysis were considered as significant independent predictors in this study.

For the qualitative study, a phenomenological approach was used to explore the lived experience of healthcare workers and management staffs towards infection prevention practice and control.

Data were collected from ten in-depth interviews and four focus group discussions, by face to face interviews using open ended interview guides in safe and quiet places. Data were managed using open code software version 4.03 and contents were analyzed thematically.

Results: The overall point prevalence of hospital acquired infection was 14.9 % (95% CI: 12.7-17.1). *Klebsiella spp* (22.44%) and *Staphylococcus aureus* (20.4%) were the most commonly isolated hospital acquired infections causing pathogen in these hospitals.

Patients admitted in wards with medical waste containers the room had 82% less chance of developing hospital acquired infections (AOR 0.18: 95% CI, 0.03-0.98). The odds of developing hospital acquired infections among immune deficient patients were 2.34 times higher than non-immuno-compromised patients, with 95% CI: (1.17-4.69). Patient received antimicrobials, central vascular catheter and surgery since admission had 8.63, 6.91 and 2.35 higher odds of developing hospital-acquired infection, respectively.

The proportion of infection prevention practice towards hospital acquired infection was 55% with 95% CI: (50.1-59.6). In the past one year 234 (56.7%) and 150 (36.3%) health care workers were exposed to blood and body fluids and sharp or needle sticks injury, respectively. Nurses practice 2.09 times more compared to physicians to infection control with (95% CI: 1.27-3.43).

In the qualitative assessment, a total of ten different barriers were identified: such as lack of availability of facilities, shortage of material supply, lack of maintenance of facilities and equipment's, high patient flow, lack of experience, emergency situation, healthcare worker behavior and healthcare worker's knowledge, low awareness of patients and visitors and large number of families and visitors to the hospital.

Conclusions: High prevalence of hospital acquired infection was observed in teaching hospitals. Surgical site infection and pneumonia were the most common type of infections. Infection prevention and control practice were low in the study setting. High proportion of healthcare workers were exposed to risks. Nursing professionals practiced prevention better than physicians. Important barriers for infection prevention were identified.

Recommendations: Managers should give more attention to promote infection prevention practices for better control of hospital acquired infections. Health providers and managers should consider the availability of health care facilities and follow appropriate medical procedures for use of external devices and give attention to those immune-compromised patients for the prevention and control of hospital acquired infection. For effective infection prevention practice implementation, barriers should be considered via identifying specific organizations, health care worker and patients and visitor's as a target

Key words: *Hospital acquired infection, surgical site Infections, risk factor, teaching hospital, Infection prevention and control, Ethiopia.*

1. INTRODUCTION

There have been advances in healthcare systems and technology pertaining to prevention of Hospital Acquired Infection (HAI), but the magnitude of hospital acquired infection in developing countries has not been precisely known. Risk factors and barriers to the prevention and control of hospital infections and infection prevention are not well studied in developing countries, including Ethiopia.

1.1. Background

HAI are a major public health concern throughout the world, contributing to increased morbidity, mortality, and healthcare cost (1). Hospital-acquired infection is defined as a localized or systemic condition that results from adverse reactions to the presence of an infectious agent(s) or its toxin(s), and that occurs 48 hours or more after hospital admission and was not incubating at the time of admission (2,3).

HAI are caused by viral, bacterial, and fungal pathogens. An important predisposing factor to HAIs is the use of instrumentation or devices for intubation, delivery of therapeutic agents, or drainage of body fluids during patient care as supportive measures(4). Healthcare associated bacterial pathogens may well survive or persist on surfaces for months and can thereby be a continuous source of transmission if no regular preventive surface disinfection is performed(5).

According to Centers for Disease Control and Prevention (CDC), healthcare associated infection is defined as *“infections acquired during the course of receiving treatment, localized or systemic condition, resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) within a healthcare setting”*(6).

Nosocomial comes from the Greek word “Nosokomeian”, which means a place from which disease is acquired. This definition has been extended to include other forms of health-care facilities, such as physical and occupational settings. CDC substitutes the word nosocomial infection by healthcare associated infection for surveillance system after developing new definition of

healthcare associated infection and criteria for specific types of infections in the acute care setting(6).

In recent years, it has been recognized that relatively complex care is increasingly being delivered in the community, including the patient's own home, as well as in acute care hospital settings. The term hospital-acquired infection was used, denoting that an infection was acquired during a hospital admission, and healthcare associated infections which include all infections that develop as a result of healthcare, no matter where the care is delivered(7,8).

Health Protection Agency (HPA) in the United Kingdom (UK) and the World Health Organization (WHO) defined healthcare associated infections as “infections acquired in hospital” or “as a result of healthcare interventions”. The term HAIs is specifically used for hospital acquired infections, and Community Acquired Infections (CAIs)(9,10). In this dissertation, hospital acquired means infection acquired only in the hospital.

Hospitals are the main health facilities for acquiring infection during delivery of care. There is little evidence concerning the burden of unsafe care in developing countries, where the risk of harm to patients is likely to be greater, due to limitations in infrastructure, technologies, and human resources(11). Hospital-related infections constitute an important health challenge worldwide.

Healthcare-associated infection is a major safety issue affecting the quality of care of hundreds of millions of patients every year in both developed and developing countries (12). According to the WHO national and multicenter literature review, the prevalence of acquiring at least one HCAI ranges from 3.5% to 12% among high income countries (13).

In developing countries, the problem reaches up to three times higher compared to the incidence seen in adult intensive care units in USA(14). According to the WHO review, hospital-wide prevalence of HCAI varies from 5.7% to 19.1%, with a pooled prevalence of 10.1% in low income countries(13).

Though there is no regional data in low income countries, a literature review shows that increased length of stay at hospitals is associated with HCAI varying between 5 and 29.5 days(13). In Jordan, the mean Length Of Stay(LOS) after infection for cases was 12.1 days(15).

In Ethiopia, there is no a comprehensive research that shows the picture of hospital acquired infection in hospitals. Researches on surgical site infection show that the prevalence of hospital acquired infection varies from 5.74% to 35% in surgical patients(16–21).

1.2. Statement of the problem

Healthcare associated infections are major worldwide public health problems. The Centers for Disease Control and Prevention estimates that 2 million patients suffer from hospital-acquired infections every year and nearly 100,000 of them die(22). HAIs are associated with an increased attributable mortality, length of stay, and healthcare costs incurred by patients, insurers and healthcare facilities(23,24). Hospital acquired-infections incur substantial financial burden to the budget of medical institutions, mainly due to additional costs derived from risk factors associated with medical procedures(25).

The burden of health-care-associated infection in developing countries is high. Prevalence of health-care-associated infection is much higher than proportions reported from Europe and the USA. The overall health-care-associated infection density in adult intensive-care units was 47.9 per 1000 patient-days, being at least three times as high as densities reported from the USA(14). In developing countries, the risk is two to twenty times higher and the proportion of infected patients frequently exceeds 25%(26). In low and middle income countries, the burden of hospital acquired infections is unknown due to lack of reliable data and the use of different definitions and methodologies(27).

In Africa, literature review shows that hospital-wide prevalence of HAI varies between 2.5% and 14.8%; in surgical wards, the cumulative incidence ranging from 5.7% to 45.8%. The largest number of studies focused on surgical site infection, whose cumulative incidence ranges from 2.5% to 30.9%(28). Infrastructure of hospitals, low compliance of hand hygiene, understaffing, overcrowd-

ing, heavy workload, misuse of personal protective equipment, late establishment of infection control programmes are major problems in resources limited countries. These problems cause high infection rates and spread of multi-drug resistant pathogens(29).

A study show that most hospitals in developing countries especially in Africa, have no effective infection control programmes due to lack of awareness of the problem, lack of personnel, poor water supply, erratic electricity supply, ineffective antibiotic policies with emergence of multiple antibiotic resistant microbes, poor laboratory backup, poor funding and non-adherence to safe practices by health workers(30). In addition infection control and hospital acquired infection prevalence reports are often not well established because of the lack of centralized guidelines, staff and resources(31). In a Moroccan university hospital, almost 2 out of each 10 hospitalized patients contracted a nosocomial infection(32). Similar results were found in a Tunisian hospital(33).

Most published studies of HAI originate from hospitals in developed nations. Relatively few data are available from Ethiopia to indicate present HAI status of situation and focused on only surgical site infections on surgery and obstetrics wards(16,34). Healthcare workers risk may affect all staff at the facility, including nurses, doctors, laboratory technicians, waste management staff and laundry staff.

According to the AIDS Support and Technical Assistance Resources (AIDSTAR) Ethiopia, assessment of Infection Prevention and Patient Safety Commodities, show that there is lack of awareness on the proper utilization of Infection Prevention and Patient Safety (IPPS) commodities by health care workers. In addition, lack of accurate data on the quantity of essential IPPS commodities needed by the health care system to adequately protect workers, patients, and the community from health care-associated infections(35).

The Federal Ministry of Health Ethiopia (FMOHE) developed Standard National Guideline on Infection Prevention. The Guideline was developed based on international standard of Centers for Disease Control and Prevention released in 1996(36). The proportion of patients with HAIs in developing countries has been estimated to be 25% - 40% or more(37). In Addis Ababa surgical

site infections (SSI) in two hospitals (Tikur Anbesa and Saint Paul) showed that 6.9 and 5.7% respectively. High resistant organisms were observed for gentamicin (56%) and penicillin group(95%)(16). In Ethiopia Health care associated infections are estimated to be 40%(38).

Infection prevention practice is a serious concern for health care workers; it is a major risk for transmission of infections, such as HIV and hepatitis viruses(39). In Ethiopia, a research conducted in 10 hospitals and 20 health centers about the behaviors of healthcare workers indicate that, there was a high level of exposure to blood and body fluids among healthcare workers (HCWs) (40). In addition, there is a lack of up-to-date knowledge, good practices and positive attitudes towards infection prevention in health care settings. HCWs had insufficient knowledge and perception on universal precaution (40).HCWs are at a very high risk of exposure to blood and body fluids and Poor efforts to prevent infection and wrong practice of handling instrument(41).

Prospective active surveillance of hospital acquired infection is the gold standard (42). Repeated point prevalence surveys are more feasible methods for the measurement of all HAIs, in the hospitals and it is also important to estimate the burden of HAIs in teaching hospitals. It also important to prioritize areas requiring interventions(43).

In the study setting there is no such a comprehensive research that show the prevalence of Hospital acquired infections; identify determinant factors, and to explore the barriers for the prevention and control of infection prevention activities in Amhara Region government teaching hospitals.

1.3 Rationale of the study

Healthcare-associated infection is a problem increasing worldwide and significantly contributes to morbidity and mortality in hospital population. The additional costs arising from treatment of HCAI place a significant burden on healthcare resources. In most developing countries, hospital care is the most respected service, for example in Uganda hospital care is a precious gift(44). Therefore little concern is given to hospital safety and very seldom hospital acquired infection risk is evaluated (44). Limited information is available on the endemic burden of HAI in Africa(28).

Health-care-associated infection is the most frequent result of unsafe patient care worldwide, but few data are available from the developing world, including Ethiopia. Hospital-acquired infections take up scarce health sector resources by prolonging patients' hospital stay. In teaching hospitals, the quality of care is low compared to nonteaching hospitals, because of involvement of inexperienced trainees and the reduced role of senior physicians in teaching hospitals(45). Knowing the prevalence and risk factor of HAI is very essential for the control of the HAI in the Health Care system(46). There is little evidence concerning the burden of unsafe care in developing countries, where the risk of harm to patients is likely to be greater, due to limitations in infrastructure, technologies, and human resources and a lack of up-to-date knowledge, good practices and positive attitudes towards infection prevention in health care settings(40).

There is no research conducted on comprehensive HAI prevalence and risk factors in the study area. The study will investigate the prevalence and risk factors for HAI and identify the behavioral determinants of infection prevention practice. It is also an input for policy makers and to the health services and health care workers to improve their decision and the development of guideline for the work environment. It also helps to minimize the health cost of patients and the country. This assessment of HAI and identifying risk factors and barriers to infection prevention practice for HAI study in Amhara Regional State helps as a base line for further Epidemiological studies of HAIs in the country.

1.4 Literature review

This literature review addressed the prevalence and risk factors for hospital-acquired infections. This review is presented based on the major classification of Hospital acquired infections such as; hospital acquired urinary tract infections (HA-UTI), surgical site infection (SSI), hospital-acquired pneumonia/ventilator-associated pneumonia and hospital acquired bloodstream infections, risk factors for and barriers to infection prevention and control practice.

Hospital-acquired, infections have been a problem patients, healthcare workers in hospitals for a century. The problem gets a concern after Ignaz Semmelweis presented evidence that childbed fever was spread from person to person on the unclean hands of health-care workers(47).

Research data base that we used for the review were Google scholar, EMBASE, Pub Med/ MEDLINE, Web of Science, Cochrane Database, WHO-Website, HINARY library and another database. Key searching terms are hospital acquired infection, health care associated infections, nosocomial infections, surgical site infection, hospital acquired pneumonia, hospital acquired bloodstream infections, hospital acquired urinary tract infections, point prevalence, healthcare workers infection prevention practice, barriers to infection prevention and risk factors for hospital acquired infection. We narrated all the relevant literature based on the objectives of the paper.

According to the 2013 CDC/NHSN protocol for surveillance of HAI definition elements of site-specific infection criterion should first present together on or after the 3rd calendar day of admission to the facility (the day of hospital admission is day 1). In this definition, an element of the infection criterion may be presented during the first 2 calendar days of admission as long as it is also presented on or after calendar day 3. All elements used to meet the infection criterion must occur within a timeframe that does not exceed a gap of 1 calendar day, between two adjacent elements. If all of the elements of an infection definition are presented during the two calendar days before the day of admission, the first day of admission (day 1) and/or the day after admission

(day 2) and are documented in the medical record, the infection would be considered Present on Admission(POA). Infections that are POA should not be reported as HAIs(48).

1.4.1. Prevalence of hospital acquired infection

Hospital-acquired infections are a growing problem at every level of the healthcare system. World Health Organization (WHO) estimated that it affects hundreds of millions of people worldwide and it is a major global issue for patient safety(49). It complicates between 5 and 10% of admissions in acute care hospitals in industrialized countries(48).

Hospital acquired infection reached from 6% in USA to 13% in Finland hospitals(50,51). While in some cases, research in USA Florida on myocardial infarction patients showed that 16.6% developed infections due to the intrinsic characteristic of the patient(52).

A point prevalence study in Litwania on 731 patients in 2010 showed that; the prevalence rate of health care-associated infections was 3.8%(53). The prevalence differed by hospital wards (range 0.0%–19.2%). The lower respiratory tract (32.2%), urinary tract (28.5%), and surgical site infections (32.1%) were the most common health care-associated infections(53). A similar study in Iran showed that the overall HAI prevalence was 9.4%(54). The most common HAIs were blood stream infections (2.5%), surgical site infections (2.4%), urinary tract infections (1.4%) and pneumonia 1.3%(54).

In Scottish National Point Prevalence Survey (PPS) in National Health Service (NHS) acute, NHS non-acute, NHS pediatric and independent hospitals was carried out in September and October 2011 using the European Centre for Disease Prevention and Control protocol designed for the European PPS. The prevalence of HAI was 4.9%, 2.5%, 6.1% and 1.2% in acute, non-acute, pediatric and independent hospitals respectively(55). The prevalence of HAI was significantly higher in acute hospitals compared with non-acute hospitals(55). A similar research in Canada in pediatric hospital showed that a prevalence of 8.7%(56). Bloodstream infections were the most frequent infections in neonates (3.0%), infants (3.1%), and children (3.5%)(56).

A six-month point prevalence survey conducted in UK showed that, the prevalence of catheter-associated urinary tract infection, central-line-associated bloodstream infection, local vascular access infection, and ventilator-associated pneumonia was 3.9%, 3.1%, 3.8% and 11.6%, respectively(57). Similar research in Finnish disclosed that the overall prevalence was 13% and hospitalization of >7 days was associated with increased prevalence of HAI 8%(50).

A prospective surveillance based on CDC-NNIS definitions conducted in Morocco on 1,731 patients hospitalized for 11,297 days acquired 251 HAIs, an overall rate of 14.5%, and 22.22 % HAIs per 1,000 ICU days(58). A similar prospective cohort Device Associated (DA) HAI surveillance study in Egypt hospitals showed that, an overall rate of 32.8%(59). The central line-associated blood stream infection (CLABSI) rate was 22.5 per 1000 line-days and ventilator-associated pneumonia (VAP) rate was 73.4 per 1000 ventilator-days and the catheter associated urinary tract infection (CAUTI) rate was 34.2 per 1000 catheter-days (59).

A Retrospective cohort study conducted in Nigeria from January 2012 to February 2012 at Olabisi Onabanjo University Teaching Hospital from 386 surgical patients showed that incidence rate of SSI was 13.0%(60). The children had the highest infection rate of 22.9%. The most frequently isolated bacteria were *E. Coli* 17 (34.7) and *Staphylococcus aureus*, 16 (32.7%). Pre-existing medical condition and length of post-operative stay in the hospital were predictors of risk of surgical site infection(60). A prospective descriptive study at Jimma University Teaching Hospital on surgical site infection rate was 11.4%(18). Wound class at time of surgery and absence of antenatal care follow up were associated with increased severity of surgical Site Infections(18).

In developing countries, HAI reaches up to three times higher compared to the incidence seen in adult intensive care units in USA(14). According to the WHO review, hospital-wide prevalence of healthcare associated infections(HCAI) varied from 5.7% to 19.1% with a pooled prevalence of 10.1% in low income countries(13). In addition, hospital acquired infection prevalence reports are often not well established because of the lack of centralized guidelines, staff and resources(31). In

a Moroccan University hospital, almost 2 out of each 10 hospitalized patients contracted nosocomial infections (32). Similar results were found in a Tunisian hospital(61).

Researches in some developing countries showed that ,the overall prevalence of Hospital acquired infection ranges from 3.8% to 28% in Uganda and Litwania respectively (44,53). The prevalence increases up to 32% in Egypt due to the device used associated infections and 38.3% in Turkey Hospitals in the intensive care unit(59,62).

In Africa, reviewed literature show that the hospital-wide prevalence of HAI varies between 2.5% and 14.8%; and the cumulative incidence range from 5.7% to 45.8%(28). The largest number of studies focused on surgical site infection, whose cumulative incidence ranged from 2.5% to 30.9%(28).

The burden of health-care-associated infection in developing countries is high. In low and middle income countries the burden of hospital acquired infections is unknown due to lack of reliable data and the use of different definitions and methodologies(27). In developing countries the prevalence of Hospital acquired infection ranges from 7.8% in Vietnam to 28% from Uganda(44,63). Though there are few researches conducted on Hospital acquired infection, the prevalences are very high, Tunisia, 17.9%, Morocco 14.5% Mali 9.6%(58,64,65).

A research conducted in Uganda on 410 patients showed that, the overall HAI prevalence was 28%, more in surgery (47%) and less in pediatrics (21%)(44). Blood stream infections were the most frequent, followed by surgical wound infections and Urinary Tract infections(44). A one-day prevalence survey was conducted at the Habib Bourguiba University Hospital, Tunisia and the overall prevalence of HAI was 17.9%(33). HAI is linked to the medical category, the use of intravascular devices and antibiotic prophylaxis(33).

A research conducted in Mali showed that 9.6% of patients were affected by nosocomial infections. The most frequently isolated bacteria were *Escherichia coli* (44%).All isolated bacteria were resistant to amoxicillin and 46% were sensitive to ciprofloxacin. The risk factors for infection were

emergency surgery, American Society of Anesthesiology(ASA) class and the type of surgery defined by Altemeir(65).

A study has shown that most hospitals in developing countries, especially in Africa, have no effective infection control programme; due to lack of awareness of the problem, lack of personnel, poor water supply, erratic electricity supply, ineffective antibiotic policies, with emergence of multiple antibiotic resistant microbes, poor laboratory backup, poor funding and non-adherence to safe practices by health workers(30).

The prevalence of hospital acquired infection in general is high both in developed and developing countries. The prevalence increased due to some special conditions, like the device used in the intensive care units. In Ethiopia even though there is no a comprehensive general prevalence study on hospital acquired infection, researches in specific SSI in Tikur Ambesa Hospital(52.1%), Saint Paul Hospital(79%), and Felege-Hiwot Referral Hospital(10.2%) are recorded (18,66). In Ethiopia, there is no a comprehensive research that show complete picture of hospital acquired infection in hospitals. Relatively few data are available from Ethiopia to the present HAI situation and focused on only surgical site infections on surgery and obstetrics wards.

1.4.1.1 Surgical site infection (SSI)

Before the mid-19th century, surgical patients commonly developed postoperative fever followed by purulent drainage from their incisions, overwhelming sepsis, and often died(67). It was not until the late 1860s, after Joseph Lister introduced the principles of antisepsis that postoperative infectious morbidity decreased substantially(67). Lister's work radically changed surgery from an activity associated with infection and death to a discipline that could eliminate suffering and prolong life(67).

The term 'surgical site infection' (SSI) was introduced in 1992 to replace the previous term surgical wound infection(68). Surgical site infections (SSIs) are important cause of healthcare associated infections (HAIs). Surgical site infections (SSI) account for a major proportion of healthcare

associated infections (HCAI), yet many hospitals capture little data on the risk of SSI in patients undergoing surgery(69).

Surgical site infection is common in developed and developing countries. A research conducted in a 30 days follow up of post vasectomy surgery showed that 2.5% of patients developed SSI(70). A prospective study conducted in Italy for 18 months in a tertiary care center on cardiac surgery showed that 9% developed nosocomial infection(71). In that study 51.8% were respiratory tract Infections, 20.5 % blood stream and wound infection in 27.7% patients. Some of the predictors of NI were immunosuppressive therapy, reintubation, stroke, emergent/urgent status, and length of intubation(71).

In another study in Italy, the point prevalence rate in 20 surgical departments indicated that SSI varies from 8.2 to 16.4 per 100 surgical patients. Age greater than 31 years, kidney insufficiency, and infection at admission were confirmed as significant risk factors for SSI(72).

Surgical Site Infections are the most common nosocomial infections and the rate is higher in sub-Saharan Africa. In Mali, 57.4% of the total Hospital acquired infection is SSI(65). A retrospective cohort study conducted in Nigeria University Teaching Hospital showed that incidence rate of SSI was 13.0%. Children had the highest infection rate of 22.9% (60). The most frequently isolated bacteria were *E. Coli* 34.7% and *Staphylococcus aureus* 32.7%. Pre-existing medical condition and length of post-operative stay in the hospital were predictors of risk of surgical site infection(60).

A study in Ethiopia showed that surgical site infection rate in obstetric ward at the University Teaching Hospital was 11.4%(18). Absence of antenatal care follow up was also associated with increased severity of surgical site infections(18).

1.4.1.2 Urinary tract infection (UTI)

Urinary tract infection (UTI) is an infection in the urinary system, which includes, bladder (which stores the urine) and kidneys (which filter the blood to make urine). Urinary tract infections are

one of the most common types of bacterial infections in humans occurring both in the community and the health care settings. Hospital acquired urinary tract infections (HA-UTIs) account for at least 40% of all nosocomial infections and are mainly associated with catheters(73). A systematic review on UTI showed that 79.3% of UTI can be prevented, if catheterization was not performed in hospitals(74).

A study showed that the prevalence of UTI reaches up to 73% from the total Hospital acquired infections in Serbia Hospital(75). In Nigeria and Pakistan Hospitals, the prevalence of UTI were 60% from the total hospital acquired infections(76,77). A research conducted in USA by Nicholas Graves showed that, urinary tract infection was not associated with an increase in length of hospital stay or variable costs(78).

A research conducted on the prevalence of nosocomial urinary tract infections (NAUTIs) in urology sections in Europe and Asia showed that; the prevalence of NAUTI was 10% in the Pan European Prevalence (PEP) study, 14% in the Pan EuroAsian Prevalence (PEAP) study, and 11% in the combined analysis(79). The largest group was asymptomatic bacteriuria (29%), followed by cystitis (26%), and urosepsis (12%). There were significant differences between regions and types of hospitals(79).

Prospective active surveillance in Egypt on CAUTIs in 4 ICUs during a 13-month period showed that female gender, previous catheterization within the same hospital admission patients admitted to the chest unit, patients ≥ 40 years, patients with prolonged duration of catheterization, prolonged hospital and ICU stay had a significantly higher risk of acquiring CAUTIs (80).

The most common organisms recorded in UTI infections were *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Proteus mirabilis*(77,81–83). Some of the risk factors of UTI are, female sex, increasing age, diabetes mellitus, length of hospital stay, prior stroke, urinary catheter and duration of urinary catheter(74,80).

1.4.1.3 Hospital acquired bloodstream infection.

Worldwide, use of intravascular catheters (IVC) has been associated with both local and systemic infections. A “central line” or “central catheter” is a tube that is placed into a patient’s large vein, usually in the neck, chest, arm, or groin. The catheter is often used to draw blood, or give fluids or medications. A bloodstream infection can occur when bacteria or other germs travel down a “central line” and enter the blood(84).

The prevalence of Blood Stream Infections (BSI) in Italy was 21.4% of the total infections in the Hospital(85). In the US, a matched case-control design to estimate LOS and costs associated with HCABSI based on the 2003 (NIS) showed that the weighted mean LOS for HCABSI cases was 16.0 days compared with 5.4 days for the control group(86). Another matched case-control design was used to determine the extra length of stay (LOS) and cost associated with HCABSI among adult hospitalized Jordanian patients (87). The mean LOS after infection for cases was 12.1 days compared with 8.3 days for controls(88). A study in Saudi Arabia in ICU showed that 6.1% patients develop BSI(87).

Hospital-acquired infections risk increased with invasive device used (89) and a patient in Intensive Care Unit (ICU)(90). Incidence of Device-Associated Infections(DAIs) report from International Nosocomial Infection Control Consortium(INICC) are higher than US National Healthcare Safety Network (NHSN)(91,92). The overall DAIs patients indicated that 5.3% in China(93),12.2% in Colombia(94) and 13% in Peruvians ICU patients(95). Evidences showed that this device-associated hospital-acquired infection increases and contribute extra extended length of stay(96–98), and mortality(94,95,98). Researches in developing countries showed that device-associated infections in intensive care unit were high(99,100) and incurred extra cost for patients(101–103).

A cross-sectional study on Jelliffe ward in Mulago Hospital in Uganda, showed that, out of the 391-short term peripheral venous catheters collected, 20.7% catheter tips and 11.3% catheter hubs were colonized(104). Bacteria isolated from colonized catheter tips were *Staphylococcus aureus* (60.5%), *Staphylococcus epidermidis* (23.5%). The most common organism isolated from the hub

was *Staphylococcus aureus* (56.8%) followed by *Staphylococcus epidermidis* (18.1%). Gram positive and negative organisms were sensitive to ciprofloxacin, gentamycin for gram-negative organisms and Augmentin, cefuroxime, ceftriaxone for the gram-positive organisms(104). In Ethiopia, studies showed that the BSI prevalence was 2.1% in Surgery patients, the lower prevalence in may be due to the focus only in specific patients(66).

Central venous catheters (CVCs) play essential role in patient care, both in the inpatient and outpatient settings. The use of CVCs carries a risk of the development of catheter-related bloodstream infection (CR-BSI), which can be associated with significant morbidity and mortality. Nosocomial bloodstream infections account for most of the mortality and costs associated with bloodstream infection(105). Some of the risk factors for bloodstream infections are source of infection, septic shock, age over 65, and polymicrobial bacteremia (106). Some of the common microorganisms for BSI are, *coagulase negative staphylococcus*, *Staphylococcus aureus*, and *Escherichia coli*(107–109).

1.4.1.4 Hospital-acquired pneumonia

Hospital-acquired pneumonia (HAP), is the second most frequent nosocomial infection but the first in terms of morbidity, mortality and cost(110). It is the most common healthcare-acquired infection, contributing to death(110).

From total hospital-acquired infections patients develop, 21.9% (Sri Lanka), 30.5%(India) and 27.7% (Egypt) patients developed hospital acquired pneumonia infections (111–113). In Iran researches showed that from the total Hospital acquired infections, 72% of patients were diagnosed with ventilator associated pneumonia infections. The higher in Iran may be due to the risk is higher in the intensive care unit(114).

Some of the most commonly identified organisms that causes hospital acquired pneumonia are *Acinetobacter species*, *Pseudomonas aeruginosa*, *Klebsiella*, *Staphylococcus aureus* and *Escherichia coli*(112,115). The risk factors for hospital acquired pneumonia are hospitalization for 2 or more days within the past 90 days, residence in a nursing home or extended-care facility, home infusion therapy, long-term dialysis within the past 30 days, Physiological Score Chronic Health

Evaluation (APACHE) II score, prior use of antibiotics (indiscriminate use of broad spectrum antibiotics), red cell transfusions(111,115–118).

1.4.2 Risk Factors for Hospital acquired infection.

Health care associated infections are infections that patients acquire, while they are in contact with the healthcare system. Risk factors for all HAIs, include those associated with the host, those associated with treatment strategies, and those associated with Healthcare Workers(HCW) behaviors(119).

1.4.2.1 Factors related to Patients

Health care–associated infection (HAI) causes significant morbidity and mortality in the neonatal intensive care unit (NICU) population. Indwelling central catheter, parenteral nutrition, prior antibiotic exposure, and invasive procedures, are common in the NICU setting and a risk factor in the Intensive care unit (120).

Patients admitted in the hospital ward are susceptible to hospital acquired infections. Risk factors are also different from specific site to specific site infections, because hospital environments are complex. Previously conducted researches indicated that, long hospital stays(121,122), gender(123,124), intravascular catheter(125,126), surgery since admission(123,127), Intubation(128), mechanical ventilation(129), age of the patient(130,131), type of hospital (131,132), urinary catheter(123,128) were some of the risk factors for hospital acquired infections.

In Ethiopia, there are researches conducted in specific surgical site infections(133–135) and hospital acquired infections(131), however, none of the researches used strong epidemiological analytical method, to determine important risk factors. Matched case control study has its own bias during matching(136), but compared to cross-sectional design, matched case control design is strong for risk factor and minimizes bias(137). There was no such strong evidence generated in

the study setting. Understanding the potential risk factors is important to understand the local context. A matched case control study design, which is the first in its kind in the region, was undertaken to identify risk factors in teaching hospitals of Amhara regional state, Ethiopia.

1.4.2.2 Factors related to healthcare workers.

In low and middle-income countries, infection prevention and control policies are either non-existent, poorly adapted or insufficiently funded by governments. Lack of funds, inadequate infrastructure and management, improper use of antimicrobials and shortage of trained staff are key constraints for effective infection control in the hospitals of low income countries (27).

Infection prevention and control practice

Researches indicate that self-reported practice of healthcare workers regarding universal precaution for the prevention and control of hospital acquired infections ranges from 42% in Iran(138), 50.8% in Nigeria(139) and 63% in Indonesia hospitals(140). Nursing staffs practice more appropriate universal precaution control practice compared to physicians(141).

Healthcare workers are exposed to occupational risk for hospital acquired infection, exposed to blood or body fluids and sharp or needle stick injury. In Ethiopia, researches showed that proportion of healthcare workers exposed to blood or body fluids ranges from 22.9%(142) to 35.1% (143) and sharp or needle stick injury from 29% to 42.8%(144–146).

Systematic review and meta-analysis on prevalence of needle stick injury and exposure of blood and body fluids in Ethiopia show that the pooled prevalence of needle stick injury and exposure of body fluids among healthcare workers were 33.43%and 36.98%respectively (figure 3 and 4).

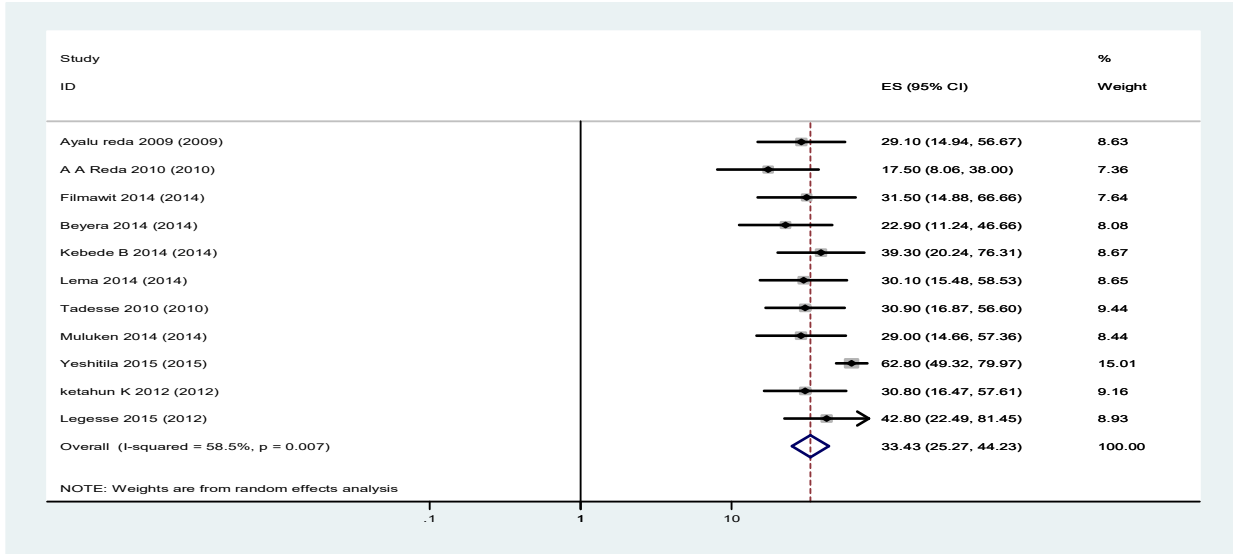


Figure 1: Pooled estimate of needle stick injury in Ethiopian healthcare workers

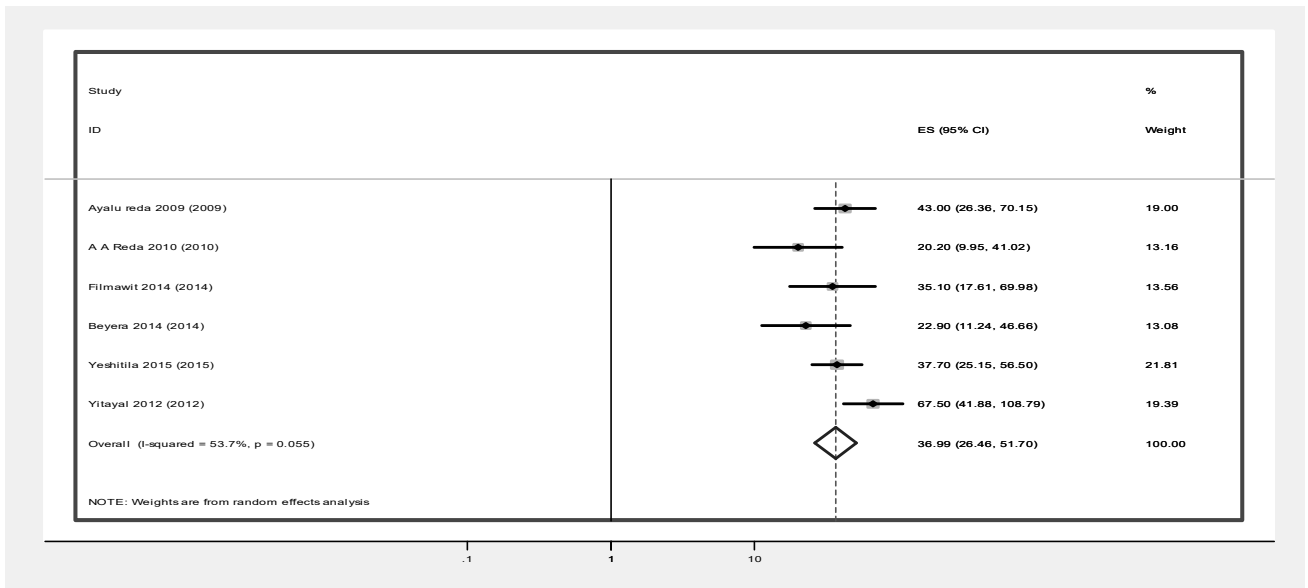


Figure 2: Pooled estimate of exposure of blood and body fluids in Ethiopian healthcare workers

In Ethiopia, there are studies on healthcare worker's infection prevention practice and control conducted by Teshager et al (147) with focus on surgical site infection, Abdella and Tena

(148,149) on hand hygiene compliance, Demissie Gizaw et al(150) for tuberculosis (TB) and Aynalem (143) for HIV/AIDS universal precautions, but none of them focused on all components of hospital acquired infection. Therefore, this research on components of infection prevention control items for hospital acquired infection in teaching hospitals is important.

1.4.2.3. Factors related to etiologic agents

The drug sensitivity pattern of microorganisms is one of the agent factors for the infection in the health care system. Patients are exposed to crowded rooms, undergo invasive procedures, be fitted with prosthetic devices, and require broad-spectrum antibiotics or immunosuppressive therapies. These conditions leads to the adaptation and spread of pathogenic microorganisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, vancomycin-resistant enterococci and multi-resistant *Acinetobacter* species(151).

Healthcare-associated infections caused by multi drug resistant organisms are associated with prolonged medical care, worse outcome and costly therapies(152). In Hungary, five-year surveillance showed that the overall incidence of infections increased from 5.4 in 2005 to 14.7 per 100,000 patient-days in 2010(152). Methicillin resistant *Staphylococcus aureus* (MRSA) was the most frequently reported pathogen (52.2%) and multidrug-resistant Gram-negative organisms have significantly increased from 2005 to 2010. Surgical wound and bloodstream were the most frequently reported sites of infections (152).

Health care facilities, particularly acute care facilities, are important sites for the development of antimicrobial resistance. Methicillin-resistant *Staphylococcus aureus* (MRSA) remains one of the most prevalent multidrug-resistant organisms causing health care-associated infections(84). A national prevalence survey of MRSA colonization or infection in inpatients at US health care facilities showed that, the overall MRSA prevalence rate was 66.4 per 1,000 inpatients (25.3 infections and 41.1 colonization per 1,000 inpatients) and nearly 20% of pathogens reported from all HAIs were multidrug-resistant phenotypes(153,154).

Multidrug-resistant pathogens boost the adverse impact of infections in ICUs. Researches in USA show that 16% of all HAIs were associated with the following multidrug-resistant pathogens: methicillin-resistant *S. aureus*, vancomycin-resistant *Enterococcus faecium*, carbapenem-resistant *P. aeruginosa*, extended-spectrum cephalosporin-resistant *K. pneumoniae*, extended-spectrum cephalosporin-resistant *E. coli*, and carbapenem resistant *A. baumannii*, *K. pneumoniae*, *K. oxytoca*, and *E. coli* (0.5%)(155).

Literature show that healthcare workers may acquire methicillin-resistant *Staphylococcus aureus* (MRSA) from patients, both in hospital and home environments, other healthcare workers, family and public acquaintances, and pets(156). Some of the risk factors for the MDR in hospital are age, severity index, having a bedridden condition, transfer from other units, nasogastric feeding, urinary catheterization, exposure to β -lactams or fluoroquinolones in the seven days before infection, new mutations, selection of resistant strains, and suboptimal infection control(157,158). A research in two hospitals in Addis Ababa on the resistance level from 95% isolates from nosocomial infection shown that the penicillin group such as, crystalline penicillin and ampicillin (16).

1.4.3. Barriers for Infection Prevention and Control

Hospital acquired infection affects patients, visitors, family members and health workers. Patients are more vulnerable to infection because of invasive procedures(89). Implementation of Infection prevention and control practices leads to significant reductions in hospital acquired infection(159). Effective IPC programs lead to more than a 30% reduction in HAI rates(159).

However, healthcare workers have good perception towards infection prevention(39), but there were high prevalence of needle stick injuries and exposure to blood and body fluids(142,160). This may be due to poor infection prevention practices or being unable to practice appropriate universal precaution by healthcare workers(148).

Healthcare workers behavior(161,162), environmental and organizational characters(163), occurrence of emergency situation(164,165), lack of available materials (166), shortage of time(167),

and poor communication between patients and healthcare workers(168) are some of the barriers to infection prevention practice.

Infection prevention and control are fundamental to quality of care, and essential to protect healthcare workers, patients, and communities. Failure to follow proper infection prevention practices puts healthcare workers, patients and the communities at tremendous risks (36). Researches showed that there is a strong correlation between environmental and organizational factors and self-reported compliances(169).

Behaviors of health care workers play key roles for prevention and control of Hospital acquired infections. Until recently, many clinicians have not considered themselves to be at risk from infection by working in healthcare(151). Transmission of blood borne pathogens [e.g., Hepatitis B virus (HBV), Hepatitis C virus (HBC), Human Immunodeficiency Virus (HIV)] from patients to healthcare workers (HCW) is an important occupational hazard faced by healthcare personnel (HCP)(170).

Awareness and practice of infection control by medical and other healthcare staff are often poor. These lapses in practice create significant risk for patients and staff from HAI. Most of the Health care workers do not know the relationship between bacterial hand counts and rings and fingernails, and do not believe that rings or long or artificial fingernails increase the risk of nosocomial Infections(171).

In Pakistan University hospital, 45% of health care providers reported having a needle stick injury in the past and the risk is higher among doctors(172). The most common reason identified was stress or being overburdened and careless attitude. In that study two third of participants were familiar with the prevention protocols(172). While a systematic review showed that there is no relationship between hospital staffing and the prevalence of hospital acquired infections(173).

The environment serves as a reservoir for a variety of microorganisms. Immuno-compromised populations are highly sensitive for this environmental microorganism(174). In the hospital environment, immune compromised populations need proper use of disinfectants, proper maintenance of medical equipment that use water, proper ventilation standards for specialized care environments, protective environment, and operating rooms , to minimize the risk of health-care-associated infection(174). Water can be the source of hospital acquired infection, if it lacks prevention measures and ignorance of the source(175).

Patients' participation for the control and prevention of hospital acquired infection is crucial and important. This could be enhanced by creating public awareness about of infection control practices. Patient involvement in HCWs' hand hygiene compliance, in particular, has been seen by experts as having prospects for sustained hand hygiene improvement and enhanced patient safety in the health care systems(176).

A research conducted in 2011 in USA on patients at the University of Wisconsin Hospital, regarding prevention of health care-associated infections of patients' awareness, knowledge, and perceptions showed that 76% of patients were aware of MRSA, whereas 44% were aware of C difficile(175). The awareness and knowledge of these infections was associated with having a history of HAI(175).

In Ethiopia, healthcare workers are at a very high risk of exposure to blood and body fluids. A cross sectional study conducted in six hospitals of Tigray in 2006 showed that, poor efforts are made to prevent infection after exposure and there is wrong practice of processing instrument (41). Out of 618 health care workers, needle stick injury was reported in 106 health care workers (17.2%), 348 (56.3%) had contact of blood and body fluid to their skin and 154 (24.9%) reported exposure to their mucus membrane. Regarding their knowledge to preventive measures, only 254 (41.1%) healthcare workers said that they wash their skin immediately and 318 (51.5%) flash their eyes with clean water or saline if their skin and mucous membranes are exposed. Incorrect method of processing instruments were practiced by high number of health care workers, namely, decontamination by 47.5%, disinfection by 46.5% and sterilization by 41.5% of them(41).

Based on the above review, addressing comprehensive picture of hospital acquired infection, factors that affect the prevalence of hospital acquired infection and exploring the reasons for the practice of hospital acquired infection is of a paramount important.

1.5. Dissertation Theoretical/Conceptual Frameworks

Like any infectious diseases causation, hospital acquired infection causation also applies with the theory of causal pie. The principle of causal pie assumes the multi-factorial nature of disease, which is generally accepted for infectious diseases, where micro-organisms are the essential causes of diseases(177). In this theory, lack of immunity of the host, with presence of microorganisms leads to the sufficient cause of diseases. The third component of the pie is the environment, which is considered as the background or playing field for the agent and host interaction(177).

In general, the epidemiological trait diseases causation model in hospital acquired infection is classified as agent(microorganisms), hosts (patients under care or their healthcare workers) and the common environment (hospital environment)(178).

In a health research, risk factors are important to find determinants that influence the occurrence of a health-related event. Therefore, risk factors are like personal behavior, environmental exposure, inborn or inherited characteristic which may be associated with health-related conditions. Therefore, risk factor is a determinant, but not necessarily a causal factor. However, the presence of risk factors in a population should be taken into account since any change in their occurrence will change the occurrence of a health-related event.

Based on the above principle and the theory of causation of hospital acquired infections are classified in the following ways:

Agent or microorganism must remain viable in the environment until contact with the host has been sufficient to allow infection. The type, drug sensitivity, dose, Enzyme and toxins of the organism would be the agent factors for hospital acquired infection. For the host; infection depends

on exposure of a susceptible host to an infecting agent and exposure of the susceptible host to such agents is influenced by intrinsic factors such as: sex, immune status, diseases therapy, vaccination or immunization status, hospitalization and the psychologic state of the host. Invasive medical or surgical procedures; medical devices, such as intravenous catheters or mechanical ventilators; duration of antimicrobial therapy and hospitalization; and exposure to hospital personnel are some of the common extrinsic factors(177).

Environmental factors affect both the host and agent interaction. Some of the environmental factors include; physical factors, like intensive care units, outpatient clinics, long-term care facilities, or water reservoirs; biologic factors, like patient characteristics and social factors, socioeconomic status, waste disposal and healthcare amenities(177). Hospital staff play an important role in HAI. Their conscious behavior may prevent or promote the occurrence of HAI in patients. However, their behavior plays an important role in self-defense since HAIs have occupational importance.

Procedural, Institutional and personal factors are factors that evolve from the host and environmental factors, but they are also highly interrelated and common in hospital acquired infections(177,178). Some of the factors are mechanical ventilation, end tracheal re-intubation, use of catheterization, prior antibiotic use, elective surgery, invasive procedure, contamination, perception, budget, behavior and practice of IP(Figure 3).

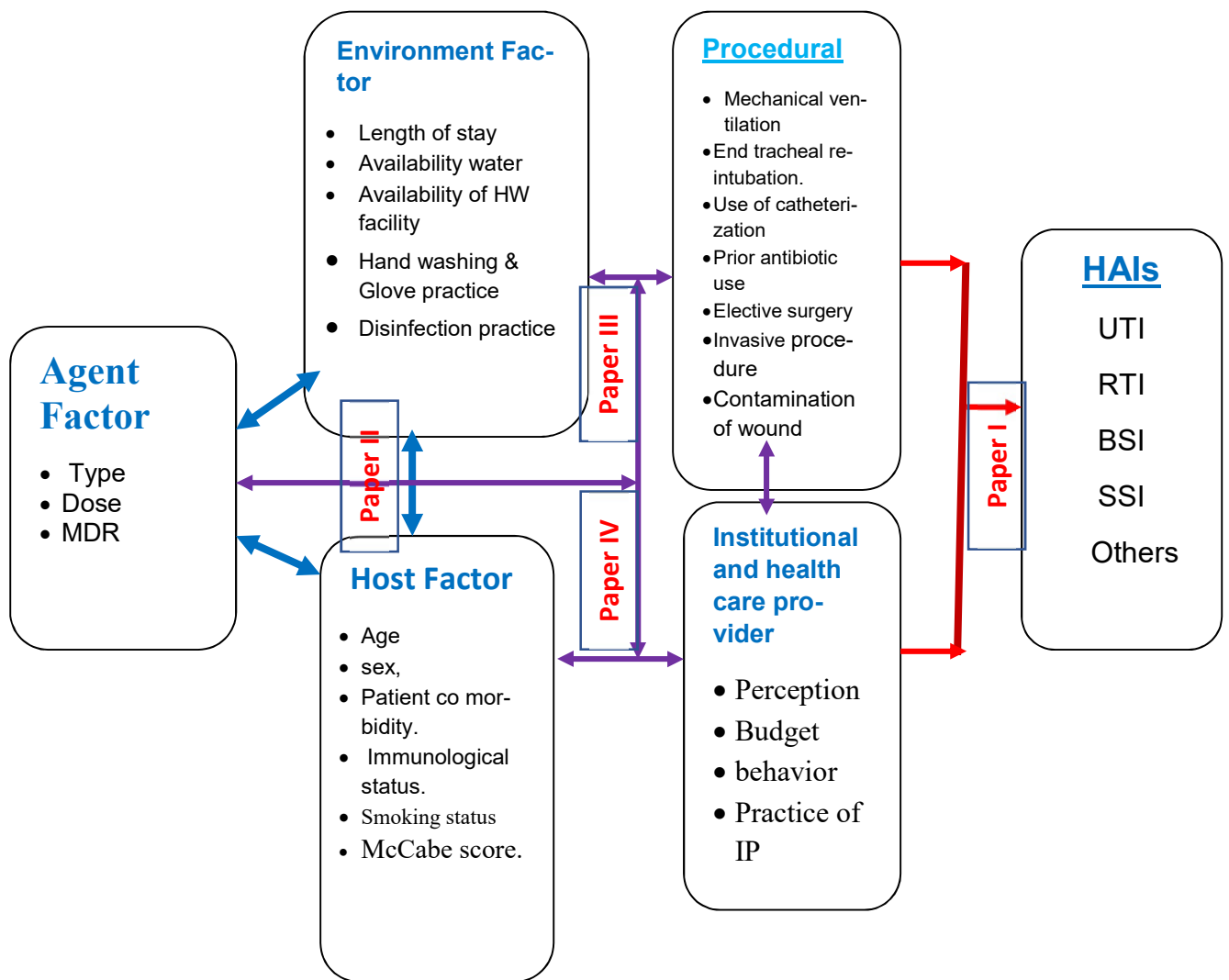


Figure 3: Conceptual frame work of factors affecting Hospital Acquired Infections(Zsolt Illetot,2003)

2. OBJECTIVES

2.1. General objective

- The overall aim of this study was to assess the magnitude and risk factors of hospital acquired infections and health care workers practice and barriers to infection prevention practice in Amhara Region Teaching Hospitals, Ethiopia

2.2. Specific- objectives

1. To determine the prevalence of hospital acquired infections (***Paper I***).
2. To identify factors associated with hospital acquired infections (***Paper II***).
3. To describe Healthcare workers practice towards infection prevention (***Paper III***).
4. To explore barriers for Infection prevention and control practice (***Paper IV***).

3. MATERIALS AND METHODS

In this dissertation four studies were conducted. The first was a repeated cross-sectional study to determine hospital acquired infection in-patients. The second paper was to identify risk factors for hospital acquired infection using case control study. Paper III focus on healthcare worker's infection prevention practice using cross-sectional study and the fourth paper was qualitative study to explore barriers to infection prevention and control practice using healthcare workers and management staffs in the two-teaching hospitals.

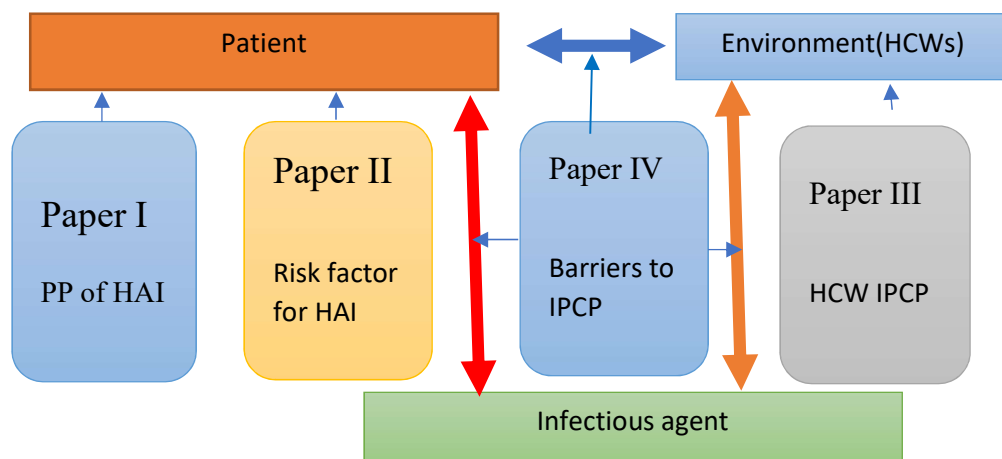


Figure 4 : Dissertation Paper focus on hospital acquired infection and barriers to infection prevention in teaching hospitals.

3.1 The setting: Study area and population

Ethiopia is the second most populous country in sub-Saharan Africa. According to the 2015/16 Central Statistical Agency of Ethiopia (CSA) projection, Ethiopia has a population of 92,206,005 people(179). Amhara region is one of the 9 administrative regional states and is the second most populous region in the country. Amhara Region has a population of 20,769,985 where 10,401,995, were men and 10,367,990 women. Urban inhabitants were 3,492,000 (16.81%) (179). Bahir Dar is the capital city of the Amhara Region, which is found 566 km far from Addis Ababa

In Ethiopia, health care delivery system is designed in three-tier system. Woreda/District is the first level with primary hospital to serve 60,000-100,000 people. The second level is a General Hospital with population coverage of 1-1.5 million people; and the third level is Specialized Hospital that covers population of 3.5-5 million(180).

The study was conducted in selected teaching hospitals in the Amhara Regional State. According to the Amhara Region Health Bureau 2013/14 report, there are 19 publics and 7 private general hospitals in the region and 840 and 3392 functional health centers and health post serving the community(181). Based on the Ministry of Health care delivery system, there are 5 referrals, 2 zonal and 12 district hospitals. A total of 2265 inpatient beds are present in public hospitals. Three hundred forty-seven physicians, with a ratio of 1:55385 to the population and 7047 nurses are available in the region to serve the population.

According to the 2012/2013 report of the Regional Health Bureau, the number of inpatients treated were 129723(182). Out of this, 22005 were from Felege-Hiwot Hospital and the rest 19088 from university of Gondar teaching Hospital. University of Gondar Hospital has a total of 498 inpatient beds and it is the first public Health College Hospital in Ethiopia. It has 105 pediatric, 112 surgical, 143 (24 Gynecology, 70 Fistula training centers and 49 obstetric beds), 128 internal medicine inpatient beds and 6 pediatric and 4 adult Intensive Care Unit. It has a total of 338 male and 242 female with a total of 580 health care workers in the Hospital(183). Felege-Hiwot Hospital has a total of 378 inpatient beds and it is found in the Capital City of Amhara Region and it also serves as a teaching hospital for Bahirdar University medical students. It has 57 pediatric, 47 gynecology, 26 maternities, 71 internal medicine, 134 surgical, 16 ophthalmology and 16 private wing inpatient beds. According to the 2012/2013 report of the Regional Health Bureau, average bed occupancy in hospitals is 70%(182).

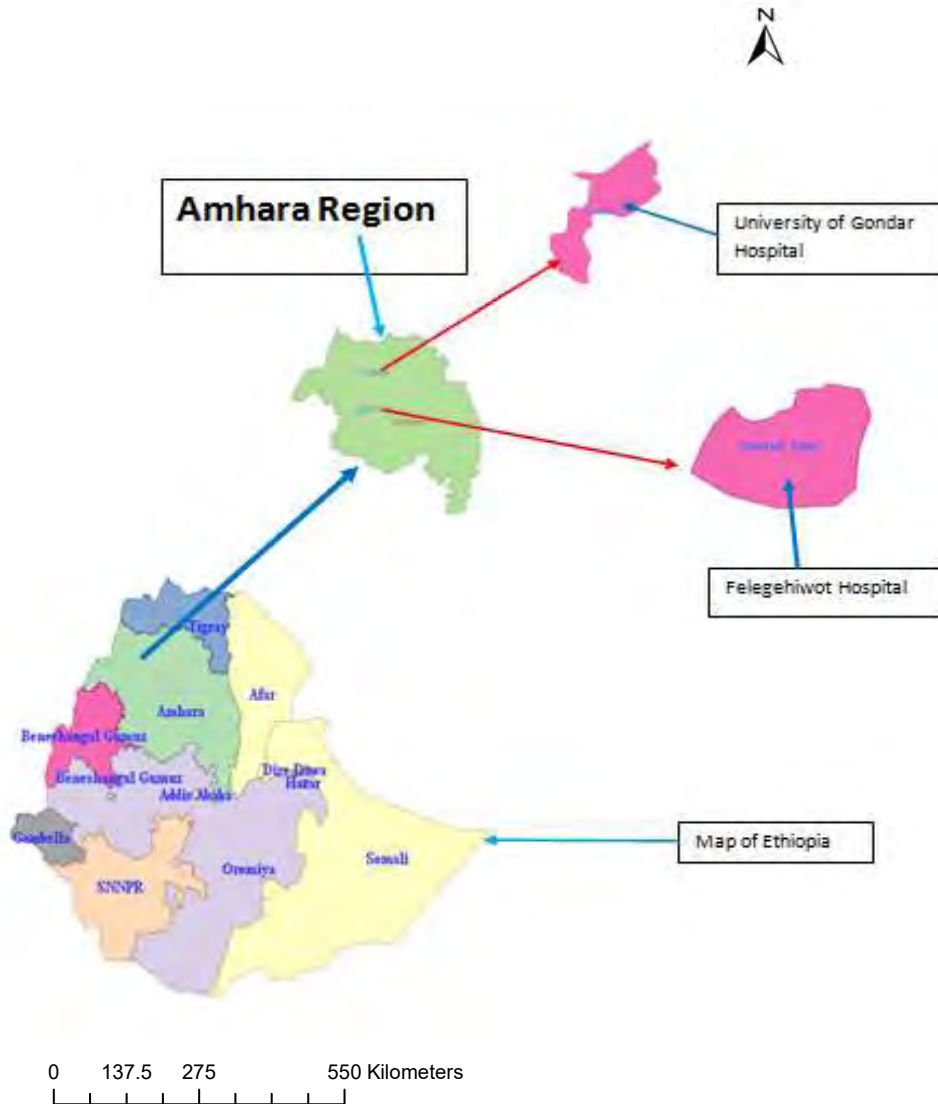


Figure 5 : Map of the study area (Amhara Region) Felege-Hiwot and University of Gondar Hospitals, 2015, Ethiopia.

3.2 Study design and time frame

3.2.1. Design

To address the objectives of this dissertation quantitative and qualitative research design approaches were used. A repeated cross-sectional study was used to determine the prevalence of HAI. A matched case control study design was used to identify risk factors for hospital acquired infections. Matching was made by age and hospital type. Descriptive cross-sectional study design was used to determine health care worker's infection prevention and control practice. To explore barriers to infection prevention and control practice phenomenological qualitative research approach was used.

3.2.2 Timeframe of the Study

To determine the magnitude and risk factors for hospital acquired infections, data were collected twice from each hospital. The first round of survey was conducted from March 16, 2015 to April 2, 2015, and the second round was conducted from July 1, 2015 to July 10, 2015. For the other two studies; health care worker's infection prevention and control practice and to explore barriers to infection prevention and control practice were conducted from March to April 2015.

3.3 Source and study population

3.3.1. Source population

The source population to address the prevalence and risk factors for hospital acquired infections were all inpatients admitted in Amhara Region teaching hospitals. To assess healthcare workers' infection prevention and control practice, source population were all health care providers working in Amhara Region teaching hospitals. Health care workers and management staffs' in teaching hospitals were the source population to explore barriers to infection prevention and control practices.

3.3.2. Study population

The study population were all inpatients, health care workers and management staffs' working in the two referral teaching hospitals, university of Gondar and Felege-Hiwot respectively.

3.3.3 Eligibility criteria

a) Hospital

For all designs in this dissertation, University of Gondar and Felege-Hiwot teaching hospitals were included in the study. Other teaching hospitals in the Region were not included, since they did not have all levels of medical students during the study period.

b) Wards and Departments

Wards in all care facilities (Surgical, Gynecology and obstetrics, Internal medicine, Pediatrics, Ophthalmology and Intensive Care Unit (ICU)) were included. Emergency and recovery departments and wards were excluded.

c) Patient

All patients admitted to the ward by 8:00am and not discharged from the ward at the time of the survey were included. Patient transfer from one ward to the other was also included in the survey.

d) Healthcare workers

All health care workers that have direct involvement with inpatient in the ward were included. Health workers who were not in their work place during the survey time due to any reason including on leave, study leave, on training, etc were not included.

e) Healthcare workers and management staffs

Health care providers and management staffs knowledgeable of the respective departments and wards were part of the qualitative study.

3.4 Sample size and sampling methods

Sample size:

To calculate sample size to determine the magnitude of hospital acquired infection in a teaching hospital, the following assumptions were made: a 17.8% proportion of HAI (19), a 3% precision and 95% level of confidence.

The following single proportion formula was used.

$$n = \frac{z^2_{\alpha/2} \times p(1 - P)}{d^2}$$

Where; n= sample size

$$d = \text{maximum allowable error (margin of error)} = 0.03$$

$$Z = \text{value of standard normal distribution (Z-statistic) at 95\% confidence level (z=1.96)}.$$

The calculated sample size was 625 subjects.

Considering a design effect of 1.5, the sample size become 936. Adding a 10% non-response rate, the final sample size required for addressing the first objective was 1031. Total number of inpatient beds expected in the two hospitals were 514 UOG +360 FHH = 865. Applying the 70% bed occupancy rate in Amhara Region, the total inpatients expected were about 606. During the two repeated surveys, the total number of in-patients expected during the study period were 1212. Hence, the two waves of data collection were expected to produce sample size required for the study to address prevalence of hospital acquired infection in teaching hospitals.

The following double proportion formula was used to determine sample size for the matched case control study.

$$n_i = \frac{[Z_{\alpha/2}\sqrt{(r+1)\pi Q} + Z_{\beta}\sqrt{rP_iQ_i + P_cQ_c}]^2}{r(P_i - P_c)^2}$$

Where:

n_i = the required sample size for cases

P_c = estimated proportion of exposure (independent variable) among controls.

P_i = estimated proportion of exposure among cases.

$$\pi = \frac{P_i + rP_c}{r+1}$$

$P_i = \frac{P_c OR}{(1 + P_c(OR - 1))}$ Where OR=Odds Ratio, in case of P_i is not available in the literature, it was estimated from the available OR.

$$Q = 1 - \pi$$

$$Q_i = 1 - P_i$$

$$Q_c = 1 - P_c$$

$Z_{\alpha/2}$ = 1.96 standard score corresponding to 95% CL (two side))

Z_{β} = 0.84 (standard score corresponding to 80% power)

r = ratio of controls to cases = 4

Based on the above formula, the sample sizes for different predictors were calculated and checked. A common assumption was used for all exposure factors considered in the sample size, except for the proportion of exposure among cases and controls. A 5% type I error, 80% power to detect exposure difference between cases and controls, a 1:4 ratio of cases to controls, a design effect of 1.5 by assuming there is variation between wards in each hospital, and a 10% non-response rate. Different factors were computed, by assuming similar studies, to get maximum sample size (184–186). Based on the above assumptions, result for risk factors for hospital acquired infections include a total of 545 inpatients, 109 cases and 436 controls were considered.

To describe health care workers, infection prevention practice, sample size was calculated using formula for estimation of single proportion. Proportion of Healthcare workers practice of infection

prevention and control was assumed to be based 46.9% on a study conducted in Eastern Ethiopia, Reda et al(40).

$d = \text{maximum allowable error (margin of error)} = 0.05$

$Z = \text{value of standard normal distribution (Z-statistic) at 95\% confidence level (z=1.96)}$.

n = 383 health care workers were required.

A 10% non-response rate was included in the sample. Totally 422, healthcare workers participated for the third objective.

The number of participants for the in-depth interview were 10 health care workers in different wards. For the focus group discussion, two focus groups in each hospital, one group of health professionals and the other management staffs of 6-8 persons were included. Level of saturation of ideas based on the guiding questions was determined by number of participants and probes during interview.

Sampling method:

For prevalence of hospital acquired infection, sampling method was determined based on the number of beds in two hospitals. Totally 865 beds were available in the two hospitals: five hundred fourteen from University of Gondar and 351 from Felege-Hiwot hospital (Figure 6). The eligibility criteria was based on the definition for hospital acquired infection by Center for Diseases Control and prevention(CDC)(187).

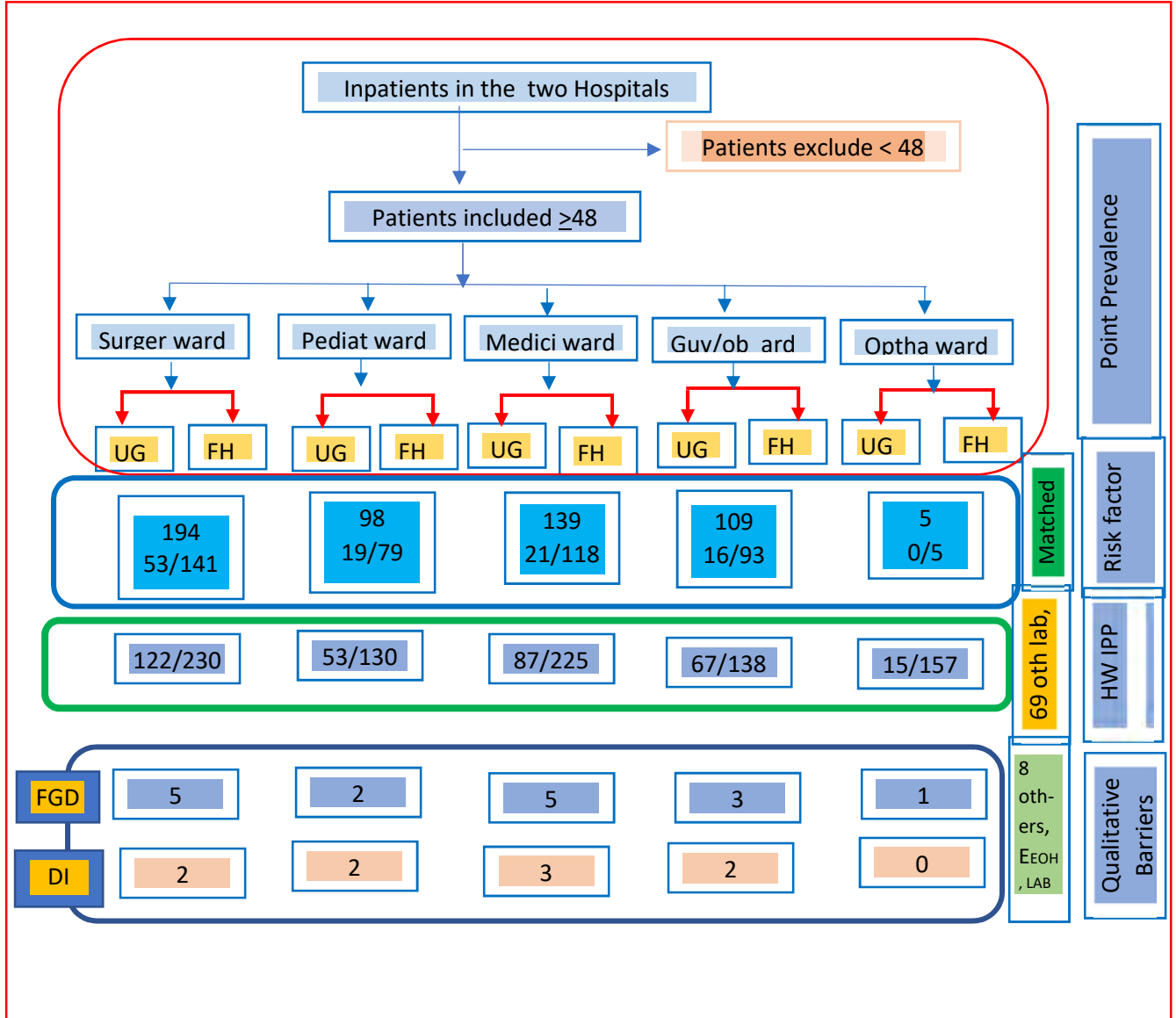


Figure 6 : Sampling procedures for patients, healthcare workers for HAI and barriers to infection prévention and control practice ,2015.

Patients that fulfilled the criteria based on CDC definition of Hospital acquired infection were included in the study for cases. The controls were matched based on age, hospital type with cases. Simple random sampling method was employed to select cases and controls to include in the study.

Health care workers were proportionally allocated in each hospital and ward based on their number. Systematic random sampling was used to select healthcare workers based on the list of the number of health care workers in the hospital and wards (Figure 6). One study subject was recruited only once.

For barrier to infection prevention and control practice, participants were selected purposively from healthcare workers and management staffs in the two hospitals. The selection considered wards and universities, those who have adequate information regarding infection prevention and control in the hospital.

3.5 Survey instruments and procedures

Questionnaire

A pretested standardized questionnaire was used to collect data for prevalence, risk factor and healthcare worker's infection prevention practice study. Questionnaires were prepared in English and then translated into Amharic. Once data were collected from respondents through the Amharic version, the responses of each questionnaire in Amharic were re-translated to English. Brief description about the importance of the study was given to eligible participants, before administering the questionnaires. For Health care professionals, self-administered English questionnaire was prepared. For the in-depth interview and focus group discussion, Amharic version guiding questions were prepared.

Laboratory Sample

Laboratory samples were analyzed in University of Gondar Hospital, Department of Medical Microbiology Laboratory and Bahir-Dar Regional Laboratories. For active hospital acquired infection patients, sample was taken based on the sign and symptom and specific site criteria recommended by CDC(6). Type of clinical samples collected included urine, sputum, wound swabs, fecal specimens, throat swabs, nasal swabs, and blood (188–190). For non-active hospital acquired infection patients, appropriate informations were collected.

Sputum sample

Sputum samples were collected from a patient suspected of respiratory tract infection using a clean, dry, wide-necked, *leak-proof* container. Patients were requested to cough deeply to produce a sputum specimen until the sputum reaches the 5-ml line (or more) on the plastic cup (one teaspoon of sputum). Collected samples were sent immediately for culturing. Collected sample were primarily inoculated on Blood and Chocolate agar(189).

Urine sample:

Urine samples were collected from patients aseptically via a urethral or supra pubic catheter or catheter sampling port from catheterized patients. Biochemical tests were conducted from pure colonies. Gram–negative rods were identified by performing a series of biochemical tests (Oxoid, LTD), such as triple iron agar, indole, simons citrate agar, lysine iron agar, urea, mannitol. Gram positive cocci were also identified using gram reaction, novobiocin, catalase and coagulase tests(188,189).

Swab sample

Swab samples were collected from patients suspected of surgical site infections. The swab samples were inoculated onto MacConkey agar, Chocolate Agar Plate (CAP) and blood agar plate (BAP) (Oxoid, LTD). The inoculated agar plates were incubated at 35⁰C for 24-48 hours. Then growth were inspected to identify the bacteria. Preliminary identification of bacteria was based on gram

reaction. Colony characteristics of the organisms, like hemolysis on blood agar, change in physical appearances in different media and different biochemical activities were performed using standard procedure(188,189).

Blood sample

Samples were collected from patients with signs and symptoms of hospital acquired infection(48). Sample were collected with sample plastic syringe of the capacity required, 2.5 ml, 5 ml, or 10 ml. For adults, 19 or 20 SWG needles and for children or an adult with small veins, 23 SWG needles were used. Before taking the sample, the site was cleaned with 70% ethanol an area about 50 mm in diameter and using 2% tincture of iodine in a circular action. Using a sterile syringe and needle, 10 ml of blood was withdrawn from an adult or about 2 ml from a young child. To increase the chances of isolating a pathogen, two specimens (collected at different times) were cultured. To reduce the risk of contamination, blood from neonates was collected from a peripheral vein not, from the umbilical vein(188,189).

Blood samples were inoculated directly into Trypton soya broth blood culture medium bottles (Oxoid LTD). The blood cultures were incubated aerobically at 37°C and observed daily for the first 3 days, for the presence of visible microbial growth by one of the following: haemolysis, air bubbles (gas production), and coagulation of broth. At the same time, subcultures were made during successive days on enriched and selective media, including Blood agar plate(BAP) (Oxoid LTD), chocolate agar plate (CAP) (incubated at 5% CO₂ atmosphere), MacConkey(MaC) (Oxoid LTD) and manitol salt agar (Oxoid LTT) plates and examined for growth after 24–48 hours of incubation. Colonies were checked by Gram staining technique, to see whether they are Gram positives or Gram negatives. Gram-positives were identified using catalase and coagulase. Gram-negatives were identified by performing a series of biochemical tests (Oxoid, UK) (188,189).

Antimicrobial Susceptibility Testing

Susceptibility tests were performed only when the amount of cultural growth of a pathogen was significant. The bacterial susceptibility testing was done by the disk diffusion method according to Kirby-Bauer method, following the National Committee for Clinical Laboratory Standards

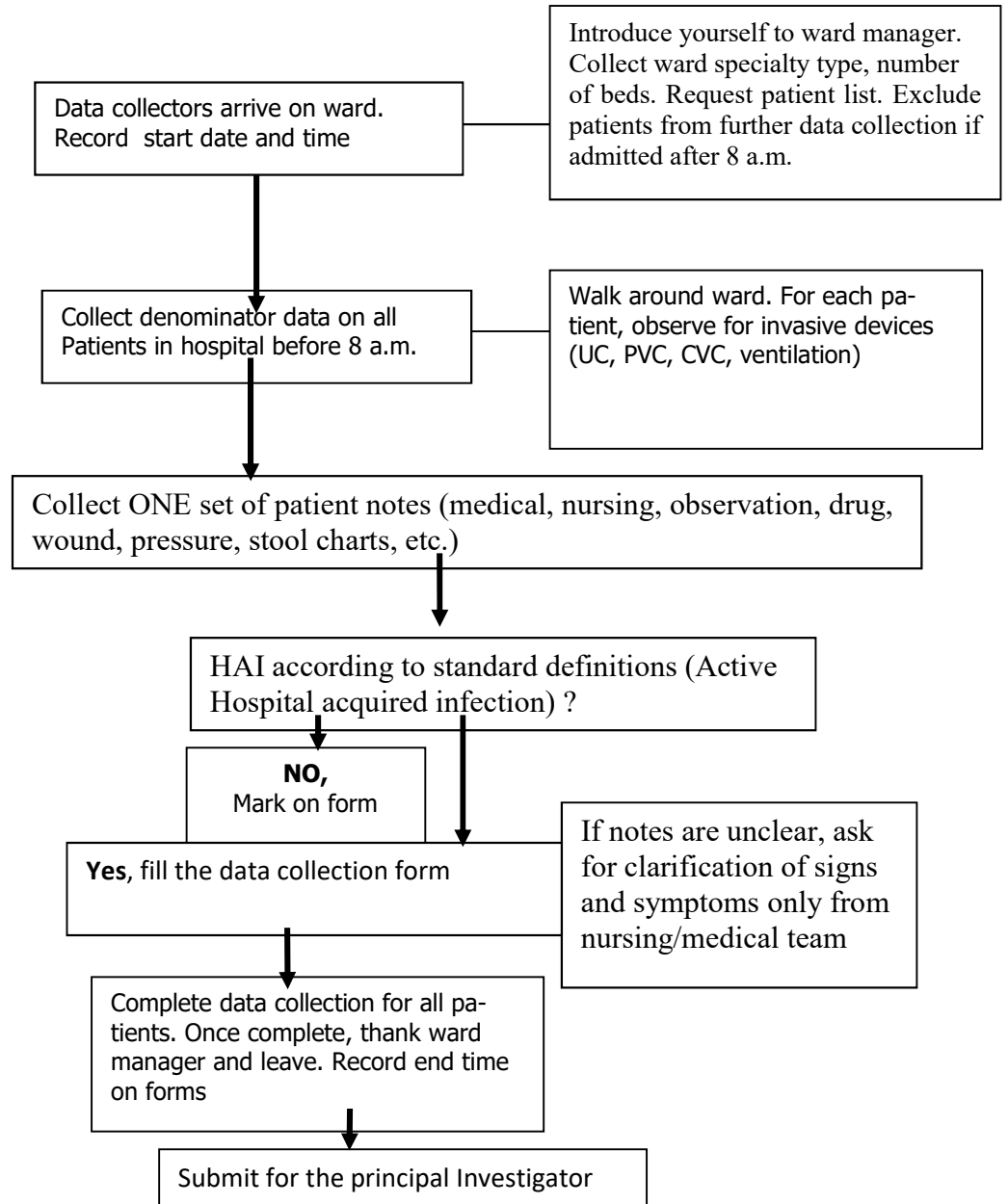
(NCCLS) assessment criteria. Bacterial inocula were prepared by suspending the freshly grown bacteria in 4-5 ml sterile nutrient broth and the turbidity was adjusted to that of a 0.5 McFarland standard. The antimicrobial susceptibility testing were performed against amoxicillin (30mg), ampicillin (10 mg), amikacin (30mg) chloramphenicol (30 mg), ciprofloxacin (5 mg), clindamycin (2 mg), erythromycin (15mg), gentamicin (10mg), methicillin (5mg), rifampicin (5mg), streptomycin (10mg), trimethoprim-sulfamethoxazole (5mg), oxacillin(1µg) and vancomycin (30 mg).The zones of inhibition were measured and compared with National Committee for Clinical Laboratory Standards (NCCLS) guidelines *S. aureus* ATCC 25923, an all-sensitive reference strain was used as a quality control strain for the disc agar diffusion test. The suspension was used within 15 minutes. The plates were incubated aerobically at 37°C for 18-24 hours. Zone of inhibition around antibiotic disks were recorded and using the chart provided by the antimicrobials manufacturer, results were interpreted as sensitive, intermediate or resistant(191,192).

To assess practice of infection prevention and control, structured and pre-tested self-administered questionnaire was used. Ten trained data collectors for one day collect the data. For the qualitative part to explore barriers for IPC practice, face to face interview was conducted. The interview was conducted in their office. Both face to face interview and focus group discussions were facilitated by the principal investigator. One additional note taker was recruited for the FGD.

Semi- structured interview guide was used for both in-depth-interview and FGD discussions. The interview guide was developed based on previous literature on barriers and challenges to the implementation of infection prevention and control practice. Interview guide was tested and checked before the actual data collection. Questions were arranged with simple definition terms to the broader contextual definitions to the inter linked ideas.

Data were collected by eight trained physicians (Pediatrician, Internist, Surgeon, Gynecologists) and eight nurses in each ward and two Laboratory technicians. Each ward was surveyed and completed on one day. Data were gathered from a number of sources available on the ward at the time of the survey, such as nursing notes, medical notes, temperature charts, drug charts, surgical notes, laboratory reports. A detailed history of patients were taken and recorded or discussions with nursing staff were held. Data were collected by pretested standardized data collection forms

adopted from European Centre for Disease Prevention and Control Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals protocol version 4.3(193). Laboratory samples were taken from active HAI cases with the standard procedure recommended by CDC HAI definition criteria(6,48). Data collectors checked every sign and symptom to include in the relevant CDC HAI definition and to decide whether the patient developed HAI or not. Information regarding causative organisms sample was collected.



UC=urinary catheter; PVC=peripheral vascular catheter; CVC=central vascular catheter

Figure 7: Recommended case finding algorithm for healthcare-associated infections

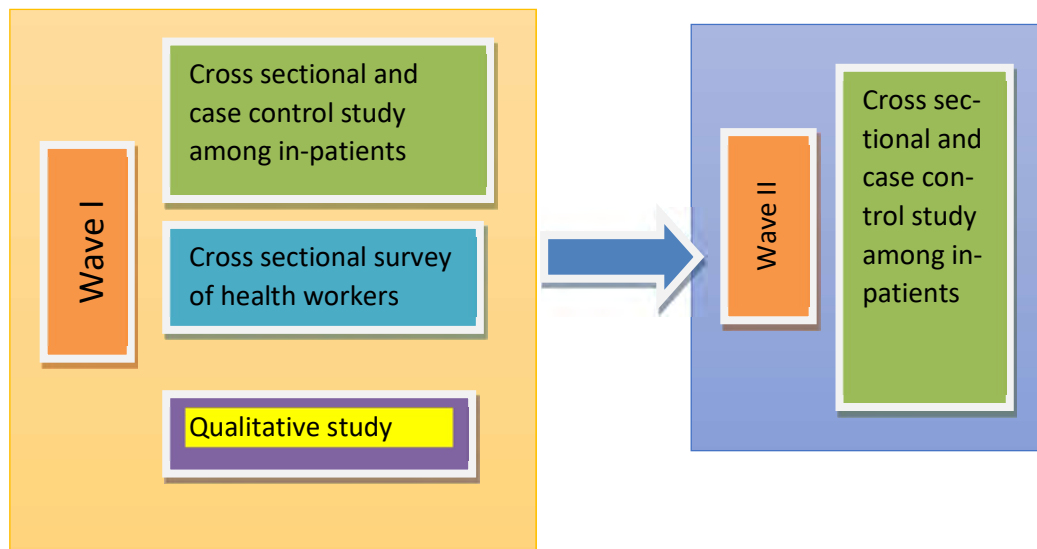


Figure 8: Summary of data collection methods of the two waves

3.6 Data management and analysis

3.6.1 Data Management

For magnitude and risk factors study, medical record and the consultation with the person in charge of the patient were gold standard for the identification of infection. All inpatient beds in each ward were included in each hospital. Internal medicine, surgery, obstetrics and gynecology, pediatrics, and ophthalmology were the departments. Data collectors were trained for three days about the definitions and the study protocol prior to starting the study. During training, practical case exercises were provided and training manual and standardized case record form were reviewed and practiced.

Infection prevention and practice to healthcare worker's data were collected using pre-tested questionnaire. Data collectors were trained for one day. Principal investigator supervised and moni-

tored the overall activities of the study project. The collected data were checked for the completeness, accuracy and consistency by the principal investigator. Missed and incomplete response in the questionnaire were corrected during data collection date.

All quantitative data were checked and cleaned before data were entered to the computer. Missing data or inconsistencies were returned to the data collector for correction. Data were checked, coded, and double entered to EPINFO version 3.5.3 and transported to SPSS 21 and STATA 13 for analysis.

Data were gathered in the form of audio record and notes from the in-depth interview and FGD and the texts were analyzed thematically. Prior to analysis, all the collected data were transcribed into English. The field notes were checked for accuracy and completeness. The transcribed data was read more than three times to understand the context. Word transcript documents were changed to text files and imported to open code software.

Operational definition

Hospital acquired infection:

Hospital Acquired Infection is defined as an infection arising >48 h or more after admission to hospital that neither present nor incubating on admission. HCAI was confirmed if the patient has signs and symptoms which met the Centers for Disease Control and Prevention (CDC, Atlanta, GA, USA) definition at the time of data collection date. CDC's HAI case definitions are a widely accepted and used internationally.

An active healthcare-associated infection:

Infection present on the day of the survey is defined as follows:

- An infection is active when signs and symptoms of the infection are present on the data collection date OR signs and symptoms were present in the past and the patient is (still) receiving treatment for that infection on the data collection date. The presence of symptoms and signs should be verified until the start of the treatment in order to determine

whether the treated infection matches one of the case definitions of healthcare associated infection.

- The onset of symptoms was on Day 3 or later (day of admission = Day 1) of the current admission OR the patient presents with an infection but has been readmitted less than two days after a previous discharge from an acute care hospital OR
 - ✓ The patient has been admitted (or develops symptoms within two days) with an infection that meets the case definition of an active surgical site infection (SSI), i.e. the SSI occurred within 30 days of the operation (or in the case of surgery involving an implant, was a deep or organ/space SSI that developed within a year of the operation) and the patient either has symptoms that meet the case definition and/or is on antimicrobial treatment for that infection;
 - ✓ The patient has been admitted (or develops symptoms within two days) with *C. difficile* infection less than 28 days after a previous discharge from an acute care hospital;
 - ✓ An invasive device was placed on Day 1 or Day 2, resulting in an HAI before Day 3.
- Results of tests/examinations that are not available on the survey date should neither be completed after the survey date nor taken into account when establishing whether the case definition criteria are fulfilled.

Non-active HAI Patients: patients that are eligible for the population but do not full fill the above criteria for active HAI definitions.

McCabe score. Classification of the severity of underlying medical conditions. Disregard the influence of acute healthcare-associated infections, if the patient has an active HAI, estimate the score the patient had before the infection.

- Nonfatal disease (expected survival, at least five years);
- Ultimately fatal disease (expected survival between one and five years);
- Rapidly fatal disease (expected death within one year); unknown.

Examples for McCabe score:

Rapidly fatal: < one year

- End-stage hematological malignancies (unsuitable for transplant, or relapsed), heart failure (EF < 25%) and end-stage liver disease (unsuitable for transplant with recalcitrant ascites, encephalopathy or varices).
- Multiple organ failure on intensive care unit
- Pulmonary disease with cor pulmonale

Ultimately fatal: one year to four years

- Chronic leukemias, myelomas, lymphomas, metastatic carcinoma, end-stage kidney disease (without transplant).
- Motor neuron disease, multiple sclerosis non-responsive to treatment. Alzheimers/dementia.
- Diabetes requiring amputation or post amputation

Non-fatal: > five years

- Diabetes
- Carcinoma/hematological malignancy with > 80% five-year survival
- Inflammatory disorders
- Chronic GI, GU conditions
- Obstetrics
- Infections (including HIV, HCV, HBV – unless in above categories)

Device-associated HAI is an HAI in a patient with a (relevant) device that was used within the 48-hour period before onset of infection (even intermittently). The term ‘device-associated’ is only used for pneumonia, bloodstream infection and urinary tract infection. The ‘relevant devices’ are intubation, vascular (central/peripheral) catheter and urinary catheters, respectively. If the interval is longer than 48 hours, there must be compelling evidence that the infection was associated with device use. For catheter-associated UTI, the indwelling urinary catheter must have been in place within seven days before positive laboratory results or signs and symptoms meeting criteria for UTI were evident.

Endogenous risk factors: are those that originate in a patient in whom a disease develops, and such factors contribute to an increased risk of development of the disease of interest.

Exogenous risk factors: are those factors originating from a source external to the patient in whom the disease occurs; such factors are often called ‘environmental’.

3.6.2 Data analysis

The point prevalence of hospital acquired infection was determined by using descriptive statistics. The prevalence of HAI was calculated (number of infections divided by the total number of the study population) and for cases (number of patients with HAI divided by the total number of study population), with 95% Cis.

For risk factors after matching cases and controls with a unique identifier, bivariate and multivariable conditional logistic regression was employed to identify independent factors associated with HAI. For the relationship of outcome variable and explanatory variable, 95% CI and $P < 0.05$ were considered statically significant. To prevent sampling error, data were weighted based on population to a sample proportion of the ward sample

Multi Collinearity of independent predictor variables were also assessed using Pearson correlation and those with r-value of less than 0.6 were used in model fitting. Collinearity between categorical variables was assessed by looking at values of variance inflation factor (VIF) and those larger than 10 were excluded from the fitted model.

Model fitness was also checked by using Omnibus Tests of Model Coefficients, in which -2LL is significantly different with the base model. Hosmer-Lemeshow Goodness of Fit Test greater than 0.05 was considered as good model fit to final prediction. Cox & Snell and the Nagelkerke R Square (pseudo R square statistics) was also observed to model prediction (0 to 1 scale), in which the higher value indicated that the model predicts well.

For all quantitative analysis, relationship of outcome variable and explanatory variable 95% CI and $P < 0.05$ were considered statically significant(194,195).

Qualitative data analysis was conducted with open code software, version 4.03 and the contents were analyzed thematically. Important steps for data analysis were conducted, such as data familiarization, initial coding, search coding related to ideas, reviewing of themes defining and reading the transcriptions. Coding was conducted careful line by line reading several times. The codes were grouped in to categories then analyzed thematically.

3.6 Data quality assurance

Quality of the data were assured from the beginning in the designing, of the study up to final analysis and write up. Data collection tools were adapted from different credible literatures based on the available evidences in the area. Study teams attended a three-day training session regarding the definitions and the study protocol prior to starting the study. Practical case exercises and the protocol and standardized case record forms were reviewed. Amharic Language was used to ease understanding.

Data collection tools were validated on two pre-selected wards with the “Gold Standard” by comparing the collected data (inter-rater reliability). Data collectors, collect basic demographic information and other HAI on eligible patients in the selected wards, with exact application of the real data collection form and case definitions. International standard strains of *Escherichia coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used for culture and susceptibility testing(196).

Double data entry was conducted to minimize error when data were entered. After a data entry transposition, consistency, error and range to control the outlier during data entry were checked by running frequency.

For the qualitative part, all recorded audio tapes were examined for completeness each day by the principal investigator. The collected raw data by the audio record were then transcribed and translated to English. To assure the credibility of the data collected during interview, the PI give more time for the participant for discussion and triangulate the information with the available evidence and try to get feedback at the end of the discussion regarding the consistency of discussion. To

assure transferability of data, purposive sampling technique was used. Participants were selected in different wards, those who were expected to have adequate information regarding infection prevention and control.

3.7 Ethical considerations

Data were collected after ethical clearance from the College of Health Science(CHS) of the Addis Ababa University and University of Gondar Institutional Ethical Review Board. Permission was obtained from Amhara Regional and zonal administration and Hospital administration offices.

The questions from the questionnaire were proved not to affect the morale and personality of study subjects. There was no risk in participating in this research project and the samples collected were used only for this research purpose. The samples (blood, urine, stool, sputum) collected in this research were discarded after samples were analyzed. Informed consent was obtained from each study subject after explanation of the risks and benefits of participating on this research.

Confidentiality was ensured from all data collectors and principal investigator's side via using code numbers than names and keeping questionnaires locked. Data collectors were interview separately from other people to keep the privacy of the clients.

Data collectors arranged health education and advice to study participants during data collection about hospital acquired infection. Patients identified as having hospital acquired infections were treated. The research team also communicated respected health worker and management staffs for additional health care service.

In addition to all the information mentioned above, informed consent was obtained in advance from the respective FG discussants to record their responses. Notes were taken to be able to capture the interaction with participants.

3.8 Summary table of study objectives and methods

Table 1: Summary of the methods for the dissertation work

Objective	Target population	Study design	Sample size	Sampling method	Data collection tool	Data analysis
1.To determine the prevalence of HAI	All admitted Inpatient >48 hrs	Cross-sectional	908	All inpatients admitted in to wards before 8:00 am	-questionnaire - physical examination -Chart review -Laboratory tests	Descriptive analysis
2.To identify factors associated with HAI	Patients with HAI and Without HAI	Matched Case control	109 cases and 436 controls a total of 545	-Cases (fulfills the CDC definition, -Controls randomly selected	-questionnaire - physical examination -Chart review -Laboratory tests	Conditional logistic regression
3.To describe Healthcare workers practice towards IPC	All health workers working and have contact with patients	Cross-sectional	422 health care workers	Systematic random proportionally allocation of Health professionals	- self-administered questionnaire	Multivariable logistic regression analysis
4. To explore barriers to IPC practice	Different HWs and managements of the hospital	Qualitative	10- DI HCW 4 -FGD (23 HCWs) management staffs	-Purposive Sampling	- Semi structured Open Ended Guiding questions	Thematic analysis

4. MAIN FINDINGS

The detailed results of the findings are found at the end of this thesis attached in the annex part.

The descriptions of main findings presented below are based on the objectives of the study.

4.1 Point prevalence and patterns of hospital-acquired infections

Totally 908 patients were included in this point prevalence survey. Records of 9 patients with incomplete information were excluded from the analysis. The median age of the patients was 27 years (inter-quartile range of 16 to 40 years). Out of the total patients included in this study, 573 (63.1%) were from the University of Gondar and the rest 36.9% from Felege-Hiwot Hospital. Almost half of the participants were males 466(51.3%). Four hundred sixty (50.7%) of the data were collected in the dry season and 45.5% of the participants were in age group of 15-34 years. More than half of the participants were from the two departments, surgery 289 (31.8%) and medical wards 235 (25.9%). A total of 650 (71.6%) patients received antimicrobial during the survey. Only 12(1.3%) and 162(17.8% of patients used Central vascular catheter and Urinary catheter respectively. More than half or 56.9% of patients' health status were in nonfatal diseases (**Table 2**).

Table 2: Demographic and Clinical Characteristics of patients who participated in the survey, University of Gondar and Felege-Hiwot hospitals, 2015, Ethiopia (n=908 Patients)

Characteristics		No of Patients (percent)
Sex	Male	466 (51.3)
	Female	442 (48.7%)
Hospital	University of Gondar	573(63.1%)
	Felege-Hiwot	335(36.9%)
Season	Dry	460(50.7%)
	Wet	448(49.3%)
Age	< 1 year	39 (4.3)
	1-14 years	162 (17.8)
	15-34 years	416 (45.8)
	35-55 years	196 (21.6)
	>56 years	95 (10.5)
Patients Ward specialty	Surgical	289 (31.8)
	Medicine	235 (25.9)
	Pediatrics	158 (17.4)
	Obstetrics and gynecology	177 (19.5)
	Ophthalmology	31 (3.4)
	Mixed ward	18 (2)
Received anti-microbial	Yes	650 (71.6)
	No	258 (28.4)
Central vascular catheter	No	893 (98.3)
	Yes	12 (1.3)
	Unknown	3 (0.3)
Urinary catheter	No	746 (82.2)
	Yes	162 (17.8)
McCabe scores	Nonfatal diseases	517 (56.9)
	Ultimately fatal diseases	272 (30)
	Rapidly fatal diseases	66 (7.3)
	Unknown	53 (5.8)

A total of 135 patients had hospital acquired infection, with a mean prevalence of 14.9 % hospital acquired infection with (95% CI: 12.7,17.1). In addition, five patients had two types of hospital acquired infections. The overall mean infection prevalence of the two hospitals was 15.41% (95% CI: 13.13%–17.93%). Surgical site infection was the most common type infections recorded in this survey with 51%, (95% CI: 43.0-59.3) (Table 3).

Table 3 : Proportion of specific site infections among hospital acquired infections in teaching hospitals in Amhara Region, Ethiopia, 2015. (135 Patients)

	Characteristics	Number	Proportion	95% CI
Specific site Infection	Surgical Site infection	69	51.1	43.0-59.3
	Pneumonia	25	18.5	11.9-25.9
	Blood Stream Infection	19	14.1	8.1-20
	Urinary Tracts Infection	9	6.7	3.0-11.1
	Gastrointestinal System Infections	5	3.7	0.7-7.4
	Skin and Soft Tissue Infections	5	3.7	0.7-7.4
	Others (SYS, NEO, PVC) *	3	2.2	0.0-5.2
	Total	135	14.9	12.7-17.1

NB: *SYS= *Systemic Infections*, NEO= *Case Definitions for Neonates*, PVC= *Peripheral Vascular Catheter*.

Microorganisms were identified among hospitals acquired infection cases. The most common isolates were *Klebsiella spp* 22.44%, followed by *Staphylococcus aureus* 20.40%, *Pseudomonas aeruginosa* 18.36%, *Escherichia coli* 16.32%, *Enterobacter spp* 12.24%, *S. pneumoniae* 10.20%, *Proteus spp* 6.12%, *Citrobacter spp* 6.12%, *K.pneumoniae* 4.08%, *Acitnobacter species* 4.08% and *Serratia spp* 2.04% .

Multivariable logistic regression analyses were conducted to explore the association between dependent and independent variables. In this analysis, dependent variable was presence of hospital acquired infection and independent variables were sex, season of data collection, ward type and type of hospital.

The chance of developing hospital acquired infection is 75% less among children age 1-4 years compared to age 56 years and above (AOR=0.25, 95% CI: 0.09-0.71). Patients admitted in surgery ward had 2.86 higher odds of developing hospital acquired infection compared to medicine department ward (AOR= 2.86, 95% CI: 1.72-4.78). The odds developing hospital acquired infection among patients admitted in Felege-

Hiwot hospital were 1.95 times higher than patients admitted in University of Gondar Hospital (AOR: 1.95, 95%CI: 1.36-2.93) (Table 4).

Table 4: Distribution of hospital acquired infection among University of Gondar and Felege-Hiwot hospitals, 2015, Ethiopia (908 Patients)

Characteristic	HAI		Crude OR (95% CI)	Adjusted OR (95% CI)	
	Yes	No			
Sex	Male	83	383	1.62(1.12-2.36)*	1.25(0.81-1.95)
	Female	52	390	1	1
Age	< 1 year	9	30	1.38(0.55-3.42)	0.76(0.19-2.97)
	1-14 years	14	148	0.43(0.20-0.93)*	0.25(0.09-0.71)*
	15-34 years	66	350	0.86(0.48-1.55)	0.88(0.47-1.66)
	35-55 years	29	167	0.79(0.41-1.54)	0.76(0.38-1.51)
	>56 years	17	78	1	1
Season	Dry	70	390	1.06(0.73-1.52)	1.06(0.72-1.55)
	Wet	65	383	1	1
Department (Wards)	Medicine	24	212	1	1
	Pediatrics	19	129	1.30(0.68-2.47)	2.84(0.94-8.54)
	Surgery	75	240	2.76(1.68-4.53)***	2.86(1.72-4.78)***
	Gynecology	16	161	0.88(0.45-1.71)	1.02(0.49-2.12)
	Ophthalmology	1	31	0.28(0.04-2.18)	0.39(0.05-3.08)
Hospital	Gondar Hospital	61	512	1	1
	Felegehiowt Hospital	74	261	2.38(1.64-3.47)***	1.99(1.36-2.93)***

Notes: - * Statistically significant association P<0.05, *** Very strong statistically significant P<0.001

4.2. Risk factors for hospital acquired infections

A total of 545 patients were included in this study. One hundred nine were cases and the remaining 436 were controls. The median age of the cases was 25 years (Interquartile range of 16-35) and, for controls 25 years (Interquartile range of 16-36). Length of stay for patients in the hospital was

8 days with Interquartile range of 4-15 days. The Median length of stay for cases and controls was 7 and 8 days respectively (Table 5).

Table 5: Characteristics of cases and controls, in matched case control data in in teaching hospitals in Amhara Region, 2015, Ethiopia

Characteristics		Cases n=109	Controls n=436	P-Value
hand washing material available in ward	Yes	45(41.3%)	238(54.6%)	0.001
	No	64(58.7%)	198(45.4%)	
Sex	Male	64(58.7%)	201(46.1%)	0.01
	Female	45(41.2%)	235(53.9%)	
Age categorized	<=1 year	9(8.2%)	24(5.5%)	0.999
	1-14 year	14(12.84%)	76(17.43%)	
	15-35 years	59(54.13%)	255(51.6%)	
	36-55 years	22(20.18%)	90(20.64%)	
	>=56 years	5(4.6%)	21(4.8%)	
Ward of admission department	Medicine	21(19.3%)	118(27.1%)	
	pediatrics	19(17.4%)	79(18.1%)	
	surgery	53(48.6%)	141(32.3%)	
	Gynecology	16(14.7%)	93(21.3%)	
	Ophthalmology	0(0%)	5(1.1%)	
hand rubs available in the ward	Yes	67(61.5%)	302(69.3%)	0.003
	No	42(38.5%)	134(30.7%)	
Presence of medical waste container in the ward	Yes	102(93.6%)	431(98.9%)	0.04
	No	7(6.4%)	5(1.1%)	
Diabetics History	Yes	3(2.8%)	9 (2.1%)	0.400
	No	102 (93.6%)	402 (92.2%)	
Immune deficiency	Unknown	4(3.7%)	25(5.7%)	0.018
	Yes	31(28.4%)	92(21.1%)	
McCabe score	No	55(50.5%)	279 (64.0%)	0.006
	Unknown	23(21.1%)	65(14.9%)	
	Non-Fatal diseases	47 (43.1%)	235 (53.9%)	
	Ultimately fatal diseases	39 (35.8%)	141 (32.3%)	
	Rapidly fatal diseases	13 (11.9%)	38 (8.7%)	
Normally health patient	Unknown	10 (9.2%)	22 (5.0%)	0.494
	Normally health patient	32 (29.4%)	146 (33.5%)	
	Patient with mild systemic diseases	27 (24.8%)	85 (19.5%)	

	Patient with severe systemic disease that is not incapacitating	32 (29.4%)	100 (22.9%)	
ASA (American Society of Anesthesiology) classification	Patient with incapacitating systemic diseases that is a constant threat to life	14 (12.8%)	65 (14.9%)	
	Unknown	4 (3.7%)	40 (9.2%)	0.021
Central Vascular catheter	Yes	5 (4.6%)	4 (0.9%)	
	No	104 (95.4%)	432(99.1%)	
Peripheral vascular catheter	Yes	83 (76.1%)	291(66.7%)	0.05
	No	26 (23.9%)	145(33.3%)	
Urinary catheter	Yes	33 (30.3%)	75 (17.2%)	0.003
	No	76 (69.7%)	361(82.8%)	
Intubation	Yes	18 (16.5%)	29 (6.7%)	
	No	91 (83.5%)	407(93.3%)	0.001
Surgery since admission	Yes	64 (58.7%)	146(33.5%)	0.000
	No	45 (41.3%)	290(66.5%)	
Length of stay categorized	<8 days (below the median)	63 (57.8%)	209(47.9%)	0.06
	>= 8 days (above or equal to median)	46 (42.2%)	227(52.1%)	
The patient received Antimicrobial	Yes	104 (95.4%)	294(67.4%)	0.000
	No	5 (4.6%)	142(32.6%)	

Availability of waste management material, Immune status of the patient, central vascular catheter, surgery for admission and the patient received antimicrobial at the time of the survey were the predictors of hospital acquired infection. Variables of patients admitted in wards with the presence of medical waste container in the room were 82% less likely to develop hospital acquired infection compared to wards without medical waste container, AOR 0.18: 95% CI, 0.03-0.98. The odds of developing hospital-acquired infection among patients with immune deficient patients were 2.34 times higher compared to their counterpart patients with 95% CI: (1.17-4.69). The central vascular catheter was a risk factor for hospital-acquired infection with AOR of 6.92 with 95% CI: 1.28-37.47. The odds of developing hospital-acquired infection among Patients who had surgery since admission in the ward was 2.35 times higher compared with patients without surgery since admission in the ward with 95% CI:1.08-5.09. Antimicrobial use was also a risk factor for hospital-acquired infection with AOR of 8.63 with 95% CI: 3.11-23.95 (**Table 6**).

Table 6: Risk factors for HAI in Matched case control data in teaching hospitals in Amhara Region, 2015, Ethiopia

Characteristics		Cases	Controls	Crude OR (Odds Ratio) (95% CI)	Adjusted OR (Odds Ratio) (95% CI)
Available hand washing material in ward	Yes	45(41.3%)	238(54.6%)	0.38(0.21-0.68)**	0.81(0.35-1.86)
	No	64(58.7%)	198(45.4%)	1	1
Presence of medical waste container at room	Yes	102(93.6%)	431(98.9%)	0.12(0.003-.03)**	0.18(0.03-0.97)*
	No	7(6.4%)	5(1.1%)	1	1
Sex	Male	64(58.7%)	201((46.1%)	1	1
	Female	45(41.2%)	235(53.9%)	0.57(0.37-0.89)**	0.65(0.37-1.13)
Immune deficiency	No	55(50.5%)	279(64.0%)	1	1
	Yes	31(28.4%)	92(21.1%)	1.78(1.03-3.04)*	2.34(1.17-4.69)**
	Unknown	23(21.1%)	65(14.9%)	1.86(1.03-3.37)*	1.26(0.61-2.59))
McCabe score	Non-Fatal diseases	47 (43.1%)	235(53.9%)	1	1
	Ultimately fatal diseases	39 (35.8%)	141(32.3%)	1.48(0.88-2.48)	1.34(0.63-2.85))
	Rapidly fatal diseases	13 (11.9%)	38 (8.7%)	1.76(0.86-3.60)*	2.51(0.84-7.44))
	Unknown	10 (9.2%)	22 (5.0%)	2.54(1.05-6.13)*	1.04(0.30-3.58))
ASA classification	Normally health patient	32 (29.4%)	146(33.5%)	1	1
	Patient with mild systemic diseases	27 (24.8%)	85 (19.5%)	1.68(0.91-3.13)	0.78(0.36-1.72)
	Patient with severe systemic disease that is not incapacitating	32 (29.4%)	100(22.9%)	1.84(0.98- 3.47)	1.08(0.41-2.87)
	Patient with incapacitating systemic diseases that is a constant threat to life	14 (12.8%)	65 (14.9%)	1.20(0.55-2.59)	1.19(0.35-4.11)
	Unknown	4 (3.7%)	40 (9.2%)	0.28(0.07- 1.03)	0.09(0.01-0.64)*
Central Vascular catheter	Yes	5 (4.6%)	4 (0.9%)	5.00(1.34-18.61)*	6.92(1.28-37.47)*
	No	104(95.4%)	432(99.1%)	1	1
Peripheral vascular catheter	Yes	83 (76.1%)	291(66.7%)	1.61(0.99-2.63)	1.17(0.59-2.32)
	No	26 (23.9%)	145(33.3%)	1	1
Urinary catheter	Yes	33 (30.3%)	75 (17.2%)	2.30(1.37-3.87)**	1.23(0.59-2.55)
	No	76 (69.7%)	361(82.8%)	1	1
Intubation	Yes	18 (16.5%)	29 (6.7%)	3.40(1.66-6.97)**	0.80(0.28-2.31)
	No	91 (83.5%)	407(93.3%)	1	1
Surgery since admission	Yes	64 (58.7%)	146(33.5%)	3.31(2.05-5.36)**	2.35(1.08-5.09)*
	No	45 (41.3%)	290(66.5%)	1	1
Patient received Antimicrobial	Yes	104(95.4%)	294(67.4%)	10.69(4.22-27.07)**	8.63(3.11-23.95)***
	No	5 (4.6%)	142(32.6%)	1	1

Notes: - * Statistically significant association P<0.05, *** Very strong, statistically significant P<0.001

4.3. Healthcare worker's practice of infection prevention and control of hospital acquired infections

A total of 422 questionnaires were distributed to healthcare workers working in two teaching hospitals. Three health care workers were not voluntary to fill a questionnaire. Six questionnaires were rejected due to incomplete information. The median age of the respondents was 27 and the interquartile range of 25 and 30. The youngest was 20 and the oldest was 65 years. Year of service was also range from one year to 40 years, with a median year of service 4 years. More than half of the respondents were nurses by profession (Table 7).

Table 7: Healthcare worker's sociodemographic characteristics in two teaching hospitals in Amhara Region, 2015, Ethiopia

Characteristics		Fre- quency	Percent
Gender	Male	236	57.1
	Female	177	42.9
Hospital	University of Gondar	225	54.5
	Felege-Hiwot	188	45.5
Profession	Physicians	121	29.3
	Nurses	265	64.2
	Other*	27	6.5
Age categorized	<=30 years	326	78.9
	> 30 years	87	21.1
Year of service in the current institutions	<=5 years' service	356	86.2
	> 5 years' service	57	13.8
Marital status	Married	178	43.1
	Single	235	56.9

Nb: *= Health officer, Health assistants

4.3.1 Healthcare workers' infection prevention condition

Exposure of blood and body fluids in the past one year among health care workers were high, it accounts 234 (56.7%). While the Exposure of sharp or needle injury in the past one year were low 150 (36.3) compared to blood and body fluids. One hundred fifty health care workers exposed either of blood and body fluids or needle or sharp object. One hundred seventeen health care workers exposed both blood and body fluids and needle or sharp object. One hundred forty-six (35.4%) of healthcare workers did not expose any type of risks. Out of 267 risks exposed health care workers, only 40 (14.99%) receive post exposure prophylaxis (Hepatitis B and HIV AIDS) (**Table 8**).

Table 8: Healthcare workers background of infection prevention condition in two teaching hospitals in Amhara Region, 2015, Ethiopia

Characteristics		Frequency (%)	95% Confidence Interval
Receive formal training on Infection prevention	No	239(57.9)	(53.3-63.0)
	Yes	174(42.1)	(37.0-46.7)
Exposure of Blood /body fluids in the past one year	No	179(43.3)	(38.3-47.9)
	Yes	234(56.7)	(52.1-61.7)
Exposure of Blood /body fluids in the past one month	No	258(62.5)	(57.6-67.1)
	Yes	155(37.5)	(32.9-42.4)
Exposed sharp or needle injury in the past one year	No	263(63.7)	(58.8-68.5)
	Yes	150(36.3)	(31.5-41.2)
Exposed sharp or needle injury in the past one month	No	351(85.0)	(81.1-88.1)
	Yes	62(15.0)	(11.9-18.9)
The needle or sharp object visibly contaminated with blood prior to exposure	No	68(45.3)	(37.3-53.2)
	Yes	82(54.7)	(46.0-61.9)
Receive Post Exposure prophylaxis (Hepatitis B and HIV AIDS)? (n=267)	No	227(85.0)	(80.72-89.3)
	Yes	40(14.98)	(10.69-19.26)
Instructed about the hospital guidelines on infection control	No	227(55.0)	(50.1-59.8)
	Yes	177(42.9)	(37.8-47.5)
	Missing	9(2.2)	
Instructed to report signs and symptoms of an infectious condition promptly to a supervisor	No	246(59.6)	(54.7-64.6)
	Yes	160(38.7)	(33.9-43.6)
	Missing	7(1.7)	

4.3.2. Practice of Infection prevention and control

In this study, we assessed infection prevention practice in different categories of questions that were responded with self-administered questionnaires. The questions addressed in blood borne diseases practice comprise of seven questions. Personal hygiene and personal protective equipment consist of five questions. Urinary catheters and surgical wounds consist of four questions each and five questions for intravenous catheters. Totally 26 questions were asked to answer infection prevention practice. Composite squares were constructed for each component based on the response of health care workers practice for each question. Composite score was computed by adding “yes” as a value of one and the rest “no”, “missing” and, “not applicable” responses were recorded a value of zero. Finally, below the median score were considered poor practice and above and equal to the median were considered as good practice.

The total composite score showed that 55% with 95% CI: (50.1-59.6) practice for infection prevention control in their activities. Healthcare workers highly practice in blood borne disease, infection control practice proportionally compared to other practices. Least proportion practice was observed in personal hygiene infection prevention and control practice (**Table 9**).

Table 9: Healthcare worker’s infection prevention practice in two teaching hospitals in Amhara region, 2015, Ethiopia

Characteristics			Frequency (%)	95% CI
Blood Borne Diseases Practice	Good practice	No	157(38.0)	(33.7-43.1)
		Yes	256(62.0)	(56.9-66.3)
Personal Hygiene Practice	Good practice	No	205(49.6)	(45.0-54.5)
		Yes	208(50.4)	(45.5-55.0)
Urinary catheter practice	Good practice	No	181(43.8)	(39.0-48.4)
		Yes	232(56.2)	(51.6-61.0)
Surgical Wound Infection Practice	Good practice	No	186(45.0)	(40.2-49.6)
		Yes	227(55.0)	(50.4-59.8)
Intravenous Catheter Practice	Good practice	No	166(40.2)	(35.6-44.8)
		Yes	247(59.8)	(55.2-64.4)
Total composite score for infection prevention practice	Good practice	No	186(45.0)	(40.4-49.9)
		Yes	227(55.0)	(50.1-59.6)

4.3.3. Factors associated with infection prevention practice and control

Multivariable logistic regression analysis was conducted to see the association between the explanatory and the outcome variable. To control confounding variables all variables were inserted in the final model. The model fitness checked by Hosmer and Lemeshow (0.827). The final model showed that, nurses were 2.09 times more likely to practice infection control practice compared to physicians with (95% CI: 1.27-3.43). The result showed that other professions like the health officer and Health assistants were 69% less likely to practice infection control compared to physicians with (95% CI: 0.11-0.84) (Table 10).

Table 10: Healthcare worker's infection prevention practice and associated factors in two teaching hospitals in Amhara Region, 2015, Ethiopia

Characteristics	Infection Prevention control practice		Crude OR (95% CI)	Adjusted OR (95% CI)	
	Good	Poor			
Gender	Male	130	106	1.01(0.68-1.49)	1.29(0.83-1.99)
	Female	97	80	1	1
Age	<=30 years	172	154	0.65(0.40-1.06)	0.55(0.30-1.02)
	> 30 years	55	32	1	1
Service year	<=5 years' service	138	123	0.79(0.53-1.19)	1.140(0.66-1.96)
	> 5 years' service	89	63	1	1
Profession	Physicians	56	65	1	1
	Nurses	165	100	1.91(1.24-2.96) *	2.09(1.27-3.43) *
	Other [#]	6	21	0.33(0.12-0.88) *	0.31(0.11-0.84) *
Marital status	Married	100	78	1.09(0.74-1.61)	1.08(0.68-1.69)
	Single	127	108	1	1
Training on Infection prevention	Yes	102	72	1.29(0.87-1.92)	0.92(0.59-1.42)
	No	125	114	1	1

Notes: - * Statistically significant association P<0.05, # Health officer, health assistance

4.4. Barriers of Infection prevention practice

4.4.1 Characteristics of the respondents

A total of 33 healthcare workers and management staffs participated in this qualitative study. Seventeen participants were from Felege-Hiwot and 16 from the University of Gondar teaching hospitals. One health care worker was not volunteer to participate. Among the participants, 20 were males and the remaining 13 were females. Of the total participants, 17 were nurses, Eight physicians, four Environmental Health officers, three laboratory technologies and one occupational health and safety officers. The minimum and maximum age of the respondents were 23 and 48 respectively.

4.4.2 Understanding the problem

All participants in this discussion had adequate information regarding hospital acquired infection and infection prevention practices. The majority of the participants agree that there were activities related to infection prevention and control in their hospitals. The majority of the respondents agree that, the activities were not enough to prevent hospital acquired infection. Some of the activities related to infection prevention were, infection prevention monthly report and discussion, quality team works on death audit and needle stick injury survey, hepatitis B vaccination for healthcare workers for those who had sharp and needle stick injury report, Surgical site infection audit, supplies check and balance system and health education for patients. A nurse expressed on the activities:

“It has check and balance system for infection prevention activities. Regarding healthcare worker’s utilization of hand rub materials, following standard procedures, washing their hands with soap, hand rub with alcohol available in the pockets of healthcare workers, presence of sinks in the room and utilization were some of the criteria”

Another nurse on their audit finding explained:

“Based on the audit result, we have seen sterility problem, some antibiotics were miss administered to the patient, or communication was identified as a problem”

In spite of adequate information and activities conducted in their hospitals, all participants admitted that noncompliance to universal precautions and challenges and barriers to IP practice were common in their wards.

4.4.3. Barriers to infection prevention and control practice to Hospital acquired infection

The major themes developed in the analysis were organizational, healthcare workers and patients and visitor barriers to practice infection prevention. The sub themes were described in the following sections.

4.4.3.1. Barriers related to organizations (institutional, administrative and management)

4.4.3.1.1. Availability of facilities

The majority of the participants described the major barrier to practice infection prevention were shortage of facilities in wards or in general in the hospital. Thus, facilities are relevant for patients, healthcare workers and family caregivers. Some of the important facilities discussed by participants during the discussion were lack of toilets, hand washing facilities and shower. In some wards, although there were facilities, there was no water. The problem was aired by one female nurse in the following way. *“..... But in our case for 40 beds there is only one toilet and it is not cleaned regularly and there is continuous bad odor due to lack of water. When we see the shower, it is possible to say that there is no water in general and it is not functional at all, even if there is water, it is used for another purpose and not to wash patients”*

A physician in obstetrics ward expresses the seriousness of the issue like this: *“..... The problem is due lack of proper maintenance for handwashing basins, only three hand washing basins are working in our ward. So, we are forced to go to the next operation, simply with hand rub disinfection, without appropriate procedures for hand washing, including from arms to the elbows of the hand”*

The problem was also paramount and witnessed by another physician. *“I have not seen a single patient who washed their bodies for the last 8 months in the ward, because though there is installed pipe, there was no water”*

4.4.3.1.2. Shortage of material Supply

Reusing materials and equipment in resources limited countries are common. But, before reusing these equipment and materials it should be free from microorganisms. The materials should pass through standard recommended sterility techniques. In this discussion, majority of the participants raised the issue of material shortage to apply infection prevention practices in some procedures. A physician in the gynecology and an obstetrics ward shared his experience as follows:

“In our ward, some instruments are very few in number. For example, manual vacuum aspiration materials are limited in number in our ward, we have only four manual vacuum aspiration tools. Hence, we are forced to re-use without proper sterility procedure. Sometimes in one night, more than four abortion cases came at a time and to sterilize the material, it takes three to four hours, including cooling time. Due to this reason, sometimes we are forced to use the material without appropriate sterility technique, to save the life of the mother”

The material shortage was also reflected by the majority of the participants. A female nurse working in the surgery department expressed that,

“I remember in surgery ward we were forced to use one material several times without the proper sterility procedure. We use suction tips several times for many patients with light disinfection for less than 10 minutes, due to absence of the instruments in our ward, to save the life of the patient”

Similar problems and concerns were transpired by several study participants.

4.4.3.1.3. Lack of maintenance

Regular inspection of materials and maintenance are very important phenomena to ensure the quality of the material. It helps whether the material is working properly or not. Specially highly sensitive procedures and materials need such inspection and central supply. Such issues were discussed with participants. The problem was considered an obstacle to perform activities in infection prevention. One experience was shared by a physician in the surgery room

“To tell you frankly, I got a dirt on an operation room cloth, although it was sterilized by the central supply. This is due to an old laundry machine in our hospital”

Maintenance problem was raised by participants, in addition to equipment and building problems. The listed problems were like; latrine, rooms, drainages and hand washing basins. Majority of the participants reflected that age of building affects activities of infection prevention. due to lack of maintenance of buildings and latrines. A male Environmental health officer said that:

“... .. buildings are old, for example latrine constructed with the help of Germany government was old and has no drainage system. In addition, even new constructed buildings were constructed without considering the space for drainage and sometimes when the latrines are full it was difficult to drain the latrine because of unable to access site to the car”

4.4.3.1.4. High patient flow

All participants agreed that the flow of patients in two hospitals were high and which stands to be a barrier for infection prevention practice. A physician expressed his feeling that *“..... after 60 years, we have seen our wards without increasing in number”* In addition a female nurse said that *“..... the patients flow increased without increasing the hospital facilities, that leads women forced to delivery and sleep in the floor with rubber sheet”*

In addition, patient flow increases the work burden to healthcare workers. A female nurse said

“..... There were no sufficient nurses in our ward, sometimes one nurse assigned to 24 patients”

Another female nurse expressed that “Sometimes I assigned for 30 beds to manage in one night. In addition to this there would be an emergency cases. Therefore, my focus would be to save lives of a patient rather than long impact of hospital acquired infection. I became unconscious and infection prevention activities do not considered in my mind” This leads nurses for loss of intention and improper practice of universal precaution practices.

4.4.3.2 Barriers related to healthcare workers

4.4.3.2.1. Experience

Regarding experience, health care workers has generally two views regarding infection prevention practices. Majority of participants agreed that high occurrence of sharp and needle sticks injury in medical students in their wards. One physician expressed the problem in this way *“In our ward, in one group of internship students, four to five students are taking prophylaxis vaccination due to sharp and needle stick injury in one academic semester”* Another physician in medical ward said that *“Most activities are doing by intern physicians and they are always in pressure. Students are doing and linking activities with their pass and fell evaluation. Although they are busy, they should cover all patients and report to their senior on time. Unless to do so, they will be delayed for 3 months. So, students do not follow the appropriate procedures like, doing activities without glove”*

Another group of participants observe experience in a different way. Majority of discussants agreed that experienced health workers did not follow appropriate universal precaution procedures. One physician in surgery department, expressed his observation in operation room said that *“I observed a senior physician pick pins and insert into the human bone with simple alcohol rub without sterilization. I think this may be due to shortage of pins or senior physicians believe with their faced experience rather than science”* In addition female nurse expressed her observation on this way *“it is common seniors remove wounds without glove”* Another barrier agreed by healthcare workers regarding to experiences are no communication or exchange of ideas between seniors and juniors or other team members in the team.

4.4.3.2.2. Emergency situation

Sometimes physicians and nurses are in a hurry saving patients life in an emergency condition. Application of the normal procedure for universal precaution may not be performed. Most of the participants agreed that there was an emergency condition unable to follow the normal procedure. One of the male nurses in the gynecology ward explained that *“I was forced to support the mother without a glove while she delivers the baby on the corridor. At that time, I didn’t think of infection prevention practice, but the lifesaving activity comes to my mind and I did it. If I were considered IP practice at*

that time, I would have lost the child or the mother” Emergency situation creates shortage of time to act healthcare workers without appropriate precaution. A male nurse in the surgery ward explained that “Sometimes shortage of time to act forced me to accept my mind. If there is no visible fluids and wounds in the patient, it would have risk for me”

4.4.3.2.3. Behavior of health care worker

Majority of participants agreed that there was professional variation between nurses and physicians to proper utilization of universal precautions. Majority discussed that nurses practiced properly compared to physicians in some universal precautions. One female nurse expressed the variation in that *“Physicians more focus on treatment part rather than infection prevention practices”* Another female nurse added in line to this *“Every health care professionals had information towards five moments of hand hygiene practices, but majority of healthcare worker including me, wash our hands only at the beginning and end of our tasks. This may be due to an indication to negligent behavior of healthcare workers”* One physician added regarding challenges to utilization of hand rub *“Healthcare workers believe that, alcohol based hand rub provided to this hospital is not vaslin based, they afraid that the alcohol would dry their hands and causes skin breakage”*

4.4.3.2.4. Healthcare workers Knowledge

Healthcare workers understanding towards infection prevention and control practices are crucial in hospital environment. Majority participants agreed that knowledge gap was observed in some professionals and cleaners/janitors. One male management staff expressed the problem in this way *“cleaners have no information towards proper infection prevention practices. Because they are using soft glove for cleaning activities, although they should use hard glove for cleaning purpose. In addition, they don't have adequate information towards solution proportion of water to chlorine formation for cleaning purpose”*

4.4.3.3. Barrier related to Patients and visitor's

4.4.3.3.1 Low awareness of patients and visitors.

Healthcare workers are expected to give information to patients towards infection prevention practices to protect infections by themselves in hospitals. Information provided to patients should also be provided to their families or caregivers. Though the patient expects that hospital environment is

safe and clean, but there are risks of infection in healthcare environment. Majority participants observed that there were challenges in infection prevention practice in patients and families or caregiver's in wards.

One of the main challenge towards infection prevention practices by patients, families and visitors are poor perception towards hospital environment. A female nurse in a pediatric department said that *“hospital environment is considered as clean by patients and visitors, simply by observing the whiteness of the floor and the wall. Sometimes, they ate their food on it”* Another female nurse added on this *“inappropriate utilization of material and equipment by patients and visitors, shorten functionality of facilities in wards”*

Sometimes health education may not be sufficient to bring the appropriate infection prevention practice to patients and families or visitors. Majority of the participants agree on this. A female nurse explained that *“Infection prevention practice was given regularly to the patient but they didn't understand our health education, because they wash their dish, cloth and hands in the same sink in the ward, so it is difficult.* Another hospital management staff added also *“majority of our patients come to the rural part and they sleep inside the institution with cardboard, it is difficult for the health of the individual or to the facility”*

4.4.3.3.2. Overflow of families and visitors

Majority of the participants agreed that it was major obstacle to practice infection prevention activities in the two hospitals. One male nurse expressed the problem in the following way:

“For single patient, more than 4 to 5 family members/ visitors are coming to this hospital. I remember one event before a year, one family member was injured by needle in the ward” Another nurse at internal medicine also explained that *“high flow of visitors in the room disturb our normal activities. Sometimes for a single patient you may get five to six family caregivers in the room. and they disturb you. Presence of high number of visitors in the ward affects the behavior of health care workers”*

4.5. Summary of main findings of the dissertation by objectives

Table 11: Summary of main findings of the dissertation by objectives

Man.	Objective	Main findings
I	To determine the prevalence of HAI	<ul style="list-style-type: none"> ▪ The mean prevalence of hospital acquired infection was 14.9% with 95% CI, 12.7—17.1. ▪ The overall mean infection prevalence of the two hospitals was 15.41%. ▪ Surgical site infection was the most common type of infections recorded in this survey with 51%, (95% CI: 43.0-59.3). ▪ <i>Klebsiella, spp</i> 22.44%, <i>Staphylococcus aureus</i> 20.40%, <i>Pseudomonas aeruginosa</i> 18.36%, <i>Escherichia coli</i> 16.32%,
II	To identify factors associated with HAI	<ul style="list-style-type: none"> ▪ Availability of waste management material in the room, Immune status of the patient, central vascular catheter, surgery for admission and the patient receive antimicrobial were risk factors for HAI
III	To describe Healthcare workers practice towards IPC	<ul style="list-style-type: none"> ▪ 56.7% of health care workers were exposed to blood and body fluids in the past one year. ▪ 36.3% of health care workers were exposed to sharp or needle injury in the past one year. ▪ Out of 267 exposed health care workers, only 40 (14.99%) received Post Exposure prophylaxis (Hepatitis B and HIV ▪ 55% with 95% CI: (50.1-59.6) had good practice for infection prevention control ▪ Nurses had 2.09 higher odds of practicing infection control practice compared to physicians with (95% CI: 1.27-3.43).
IV	To explore barriers to IPC practice	<ul style="list-style-type: none"> - Ten themes identified with three sub themes ▪ Organizational barriers: availability of facilities, shortage of material supply, lack of maintenance of facilities and equipment's, high patient flow ▪ Healthcare barriers: experience, emergency situation, healthcare worker behavior and healthcare worker's knowledge, ▪ Patient and family caregiver barriers: low awareness of patients and visitors and overflow of families and visitors to the hospital.

5. DISCUSSION

The overall aim of this dissertation was to describe the magnitude of HAI and infection prevention practice and barriers in teaching hospitals. The prevalence of hospital acquired infection was 14.9 % and the overall infection prevalence was 15.41% in the two hospitals. Availability of waste management material in the room, Immune status of the patient, central vascular catheter, surgery since admission and patient received antimicrobial were the risk factors for hospital acquired infection. Infection prevention and control practice were 55%. Nurses practiced positively for infection prevention compared to physicians and other professionals. Healthcare worker's exposure to Blood /body fluids and sharp or needle injury in the past one year were 56.7% and 36.3% respectively. Barriers identified to practice infection prevention and control in teaching hospitals were lack of availability of facilities, shortage of material supply, lack of maintenance of facilities and equipment and high patient flow, experience, emergency situation, healthcare worker behavior and healthcare workers' knowledge, low awareness of patients and visitors and overflow of families and visitors to the hospitals.

5.1. Point prevalence of hospital-acquired infections

The point prevalence of this survey is similar to previously conducted surveys in Uganda and Tunisia 17%[25,26]. This point prevalence finding is lower than a research conducted in Albania 19.11%.(199). This high discrepancy may be related to methodological issues and study period gap between this study and the above two studies. This finding is also lower than to some studies conducted in specific wards in Morocco 34.5%,(200) and in European countries ICU 28.1%.(201)

The prevalence of hospital acquired infections vary by specific sites of infection and indwelling devices used(202–204). This comprehensive hospital acquired infection was lower than a specific site infection conducted in another study in Ethiopia, 39.10%(134). This point prevalence of 15.14% is higher than a study conducted in other developed countries,(205–208) and studies in other developing countries(209–212).

The most common type of hospital acquired infection in this survey was surgical site infection which was 51% from the total hospital acquired infections. This high proportion of surgical site

infections is similar to a systematic review in sub-Saharan African countries(213). High proportion of surgical sites infections were also seen in a researches conducted in Mali (57.4%)(214) and Ethiopia (49.4%)(134).

Pneumonia constituted highest proportion of hospital acquired infections according to studies in India (50%),(215) Saudi Arabia (28.9%)(216) and Vietnam (41.9%),(185), while in this study the proportion of pneumonia was the second 14.1%. The highest rate in India may be due to the fact that the studies were conducted in intensive care units.

Age of the patient and hospital type were statistically significantly associated with the occurrence of hospital acquired infections. Children age 1-4 years were 75% less likely to acquire hospital acquired infections compared to older age ≥ 56 years and above. This result is also supported by other studies conducted in Morocco and Iran(200,210). Season of data collection in dry and wet seasons of Ethiopia not statistically significantly associated with the prevalence of hospital acquired infection. This result was also supported by another study conducted in four seasons of Iran(210). *Klebsiella spp.* and *Staphylococcus aureus* were the most commonly isolated hospital acquired infections causing pathogens in the present study. This finding is also similar with a study conducted in Nigeria(217).

5.2. Risk factors for hospital acquired infections

Risk factors for hospital acquired infections are dynamic and complex phenomenon. Most risk factors for hospital acquired infections were conducted by cross-sectional studies, which has a limitation of statistical power to comparing groups internally. The introduction of bias in matched case control study is lower than cross-sectional design (137). Matched case control design is assumed to generate valid data impacting reduction of bias among main exposure variables.

The availability of hand-washing facilities and waste management material in the ward are important to prevent hospital acquired infections(218). The availability of waste management materials is believed to reduce exposure of waste to patients and health care workers. A study in Ethiopia showed that waste management in health care facilities is in poor conditions(219).

This study showed that patients with immune deficiency were vulnerable for hospital acquired infections. This finding is supported by another study, in which patients with highly compromised health status were at risk for hospital acquired infections(220).

In a modern healthcare system, invasive devices and procedures are increasing to treat patients. Example; While catheters provide lifesaving therapy, they can be a route of the transmission of microorganisms to patient's body, thereby causing infection. Hospital acquired infections can also take place with the devices used in medical procedures(221). A hospital based research in Poland showed that, there was a positive correlation between prevalence of hospital acquired infections and exposure to invasive procedures(123). In our study, patients with central vascular catheter were 7.56 times more likely to be a risk of infection compared to non-central vascular catheter patients. This finding was supported by other studies conducted in Poland, Morocco and china hospitals(123,127,222).

The high risk of central vascular catheter may be due low implementation of a multidimensional infection control strategy in the study setting. Literature from developing countries to the implementation of Nosocomial Infection Control Consortium (INICC) bundles and other infection control measures reduced device-associated infection of CLABSI(223–226), VAP(225,227,228) and CAUTI (229) in ICU patients.

Surgery since admission was one of the determining factors for hospital acquired infections in this study. This was also supported by other studies conducted by the European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey(230) and in China and Poland(124,127).

A research showed that, antimicrobial prescribing with broad-spectrum antibiotics to patients increased the risk of hospital acquired Drug-Resistant *Acinetobacter baumannii* infections(220). A similar finding was also observed in Morocco indicating that; antimicrobial use was associated with hospital acquired infections(222). Our study supported the above finding indicating that patients receiving antimicrobial were 9.16 times more likely to acquire hospital acquired infections compared to those who didn't take antimicrobials.

5.3. Practice of infection prevention and control to hospital acquired infection

Healthcare worker's infection prevention practices are among the major pillars for the prevention and control of hospital acquired infections. Practice of healthcare workers regarding prevention and control of Hospital acquired infections were high compared to a research conducted by Teshager(48.7%) in Ethiopia(147) and Hamed Sarani,(42%) in Iran(138). The lower practice in the previous researches may be due to the fact that research was conducted only on surgical site infection and nurses. Our study was similar to a study conducted by Dimie(50.8%) in Nigeria(139) and by Demissie(51.7%) in Ethiopia(150). This practice was low compared to a research conducted by Reda(68%) of universal precaution practice to control HIV/AIDS in Ethiopia(231) and Duerink 60% in Indonesian island of Java(140). This difference may be due to time gap between the two studies and focus only on exposure of body fluids for the prevention and control of HIV/AIDS in the Ethiopian study.

Nurses were 2.09 times more likely to practice infection prevention control compared to physicians(Doctors) in this study. This finding is supported by a research conducted in Italy emergency ward regarding hand hygiene measures after removing gloves(141) and Indonesian island of Java(140).

Health care workers are highly affected by hospital acquired infections through exposure of blood and body fluids(232). In this study, 56.7% of healthcare workers were exposed to Blood /body fluids in the past one year. This prevalence was high compared to the previous researches conducted in Ethiopia(233,234). This discrepancy may be due to the difference in components of items in the questionnaires.

Healthcare workers' exposure to sharp objects or needle stick injury may lead to serious and potentially fatal infections. In this study, 36.3% of healthcare workers were exposed to sharp or needle injury in the past one year. The finding was similar to a study conducted by Aynalem Tesfay (143) and lower than a research conducted by Legesse (146), in Ethiopia, but it was higher

than a study conducted by Yenesew (144) in another part of Ethiopia. These variations may be due to study time difference and since they included health centers, in addition to teaching hospitals.

5.4. Barriers for Infection prevention practice and control

Healthcare workers, patients and families or visitors understanding of cause and barriers to infection prevention and control practice to hospital acquired infections are crucial and important to minimize infection in the hospital set up. This study identified barriers in infection prevention in to three sub teams, such as organizational, healthcare workers and patients or families' perspective. Barriers identified in this finding were based on observed, perception and practice of research participants, considered highly influential to practice infection prevention and control.

5.4.1. Organizational Barrier (institutional, administrative and management)

Availability of toilet, shower, handwashing material and other facilities are very important to practice infection prevention in healthcare workers, patients and families or visitors in the hospital. Lack of the of facilities were considered barriers for the practice of infection prevention in this study. This was also supported by a similar study conducted in Cyprus on nurses that inhibit to compliance with the standard precaution(166). A similar questionnaire based finding also supports this finding for practice of infection prevention (165).

Shortage of material supply and equipment were other important teams identified as a barrier to infection prevention and practice. Regular maintenance of materials and equipment in wards were barriers to practice infection prevention in this study. It was reflected by majority of the participants, that, they were forced to practice inappropriate procedures and steps. The problem was also explained by healthcare workers working in countries like USA and Netherland hospitals(165,167).

High patient flow in the hospitals lead health care workers with shortage of time to practice their activities, including infection prevention practice(166,167). In our finding the high burden of patients in the two hospital leads healthcare worker's loss of intention to improper practice of universal precaution. A similar research was reported that, lack of time was a barrier to practice infection prevention in the work environment(165,235).

5.4.2. Healthcare workers related barriers

Experiences of healthcare workers were one of the barriers to practice infection prevention practice in this study. Some of the discussants agreed on that; experienced health workers did not follow appropriate universal precaution procedures. This was supported by a questionnaire survey conducted on healthcare workers, when experience increases, the risk of needle stick injury and exposure of blood and body fluids increase(142,160). In contrary, experience regarding students, sharp and needle stick injuries were observed in medical students than experienced staffs. This may be experienced by healthcare workers develop a skill regarding this issue(166). Students may be overloaded with work and focus only to pass their grade.

Activities in the hospital may be in a hurry for saving a patient life in an emergency condition. This was seen as a barrier to practice infection prevention activities in this study. Participants stated that sometimes-emergency conditions were unable to follow the normal procedure in their institution. The same finding reported from abroad indicated that emergency conditions unable to wear gloves and follow appropriate procedures(165–167).

Many studies indicated that there was professional difference between physicians and nurses. Some researchers concluded that nurses practice more compared to physicians regarding to appropriate universal precautions practice and physicians deviate the rule(167). In this study majority of discussants agreed that nurses were practiced properly compared to physicians in some practice of infection prevention. In spite of this previous researches indicate that physicians have good knowledge regarding to universal precaution to hand hygiene (236) and physicians were also more utilized hand rub alcohol material compared to nurses(237). This difference may be, the study was conducted in teaching hospitals and physicians were more experienced and have confidence to perform their activities(166). The other reason may be sourness

and dryness of hands using alcohol may inhibit physicians to practice(167). In line with this study researches showed that, the behaviors of healthcare workers were a barrier to infection prevention practice hospitals(161,238).

Knowledge of healthcare workers is a core to practice infection prevention activities in the hospital. In this research, some participants reported that, there were no uniform understanding of infection prevention practice in all healthcare teams in their wards. This knowledge gap was observed specially in cleaners or janitors regarding infection prevention. Although the research did not include cleaners and janitors, the practice gap was observed in thus workers by study participants. This type of gap was also observed in a similar research conducted by Ider on Perceptions of healthcare professionals effective hospital infection control(238).

5.4.3 Patients and visitor's barrier

Patients are at greater risk than non-patients to hospital acquired infection in hospital environment. Those patients are expected to have adequate knowledge to care for themselves, because, healthcare workers are expected to give information to patients, how they can prevent from infection. A studies show that patients had poor communication with healthcare workers regarding infection prevention(168). A questionnaire based study conducted in different parts of the world to assess patient's knowledge and practice of infection prevention in the hospital was poor(168,239–241). In this study, majority of the participants observed that there was poor infection prevention practice by patients, families or caregivers. Therefore, poor perception of families, care giver or visitors, increases their number in the hospital wards unnecessarily. Healthcare workers unable to perform their task and creates a challenge to practice infection prevention in the study hospitals.

6. VALIDITY AND GENERALIZABILITY

Validity and reliability of the data was assured in this dissertation by using different data quality and management techniques.

Internal validity

Data collection tools were adapted from different credible literatures based on the available evidences to HAI and infection prevention and control practices. Training was given for data collectors with practical case exercises. The tool was validated on two pre-selected wards with the “Gold Standard cases by comparing the collected data (inter-rater reliability). Data collectors collected on basic demographic information and other HAI on eligible patients in selected wards, with exact application of the real data collection form and case definitions. International standard strains of *Escherichia coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used for culture and susceptibility testing(196) for the validity of culture. Matching of cases and multivariable logistic analysis were used to control confounders.

The trustworthiness of the qualitative finding was assured by credible information collected by data collectors. The data collectors give more time for the participant for discussion and triangulate the information with the available evidence and tried to get feedback at the end of the discussion regarding the consistency of discussion. The interview was conducted in quite place to prevent sounds from external source. The discussion was conducted in local language, Amharic to understand and easily communicate with participants. Debriefing was conducted daily and information and discussion was corrected for the next new discussion(interview).

External validity

We strictly followed scientific research methods in all studies in this dissertation, such as probabilistic sampling method, the power and population prediction parameters. Proper sample size determination procedure was used. As a result, adequate sample size was used to generalize from samples to the similar teaching hospitals in Amhara Region. To assure transferability of data purposive sampling technique was used in the qualitative study. Participants were selected in different wards, those who were expected to have adequate information regarding infection prevention and control.

7. STRENGTHS AND LIMITATIONS

The study has some limitations. Firstly, resource constraint and comparisons with other researches with different specific site infections and patient populations. Prospective continuous monitoring of hospital acquired infections give useful information for clinicians and patients by identifying areas needing improvement and demonstrating the effectiveness of interventions(242). A weekly point-prevalence was similar to the prevalence rate calculated by the Rhame and Sudderth (243).

Secondly, in this study, we focused on a relatively small number of risk factors for hospital acquired infections. Some of the recording system of clinical data was incomplete. This may introduce bias in statistical analysis. Those incomplete records are removed from the final analysis. To minimize this issue initially we collected data from a large proportion of controls to cases, it gives high power to identify the variations in the population.

Thirdly, healthcare workers respond to self-administered instrument, based on their behavior that may not be the real reflection of the practice they did in the actual work setup. Observation during the actual practice improves the actual measurement of practice. Data collectors tried to explain purpose of the study and to fill genuinely the responses in the questionnaire.

Some busy healthcare professionals did not respond to all questions in the questionnaire. This incomplete information in to some variables affects during analysis in the model. Sufficient sample size and control variables in analysis in the model (in and out of variables based on Log likely hood Ratio, $-2 \times LL$ smaller values retains in the model) and adding sufficient non-response sample during sample collection.

Recall bias for healthcare professionals toward the exposure of blood and body fluids and needle stick and sharp injury has also the limitation to this study. This increases bias by decreasing the real picture of the exposure of risk factors to Hospital acquired infection in healthcare workers. To minimize this bias, questions in a questionnaire were rearranged, to remember event with indexed questions and we also added two weeks' prevalence of exposure of blood and body fluids and needle stick and sharp injury.

8. CONCLUSIONS

- There was high prevalence of hospital acquired infection in teaching hospitals. One in seven inpatients had at least one hospital acquired infection. Surgical site infection and pneumonia were the most common infection types in this study. *Klebsiella spp.* and *staphylococcus aureus* were the most commonly isolated hospital acquired infections causing pathogens in these hospitals.
- Risk factors were identified in this study, that give highlight for the prevention and control measure of hospital acquired infection in teaching hospitals. Presence of medical waste container in the room, patients' immune status, central vascular catheter, surgery since admission and patients received antimicrobials were the independent predictors of hospital acquired infections.
- Healthcare workers' infection prevention and control practice of hospital acquired infections were low. Considerable proportion of Healthcare workers suffered from exposure of Blood /body fluids and sharp/needle stick injury in the past one year. Nursing professionals practice more compared to physician and other health professionals.
- Healthcare workers had good understanding of infection prevention and control practices. However, understanding the practices does not guaranty to practice desirable activities. Availability of facilities, shortage of material supply, lack of maintenance of facilities and equipment and high patient flow, lack of experience, emergency situation, healthcare worker behavior and healthcare worker's knowledge, low awareness of patients and visitors and over flow of families and visitors to the hospital were barriers to infection prevention and control practice.

9. RECOMMENDATIONS

Findings of this dissertation have valuable imputes to healthcare management, healthcare workers, individuals in the community and for researchers to their tasks to enhance improvement of hospital acquired infection prevention and control practices.

1. Policy and program managers

- Managers should ensure availability of healthcare facilities in wards.
- Managers should give more attention to strengthen low infection prevention and control practices by healthcare staffs.
- For effective infection prevention and control programs, hospitals should have adequate staff and consider action based on number of patient's flow, adequate and early maintenance of materials and facilities are as well of a paramount important.
- Infection prevention and control barriers should be addressed, identifying an effective implementation of specific organizational, healthcare worker and patients and visitor's.
- Hospitals should provide health education to patients, families or visitors to prevent infection during and after hospital stay.
- Managers should consider prospective surveillance system to hospital acquired infection

2. To Healthcare workers

- Clinician should follow appropriate medical procedures during use of external devices in clinical practices.
- The medical workforce should give attention to those immunocompromised patients and to specific site infection and drug utilization for the prevention and control of hospital acquired infection.
- Healthcare workers should follow the appropriate procedures for the prevention and control of risky behaviors of hospital acquired infection (like exposure of blood and boy fluids and needle and sharp injury).

- Training should be given to all staffs (i.e. Physicians, nurses, clinical technicians, laboratory, cleaners, laundry, maintenance, dietary workers, students, contract staff and volunteers and other) who involved in hospital care for infection prevention.

3. Community and Individual level

- Patients, families or visitors should take appropriate infection prevention practice in the hospital to prevent infection during and after hospital stay.
- Families and visitors should visit patients with limited numbers at a time in the ward, to prevent congestion in the ward.

4. Researchers

- Further research on cost of burden to the patient and health facilities regarding hospital acquired infection.
- Further prospective longitudinal hospital acquired infection study design recommended.

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12. APPENDICES

12.1 Paper I-IV

PAPER I

12.6 Letter for Declaration

LETTER FOR DECLARATION (DISSERTATION WORK)

I, the under signed, declare that this is my original work, has never been presented in this or any

other University, and that all the resources and materials used for the dissertation, have been fully acknowledged.

Name: Walelegn Worku Yallew

Signature: _____

Date: _____

Place: Addis Ababa

Date of submission: _____

This dissertation has been submitted for examination with my approval as University Supervisor.

Name: Dr. Abera Kumie

Signature: _____

Date: _____

Point prevalence of hospital-acquired infections in two teaching hospitals of Amhara region in Ethiopia

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Purpose: Hospital-acquired infection (HAI) is a major safety issue affecting the quality of care of hundreds of millions of patients every year, in both developed and developing countries, including Ethiopia. In Ethiopia, there is no comprehensive research that presents the whole picture of HAIs in hospitals. The objective of this study was to examine the nature and extent of HAIs in Ethiopia.

Methods: A repeated cross-sectional study was conducted in two teaching hospitals. All eligible inpatients admitted for at least 48 hours on the day of the survey were included. The survey was conducted in dry and wet seasons of Ethiopia, that is, in March to April and July 2015. Physicians and nurses collected the data according to the Centers for Disease Control and Prevention definition of HAIs. Coded and cleaned data were transferred to SPSS 21 and STATA 13 for analysis. Univariate and multivariable logistic regression analyses were used to examine the prevalence of HAIs and relationship between explanatory and outcome variables.

Results: A total of 908 patients were included in this survey, the median age of the patients was 27 years (interquartile range: 16–40 years). A total of 650 (71.6%) patients received antimicrobials during the survey. There were 135 patients with HAI, with a mean prevalence of 14.9% (95% confidence interval 12.7–17.1). Culture results showed that *Klebsiella* spp. (22.44%) and *Staphylococcus aureus* (20.4%) were the most commonly isolated HAI-causing pathogens in these hospitals. The association of patient age and hospital type with the occurrence of HAI was statistically significant.

Conclusion: It was observed that the prevalence of HAI was high in the teaching hospitals. Surgical site infections and pneumonia were the most common types of HAIs. Hospital management should give more attention to promoting infection prevention practice for better control of HAIs in teaching hospitals.

Keywords: hospital-acquired infection, surgical site infections, Ethiopia, point prevalence

Introduction

Hospital-acquired infections (HAIs) are a major public health concern throughout the world, contributing to increased morbidity, mortality, and cost.¹ HAI is a major safety issue affecting the quality of care of hundreds of millions of patients every year in both developed and developing countries.²

In developing countries, the problem is three times higher when compared to the incidence observed in adult intensive care units in the US.³ According to the World Health Organization review, hospital-wide prevalence of health care-associated infections varies from 5.7% to 19.1%, with a pooled prevalence of 10.1% in low-income countries.⁴

In addition, HAI prevalence reports are often not well established because of the lack of centralized guidelines, staff, and resources.⁵ In a Moroccan university hospital, almost two of the ten hospitalized patients contracted a nosocomial infection.⁶ Similar results were obtained for a study conducted in a Tunisian hospital.⁷

Studies have shown that most hospitals in developing countries, especially Africa, have no effective infection control program. This can be attributed to a lack of awareness of the problem, lack of personnel, poor water supply, erratic supply of electricity, ineffective antibiotic policies resulting in the emergence of multiple antibiotic-resistant microbes, poor laboratory backup, poor funding, and nonadherence to safe practices by health workers.⁸

In Ethiopia, there is no comprehensive research that presents the whole picture regarding HAIs in hospitals. In addition, studies on surgical site infections showed that the prevalence of HAI in surgical patients was in the range from 5.74% to 35%.⁹⁻¹⁴ Most studies published on HAIs are originated from hospitals in the developed nations. Relatively few data on the present HAI epidemic situation are available from Ethiopia, and most studies focused on only surgical site infections post-surgery and those encountered in obstetric wards.

Prospective active surveillance is the gold standard for controlling HAIs.¹⁵ Repeated point-prevalence surveys are a feasible method for the measurement of all HAIs in a hospital, and it is also important to estimate the burden of HAIs in teaching hospitals in a resource-limited country like Ethiopia. It is important to prioritize the areas that require interventions.¹⁶ The purpose of this study was to assess the point prevalence of HAIs in the teaching hospitals of Amhara region in Ethiopia.

Materials and methods

Setting

A repeated cross-sectional study was conducted to determine the prevalence of HAI in two teaching hospitals of Amhara region in Ethiopia. A total of 865 inpatient beds are available in University of Gondar and Felege Hiwot Hospitals, which serve as teaching hospitals for the medical students of the region. All inpatients admitted to the hospitals were included in the study. Data was collected after the ethical approval of Addis Ababa University College of Health Science Institutional Review Board. Written consent was obtained from each study participant. Wards of all specialties, including surgical, obstetrics and gynecology, internal medicine, pediatrics, ophthalmology, and intensive care unit (ICU), were included, whereas the wards associated with emergency and recovery departments were excluded from the study.

Sampling

All eligible inpatients who were admitted for at least 48 hours on the day of the survey were included. The survey was conducted during the wet and dry seasons of Ethiopia. Patients admitted to the ward after 8 am were not included in the study. Data were collected twice from each hospital. The first round of survey was conducted from March 16, 2015 to April 2, 2015, and the second round was conducted from July 1, 2015 to July 10, 2015. Data were collected by five trained physicians (ie, pediatrician, internist, surgeon, gynecologist, and ophthalmologist), five nurses in each ward, and one laboratory technologist in each hospital. The survey of each ward was completed within 1 day and data from all the sources available on the ward at the time of the survey, such as nursing notes, medical notes, temperature charts, drug charts, surgical notes, laboratory reports, were collected. A detailed history of the patient's medical record or discussions held with the nursing staff was recorded. Data were collected based on the standard procedure recommended by Centers for Disease Control and Prevention (CDC) definition of HAIs.^{17,18}

Data collection tools

A pretested standardized questionnaire was used to collect data for determining the prevalence of HAI. Laboratory samples of urine, sputum, wound swabs, fecal specimens, throat swabs, nasal swabs, and blood samples were collected.¹⁹⁻²¹ Medical records and consultation with the person in charge of the patient were the gold standard for the identification of the infection. Data were collected based on the signs and symptoms and the specific site criteria, as recommended by CDC.¹⁷

Data analysis

Data were checked, coded, and entered into Epi Info version 3.5.3 and transferred to SPSS 21 and STATA 13 for analysis. Descriptive statistics was used to calculate the prevalence of HAI. The prevalence of HAI was calculated (number of infections divided by the total number of patients comprising the study population), and for identified HAI cases (number of patients with HAI divided by the total number of patients comprising study population), with 95% confidence intervals (CIs) using exact binomial methods by bootstrap simulation (100,000 samples). Multivariable logistic regression analyses were conducted; the dependent variable was the presence of HAI and the independent variables were sex, season of data collection, ward type, and hospital type. Other variables were not included in the model because the bivariate analysis of independent variables with the outcome variable resulted in a *P*-value >0.2.

Data quality

Study teams attended a 3-day training session regarding the definitions and the study protocol prior to starting the study. Practical case exercises and the protocol and standardized case record form were reviewed. Data were collected by external data collectors, trained in the diagnosis of HAI according to the CDC definitions, to ensure the validity and accuracy of the data. Before the real data collection, the data collection tool was validated on two preselected wards by comparing the collected data with the “gold standard”. The data collectors obtained basic demographic information as well as information on other HAIs from eligible patients in the selected wards, the forms and case definitions being similar to those used for the real data collection. International standard strains of *Escherichia coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 25923) were used for culture and susceptibility testing.²² Double data entry was conducted to minimize errors, when the data were entered. After the data entry, consistency, errors, and range to control the outlier during data entry were checked.

Operational definition

Dry season is a season in which rain is rare and the days are mostly sunny and dry, especially from September to May, while wet season is a season in which it rains almost daily, especially from June to August. The two seasons are common in the study area.

HAI is defined as a localized or systemic condition that results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) and occurring 48 hours or more after hospital admission that was not incubating at the time of admission.^{23,24}

Active HAI is an infection where a person presents with signs and symptoms of the infection during the time of data collection, or where signs and symptoms were present in the past and the patient is still receiving treatment for that infection during the time of data collection, both these definitions should meet the CDC definition of HAI.

Results

A total of 908 patients were included in this point-prevalence survey. Two teaching hospitals were involved in this survey that was conducted twice with an interval of 3 months between the first and second survey, ie, in March to April and July 2015. The survey was conducted during the two seasons (ie, dry and wet) in Ethiopia. Of the total patients included in the study, 573 (63.1%) were from the University of Gondar Hospital and the remaining 335 (39.9%) were from Felege Hiwot Hospital. The median

age of the patients was 27 years (interquartile range: 16–40 years). A total of 650 (71.6%) patients received antimicrobials during the survey. The demographic and clinical characteristics of the patients who participated in the survey are summarized in Table 1.

A total of 135 patients experienced HAI, with a mean prevalence of 14.9% (95% CI 12.7–17.1). In addition, five patients suffered from two types of HAIs. The overall mean prevalence of infections in the two hospitals was 15.41% (95% CI 13.13%–17.93%) (Table 2). Surgical site infections (51%) were the most common type of infections that were recorded in this survey (95% CI 43.0–59.3).

Microorganisms that were identified among the HAI patients were *Klebsiella* spp. (22.44%), *S. aureus* (20.40%), *Pseudomonas aeruginosa* (18.36%), *E. coli* (16.32%), *Enterobacter* spp. (12.24%), *Streptococcus pneumoniae* (10.20%), *Proteus* spp. (6.12%), *Citrobacter* spp. (6.12%), *Klebsiella pneumoniae* (4.08%), *Acinetobacter* spp. (4.08%), and *Serratia* spp. (2.04%).

Table 1 Demographic and clinical characteristics of patients who participated in the survey (n=908)

Characteristics	Number of patients (%)
Sex	
Male	466 (51.3)
Female	442 (48.7)
Age (years)	
<1	39 (4.3)
1–14	162 (17.8)
15–34	416 (45.8)
35–55	196 (21.6)
≥56	95 (10.5)
Ward type	
Surgical	289 (31.8)
Medicine	235 (25.9)
Pediatrics	158 (17.4)
Obstetrics and gynecology	177 (19.5)
Ophthalmology	31 (3.4)
Mixed ward	18 (2)
Received antimicrobials	
Yes	650 (71.6)
No	258 (28.4)
Central vascular catheter	
No	893 (98.3)
Yes	12 (1.3)
Unknown	3 (0.3)
Urinary catheter	
No	746 (82.2)
Yes	162 (17.8)
McCabe score	
Nonfatal diseases	517 (56.9)
Ultimately fatal diseases	272 (30)
Rapidly fatal diseases	66 (7.3)
Unknown	53 (5.8)

Table 2 Proportion of specific site infections among hospital-acquired infections in teaching hospitals of Amhara region, Ethiopia (n=135)

Characteristics	Number	Proportion	95% CI
Specific site infections			
Surgical site infections	69	51.1	43.0–59.3
Pneumonia	25	18.5	11.9–25.9
Blood stream infections	19	14.1	8.1–20
Urinary tract infections	9	6.7	3.0–11.1
Gastrointestinal system infections	5	3.7	0.7–7.4
Skin and soft tissue infections	5	3.7	0.7–7.4
Others (SYS, NEO, PVC)	3	2.2	0.0–5.2

Abbreviations: SYS, systemic infections; NEO, case definitions for neonates; PVC, peripheral vascular catheter; CI, confidence interval.

Multivariable logistic regression analyses were conducted. In this analysis, dependent variable was presence of HAI and independent variables were sex, season of data collection, ward type, and hospital type.

Children aged 1–4 years were 75% less likely to acquire HAIs compared to individuals aged ≥56 years (adjusted odds ratio [AOR]: 0.25, 95% CI 0.09–0.71). Patients admitted to a surgical ward were 2.86 times more likely to acquire HAIs compared to those admitted to a medical ward (AOR: 2.86, 95% CI 1.72–4.78). The patients admitted to Felege Hiwot Hospital were 1.95 times more at risk of developing HAIs when compared to patients admitted to Gondar Hospital (AOR: 1.95, 95% CI 1.36–2.93) (Table 3).

Discussion

In this survey, the mean prevalence of HAIs among the patients was 14.9%, and the overall prevalence of HAIs in the two hospitals was 15.41%. Age of the patient, ward type, and hospital type were predictors for the occurrence of HAI. The results of this survey are similar to those reported previously for a survey conducted in Uganda and Tunisia (mean prevalence of HAI: 17%).^{25,26} The point-prevalence finding in this study was lower than that reported by a study conducted in Albania (19.11%).²⁷ This high discrepancy may be due to the differences in the methodologies adopted and time gap between this study and the aforementioned two studies. The mean prevalence of HAI's in this study was also lower than that reported by the studies conducted on some specific wards in Morocco (ICU, 34.5%)²⁸ and in European countries (ICU, 28.1%).²⁹

The prevalence of HAIs varies by the type of specific site infection and indwelling device used.^{30–32} This comprehensive HAI was lower than the HAI associated with a specific site infection according to other studies conducted in Ethiopia

Table 3 Predictive factors for the occurrence of HAI among the teaching hospitals of Amhara region, Ethiopia (n=908)

Characteristics	HAIs		Crude OR (95% CI)	Adjusted OR (95% CI)
	Yes	No		
Sex				
Male	83	383	1.62 (1.12–2.36)*	1.25 (0.81–1.95)
Female	52	390	1	1
Age (years)				
<1	9	30	1.38 (0.55–3.42)	0.76 (0.19–2.97)
1–14	14	148	0.43 (0.20–0.93)*	0.25 (0.09–0.71)*
15–34	66	350	0.86 (0.48–1.55)	0.88 (0.47–1.66)
35–55	29	167	0.79 (0.41–1.54)	0.76 (0.38–1.51)
>56	17	78	1	1
Season				
Dry	70	390	1.06 (0.73–1.52)	1.06 (0.72–1.55)
Wet	65	383	1	1
Department (wards)				
Medicine	24	212	1	1
Pediatrics	19	129	1.30 (0.68–2.47)	2.84 (0.94–8.54)
Surgery	75	240	2.76 (1.68–4.53)***	2.86 (1.72–4.78)***
Gynecology	16	161	0.88 (0.45–1.71)	1.02 (0.49–2.12)
Ophthalmology	1	31	0.28 (0.04–2.18)	0.39 (0.05–3.08)
Hospital				
Gondar Hospital	61	512	1	1
Felege Hiwot Hospital	74	261	2.38 (1.64–3.47)***	1.99 (1.36–2.93)***

Notes: *Statistically significant association, $P < 0.05$; ***very strong statistically significant association, $P < 0.001$.

Abbreviations: HAI, hospital-acquired infection; CI, confidence interval; OR, odds ratio.

(39.10%).³³ The point prevalence obtained in this study (15.14%) was much higher than that reported by studies conducted in other developed^{34–37} and developing countries.^{38–41}

The most common type of HAI observed in this study was surgical site infection, which contributes to 51% of the total HAIs. This high proportion of surgical site infections was also supported by a systematic review carried out in sub-Saharan African countries.⁴² High proportion of surgical site infections was also observed in studies conducted in Mali (57.4%)⁴³ and Ethiopia (49.4%).³³ This may be due to the reason that these studies were conducted on ward-specific infections.

The most commonly observed HAI was pneumonia in India (50%),⁴⁴ Saudi Arabia (28.9%),⁴⁵ and Vietnam (41.9%),⁴⁶ whereas in this study, among all the HAIs, pneumonia occupied the second position (14.1%). The highest proportion observed in India may be due to the studies being conducted in ICU.

The association between patient age and hospital type with the occurrence of HAI was statistically significant. Children aged 1–4 years were 75% less likely to acquire HAIs compared to individuals aged ≥56 years. This result was also supported by other studies conducted in Morocco and Iran.^{28,39} There was no significant correlation between the prevalence of HAI and

season of data collection (dry and wet seasons). This finding was also supported by other studies conducted during four seasons in Iran.³⁹ *Klebsiella* spp., and *S. aureus* were the most commonly isolated HAI-causing pathogens in the present study. This finding was also in line with a study conducted in Nigeria.⁴⁷

The limitations of this study were resource constraints and comparisons with other studies which included different specific site infections and patient populations. Prospective, continuous monitoring of HAIs can help clinicians and patients to identify areas that need improvement and to demonstrate the effectiveness of interventions.⁴⁸ A study conducted in Turkey on the validity of a weekly point-prevalence survey showed that the prevalence rate of HAIs was similar to that calculated by the Rhome and Sudderth's formula using the data of prospective-active incidence survey.⁴⁹ A study conducted at the University of Geneva hospitals indicates that more number of HAIs are identified by the period prevalence than the repeated point method.⁵⁰ Despite these limitations, findings from this point-prevalence survey can provide clues for the development of future interventions, help practitioners to prioritize interventions, and target future incidence surveillance to reduce the risk of infection in hospitals.

Conclusion

A high prevalence of HAI was noted in this study, and approximately one in seven inpatients experienced at least one HAI. Surgical site infections and pneumonia were the most common infection types observed in this study. *Klebsiella* spp. and *S. aureus* were the most commonly isolated HAI-causing pathogens in these hospitals. Patient age, ward type, and hospital type were determined to be the predictors of the occurrence of HAI. Hospital management should give more attention to promoting infection prevention practices for better control of HAIs in teaching hospitals. Furthermore, strong analytical investigations are needed to identify the risk factors associated with HAIs.

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Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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12.2 Paper Two

PAPER II

Risk factors for hospital-acquired infections in teaching hospitals of Amhara Regional state, Ethiopia: a matched-case control study

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Abstract

Background

Hospital-acquired infection affects hundreds of millions of people worldwide. It is a major global issue for patient safety. Understanding the potential risk factors is important to appreciate the local context. A matched case control study design, which is the first in its kind in the region, was undertaken to identify risk factors in teaching hospitals of Amhara regional state, Ethiopia

Method

A matched case control study design matched with age and hospital type was used. The study was conducted in University of Gondar and Felege-Hiwot medical teaching hospital. Cases were patients who fulfilled the criteria based on CDC definition of hospital-acquired infection and controls were patients admitted to the hospital that stayed for more than 48 hours in the ward in the study period, but who did not develop infection. For one case, four controls were selected. A total of 545 patients, 109 cases and 436 controls included in the study. Conditional logistic regression using STATA 13 was used for analysis.

Result

A total of 545 patients were included in this study. The median length of stay for cases and controls was 7 and 8 days, respectively. Patients admitted in wards with the presence of medical waste container in the room had 82% less chance of developing hospital-acquired infection (AOR 0.18: 95% CI, 0.03-0.98). The odds of developing hospital-acquired infection among immune deficient patients were 2.34 times higher than their counterparts with 95% CI:(1.17-4.69). Patient received antimicrobials, central vascular catheter and surgery since admission had 8.63, 6.91 and 2.35 higher odds of developing hospital-acquired infection, respectively.

Conclusion

Health providers and managers should consider the availability of healthcare facilities and follow the appropriate medical procedures for use of external devices and give attention for those immunocompromised patients for the prevention and control of hospital-acquired infection.

Key words: *Hospital acquired infection, risk factor, teaching hospital, Ethiopia*

Introduction

Hospitals are the main health facilities for the risk of acquiring an infection during the delivery of care. Hospital-acquired infections(HAI) are associated with an increased attributable mortality, length of stay, and healthcare costs incurred by patients and healthcare facilities[1,2]. Hospital-acquired infections are a growing problem at every level of the healthcare system. World Health Organization (WHO) estimated that it affects hundreds of millions of people worldwide and it is a major global issue for patient safety[3]. The prevalence of hospital acquired infection in two teaching hospitals in Ethiopia were 14.9%[4].

Hospital-acquired infections risk increased with invasive device used [5] and a patient in Intensive Care Unit (ICU)[6]. Incidence of Device-Associated Infections(DAIs) report from International Nosocomial Infection Control Consortium(INICC) are higher than US National Healthcare Safety Network (NHSN)[7,8]. The overall DAIs patients indicated that 5.3% in China[9],12.2% in Colombia[10] and 13% in Peruvians ICU patients[11]. Evidences showed that this device-associated hospital-acquired infection increases and contribute extra extended length of stay[12–14], and mortality[10,11,14]. Researches in developing countries showed that device-associated infections in intensive care unit were high[15,16] and incurred extra cost for patients[17–19].

Patients admitted in the hospital ward are susceptible to hospital acquired infections. Risk factors are also different from specific site to specific site infections, because hospital environments are complex. Previously conducted researches indicated that, long hospital stays[20,21], gender[22,23], intravascular catheter[24,25], surgery since admission[22,26], Intubation[27], mechanical ventilation[28], age of the patient[4,29], type of hospital [4,30], urinary catheter[22,27] were some of the risk factors for hospital acquired infections.

In Ethiopia, even if there are researches conducted in specific surgical site infections[31–33] and hospital-acquired infections[4], none of the above researches used strong epidemiological analytical method, to determine important risk factors. Matched case control study has its own bias during matching[34], but compared to cross-sectional design, matched case control design is stronger for risk factor assessment and minimizes bias[35]. There was no such strong evidence generated in the study setting. Therefore, the aim of this study was, to identify risk factors of hospital-acquired infections in teaching hospitals of Amhara regional state, Ethiopia. The findings of the study will be used as an input for policy makers, programmers and health care workers to improve the clinical services.

Materials and Methods

A matched case control study design, matched with age \pm 5 years and hospital, was conducted at the University of Gondar and Felege-Hiwot medical teaching hospitals of Amhara regional State, Ethiopia. Amhara region is one of the second most populous region in the country. Data were collected in two phases: the first being from 16 march to 02 April 2015 and the second from 01 July to 10 July 2015. All inpatients admitted in the two hospital wards were included in the study. Surgical, Gynecology & obstetrics, Internal medicine, Pediatrics, Ophthalmology and Intensive Care Unit wards were included. Emergency and recovery departments and wards were excluded.

Cases were patients who developed hospital-acquired infection based on Centers for Disease Control's definition, i.e., patients admitted to the hospitals and presented an infectious agent(s) or its toxin(s), and that occurred 48 h or more after admission to the hospital that were neither present nor incubating on admission.

The controls were patients admitted to the hospital that stay for more than 48 hours in the ward in the study period and did not developed hospital-acquired infection. The controls were matched based on age \pm 5 years within the same hospital. A case to control ratio of 1:4 was used.

The outcome variable was presence of hospital-acquired infections. Intrinsic and extrinsic factors, such as immunodeficiency, insertion of a urinary catheter, peripheral vascular catheter, mechanical ventilation, availability of hand washing material, and McCabe score were assessed. Hospital-acquired infections were confirmed if the patient had signs and symptoms which met the Centers for Disease Control and Prevention (CDC, Atlanta, GA, USA) definition at the time of the data collection [18].

The sample size was calculated by assuming a 5% type I error, 80% power to detect exposure difference between cases and controls, a 1:4 ratio of cases to controls, and a design effect of 1.5. Accordingly, 109 cases and 436 controls, a total of 545 subjects were required for the study.

The study was conducted after ethical approval of Addis Ababa University College of Health Science Institutional Review Board. Data were collected after written consent with a brief description on the importance of the study to the participants. In addition to consents taken from the parent/guardian, for children age between 7-18 years written assent were taken from each study participants. A pretested standardized questionnaire was used to collect data. Moreover, medical record and consultation with the person in charge of the patient were the gold standard for the identification of the cases. Data collectors were trained for three days about the definitions and the study protocol prior to starting the study. Double data entry was conducted to minimize errors occurred during data entry.

Data was entered and validated using EPI-INFO software version 3.5.3 (Atlanta, USA) and STATA 13 for analysis. After matching cases and controls with a unique identifier, bivariate and multivariable conditional logistic regression was employed to identify independent factors associated with HAI. A bivariate analysis was run for each variable. Then those variables which were significant at the bivariate analysis along with variables that were well known predictors of HAI were included in the multivariable analysis. Odds ratios with the corresponding 95% confidence intervals were estimated

and p values were determined. Variables with $P < 0.05$ in the multivariable conditional logistic regression analysis were considered as significant independent predictors of HAI in this study.

Results

A total of 545 patients included in this study. One hundred nine were cases and the remaining 436 were controls. The median age of the cases was 25 years (Interquartile range of 16-35) and, for controls 25 years (Interquartile range of 16-36). Length of stay for patients in the hospital was 8 days with Interquartile range of 4-15 days. The median length of stay for cases and controls was 7 and 8 days respectively (Table 1).

Table 1: Background characteristics of cases and controls, in teaching hospitals in Amhara region, Ethiopia ,2015

Characteristics		Cases n=109	Controls n=436	P-Value
hand washing material available in ward	Yes	45(41.3%)	238(54.6%)	0.001
	No	64(58.7%)	198(45.4%)	
Sex	Male	64(58.7%)	201((46.1%)	0.01
	Female	45(41.2%)	235(53.9%)	
Age categorized	<=1 year	9(8.2%)	24(5.5%)	0.999
	1-14 year	14(12.84%)	76(17.43%)	
	15-35 years	59(54.13%)	255(51.6%)	
	36-55 years	22(20.18%)	90(20.64%)	
	>=56 years	5(4.6%)	21(4.8%)	
Ward of admission department	Medicine	21(19.3%)	118(27.1%)	
	pediatrics	19(17.4%)	79(18.1%)	
	surgery	53(48.6%)	141(32.3%)	
	Gynecology	16(14.7%)	93(21.3%)	
	Ophthalmology	0(0%)	5(1.1%)	
hand rubs available in the ward	Yes	67(61.5%)	302(69.3%)	0.003
	No	42(38.5%)	134(30.7%)	
Presence of medical waste container in the ward	Yes	102(93.6%)	431(98.9%)	0.04
	No	7(6.4%)	5(1.1%)	
Diabetics History	Yes	3(2.8%)	9 (2.1%)	0.400
	No	102 (93.6%)	402 (92.2%)	
	Unknown	4(3.7%)	25(5.7%)	
Immune deficiency	Yes	31(28.4%)	92(21.1%)	0.018
	No	78(71.6%)	344(78.9%)	

	No	55(50.5%)	279 (64.0%)	
	Unknown	23(21.1%)	65(14.9%)	
McCabe score	Non-Fatal diseases	47 (43.1%)	235 (53.9%)	0.006
	Ultimately fatal diseases	39 (35.8%)	141 (32.3%)	
	Rapidly fatal diseases	13 (11.9%)	38 (8.7%)	
	Unknown	10 (9.2%)	22 (5.0%)	
ASA (American Society of Anesthesiology) classification	Normally health patient	32 (29.4%)	146 (33.5%)	0.494
	Patient with mild systemic diseases	27 (24.8%)	85 (19.5%)	
	Patient with severe systemic disease that is not incapacitating	32 (29.4%)	100 (22.9%)	
	Patient with incapacitating systemic diseases that is a constant threat to life	14 (12.8%)	65 (14.9%)	
	Unknown	4 (3.7%)	40 (9.2%)	0.021
Central Vascular catheter	Yes	5 (4.6%)	4 (0.9%)	
	No	104 (95.4%)	432(99.1%)	
Peripheral vascular catheter	Yes	83 (76.1%)	291(66.7%)	0.05
	No	26 (23.9%)	145(33.3%)	
Urinary catheter	Yes	33 (30.3%)	75 (17.2%)	0.003
	No	76 (69.7%)	361(82.8%)	
Intubation	Yes	18 (16.5%)	29 (6.7%)	
	No	91 (83.5%)	407(93.3%)	0.001
Surgery since admission	Yes	64 (58.7%)	146(33.5%)	0.000
	No	45 (41.3%)	290(66.5%)	
Length of stay categorized	<8 days (below the median)	63 (57.8%)	209(47.9%)	0.06
	>= 8 days (above or equal to median)	46 (42.2%)	227(52.1%)	
The patient received Antimicrobial	Yes	104 (95.4%)	294(67.4%)	0.000
	No	5 (4.6%)	142(32.6%)	

Availability of waste management material, Immune status of the patient, central vascular catheter, surgery for admission and the patient received antimicrobial at the time of the survey were the predictors of hospital acquired infection. Variables of patients admitted in wards with the presence of medical waste container in the room were 82% less likely to develop hospital acquired infection compared to wards without medical waste container, AOR 0.18: 95% CI, 0. 03-0.98. The odds of developing hospital-acquired infection among patients with immune deficient patients were 2.34 times higher compared to their counterpart patients with 95% CI: (1.17-4.69). The central vascular catheter was a risk factor for hospital-acquired infection with AOR of 6.92 with 95% CI: 1.28-37.47. The odds of developing hospital-acquired infection among Patients who had surgery since admission in the ward was 2.35 times higher compared with patients without surgery since admission in the ward with 95%

CI:1.08-5.09. Antimicrobial use was also a risk factor for hospital-acquired infection with AOR of 8.63 with 95% CI: 3.11-23.95 (Table 2).

Table 2: Risk factors for HAI in teaching hospitals in Amhara region, Ethiopia 2015

Characteristics		Cases	Controls	Crude OR (Odds Ratio) (95% CI)	Adjusted OR (Odds Ratio) (95% CI)
Available hand washing material in ward	Yes	45(41.3%)	238(54.6%)	0.38(0.21-0.68) **	0.81(0.35-1.86)
	No	64(58.7%)	198(45.4%)	1	1
Presence of medical waste container at room	Yes	102(93.6%)	431(98.9%)	0.12(0.003-.03) **	0.18(0.03-0.97)*
	No	7(6.4%)	5(1.1%)	1	1
Sex	Male	64(58.7%)	201(46.1%)	1	1
	Female	45(41.2%)	235(53.9%)	0.57(0.37-0.89) **	0.65(0.37-1.13)
Immune deficiency	No	55(50.5%)	279(64.0%)	1	1
	Yes	31(28.4%)	92(21.1%)	1.78(1.03-3.04) *	2.34(1.17-4.69) **
	Unknown	23(21.1%)	65(14.9%)	1.86(1.03-3.37)*	1.26(0.61-2.59))
McCabe score	Non-Fatal diseases	47 (43.1%)	235(53.9%)	1	1
	Ultimately fatal diseases	39 (35.8%)	141(32.3%)	1.48(0.88-2.48)	1.34(0.63-2.85))
	Rapidly fatal diseases	13 (11.9%)	38 (8.7%)	1.76(0.86-3.60) *	2.51(0.84-7.44))
	Unknown	10 (9.2%)	22 (5.0%)	2.54(1.05-6.13) *	1.04(0.30-3.58))
ASA classification	Normally health patient	32 (29.4%)	146(33.5%)	1	1
	Patient with mild systemic diseases	27 (24.8%)	85 (19.5%)	1.68(0.91-3.13)	0.78(0.36-1.72)
	Patient with severe systemic disease that is not incapacitating	32 (29.4%)	100(22.9%)	1.84(0.98- 3.47)	1.08(0.41-2.87)
	Patient with incapacitating systemic diseases that is a constant threat to life	14 (12.8%)	65 (14.9%)	1.20(0.55-2.59)	1.19(0.35-4.11)
Central Vascular catheter	Unknown	4 (3.7%)	40 (9.2%)	0.28(0.07- 1.03)	0.09(0.01-0.64) *
	Yes	5 (4.6%)	4 (0.9%)	5.00(1.34-18.61) *	6.92(1.28-37.47) *
Peripheral vascular catheter	No	104(95.4%)	432(99.1%)	1	1
	Yes	83 (76.1%)	291(66.7%)	1.61(0.99-2.63)	1.17(0.59-2.32)
Urinary catheter	No	26 (23.9%)	145(33.3%)	1	1
	Yes	33 (30.3%)	75 (17.2%)	2.30(1.37-3.87) **	1.23(0.59-2.55)
Intubation	No	76 (69.7%)	361(82.8%)	1	1
	Yes	18 (16.5%)	29 (6.7%)	3.40(1.66-6.97) **	0.80(0.28-2.31)
Surgery since admission	No	91 (83.5%)	407(93.3%)	1	1
	Yes	64 (58.7%)	146(33.5%)	3.31(2.05-5.36) **	2.35(1.08-5.09) *
Patient received Antimicrobial	No	45 (41.3%)	290(66.5%)	1	1
	Yes	104(95.4%)	294(67.4%)	10.69(4.22-27.07) **	8.63(3.11-23.95) ***
	No	5 (4.6%)	142(32.6%)	1	1

Notes: - * Statistically significant association $P < 0.05$, *** Very strong, statistically significant $P < 0.001$

Discussion

Risk factors for hospital-acquired infection are dynamic and complex phenomenon in the hospital. In this matched case control study, availability of waste management material in the room, immune status of the patient, central vascular catheter, surgery since admission and patient received antimicrobial at the time of survey were the predictors of hospital acquired infection.

Most risk factors for hospital-acquired infection were conducted by cross-sectional study, which has a limitation of statistical power by comparing the groups internally. The introduction of bias in matched case control study is lower than cross-sectional design [35]. Matched case control study design is assumed to generate valid data impacting the reduction of bias among main exposure variables.

The availability of hand-washing facilities waste management material in the ward are important to prevent hospital acquired infection[37]. The availability of alcohol-hand rub material in the ward significantly increases the consumption of alcohol-hand rub material in the ward[38]. Thus availability of materials and behaviors of healthcare workers reduced healthcare associated infections[39–41]. In Ethiopia researches showed that low hand hygiene practice[42] and waste management in health care facilities exist in poor conditions[43]. The availability of waste management materials is believed to reduces the exposure of waste to patients and health care workers

In this finding patients with immune deficiency were positive risk factor for hospital acquired infection. This finding was also supported by another finding, in which patients with high compromised health status were at risk for hospital acquired infection[44].

In a modern healthcare system, invasive devices and procedures are increasing to threaten patients. For example, while catheters provide lifesaving therapy, they can have an iatrogenic effect, by being a route of transmission of microorganisms to the patient's body, thereby causing infection. Hospital-acquired

infections can also occur with the devices used in medical procedures[45]. A hospital based research in Poland showed that, there was a positive correlation between prevalence of hospital-acquired infection and exposure to invasive procedures[22]. In our study, patients with central vascular catheter were 7.56 times more likely to be a risk factor compared to non-central vascular catheter patients. This finding was supported by other studies conducted in Poland, Morocco and china hospitals[22,26,46].

The high risk of central vascular catheter may be due low implementation of a multidimensional infection control strategy in the study setting. Literature from developing countries to the implementation of Nosocomial Infection Control Consortium (INICC) bundles and other infection control measures reduced device-associated infection of CLABSI[47–50], VAP[49,51,52] and CAUTI [53] in ICU patients. Surgery since admission was one of the determining factors for hospital-acquired infection in this finding. This was also supported by other findings conducted by the European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey[54] and China and Poland[23,26].

A research showed that, antimicrobial prescribing with broad-spectrum antibiotics to patients increased the risk of hospital acquired Drug-Resistant *Acinetobacter baumannii* infections[44]. A similar finding was also observed in Morocco that; antimicrobial use was associated with hospital-acquired infections[46]. Our study supported the above finding in which a patient received antimicrobial were 9.16 times more likely to acquire hospital-acquired infections compared to those who didn't take antimicrobials.

This study has limitations. In this research, we focused on a relatively small number of risk factors for hospital-acquired infections. Some of the recording system of clinical data was incomplete. This may introduce bias in statistical analysis. Evidence for this finding can be generalized to similar resource

limited settings. Because, the data were collected from a large proportion of controls to cases, it gives high power to identify the variations in the population.

Conclusions

Despite the above limitations, the risk factors identified in this study are very important to give highlight for the prevention and control measure of hospital-acquired infection in teaching hospitals in the country. Presence of medical waste container in the room, patients' immune status, central vascular catheter, surgery since admission and patients received antimicrobials were the independent predictors of hospital acquired infections. The medical workforce and managers should consider the availability of healthcare facilities. Hospitals and clinician needs to follow the appropriate medical procedures for use of external devices and give attention to those immunocompromised patients for the prevention and control of hospital-acquired infection.

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12.3 Paper Three

PAPER III

Infection prevention and control practice of healthcare workers in Amhara region teaching hospitals, Ethiopia

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Abstract

Background: Infection prevention practice is a serious concern for health care workers; it is a major risk for the transmission of infections in the hospital. Infection prevention practice is low and not well explored in developing countries. The aim of the present study is to assess the infection prevention practice in teaching hospitals of Amhara region in Ethiopia.

Method: A cross-sectional study was conducted among healthcare workers in Amhara Region teaching hospitals, Ethiopia. Data were collected from March to April 2015. A total of 422 healthcare workers were included in the study. Systematic random sampling was employed to select the study participants. The collected data were cleaned, coded and entered in to Epi-Info version 3.5.3 software and analysis was done using STATA 13. Multivariable binary logistic regression analysis was conducted. $P < 0.05$ was considered as statically significant.

Result: Four hundred thirteen healthcare workers participated in the study. Twenty-six questions were asked to answer infection prevention practice. The total composite score showed that 55% [95% CI: (50.1-59.6)] of the healthcare workers practice infection prevention control in their activities. For the past one year 234(56.7%) and 150(36.3%) healthcare workers exposed to blood or body fluids and sharp or needle injury, respectively. The odds of infection prevention control practice among Nurses is 2.09 [(95% CI: 1.27-3.43)] times higher than among physicians

Conclusion: Infection prevention and control practice were low in the study setting. High proportions of healthcare workers were exposed to risk factors. Nursing professionals practice better than physicians. Infection prevention and control practice need attention for the control and prevention of hospital acquired infection in the study area.

Key words: *Healthcare workers, Infection prevention and control, hospital, Ethiopia*

Introduction

Hospital's environment is a place where complex interlinked processes are performed. In this process hospital acquired infection(HAI) is a major public health issue worldwide. It affects patients, healthcare workers, visitors and in general the public at large. Healthcare workers' practices have a major role for the prevention and control of hospital acquired infections in hospitals. In developing countries, infection prevention and control practices by healthcare workers are poor[1].

Researches indicated that self-reported practice of healthcare workers regarding to universal precaution for the prevention and control of hospital acquired infections ranges from 42% in Iran[2], 50.8% in Nigeria[3] and 63% in Indonesia hospitals[4]. Nursing staffs practice more appropriate universal precaution control practice compared to physicians[5].

Healthcare workers are also exposed to occupational risk for hospital acquired infection with exposed to blood or body fluids and sharp or needle stick injury. In Ethiopia, researches showed that proportion of healthcare workers exposed to blood or body fluids ranges from 22.9%[6] to 35.1% [7] and sharp or needle stick injury from 29% to 42.8%[8–10].

Researches on healthcare worker's infection prevention practice and control conducted in Ethiopia by Teshager et al [11] focus on surgical site infection, Abdella and Tena [12,13] on hand hygiene compliance, Demissie Gizaw et al[14] on tuberculosis (TB) and Aynalem [7] on HIV/AIDS universal precautions. To the best of our knowledge there is no study that focus on all components of infection prevention control items for hospital acquired infection in Amhara region teaching hospitals.

We hypothesized that healthcare workers practice more, when they exposed to formal training on infection prevention and there is no difference between health care workers regarding to infection prevention practice. Therefore, the aim of this study was to provide the practice level of infection prevention and control and assess factors associated with practice among healthcare workers in teaching hospitals of Amhara regional states of Ethiopia.

Methods and Materials

A cross-sectional study was conducted to describe infection prevention and control practice of healthcare workers in Amhara region teaching hospitals (university of Gondar and Felege Hiwot), Ethiopia. Data were collected from March to April 2015. All health care providers that have direct involvement to inpatients in the wards were included. Healthcare workers who were on annual leave, study leave, or on training during the study period were excluded from the study.

Sample size was calculated by using single proportion formula. Assuming a 50% practice, 5% precession, 95% confidence level and 10% non-response rate, a sample of size 422 was required for determining the magnitude of practice. Internal comparison was made to assess factors associated with practice. . The sample size was proportionally allocated to the two hospitals based on the number of healthcare workers.. Systematic random sampling was used to select healthcare workers. Data were collected by trained data collectors in each ward during the working hours. One study was subject recruited only once. A pre-tested self-administered structured questionnaire was used.

The study was conducted after ethical approval of Addis Ababa University College of Health Science Institutional Review Board. Data were collected after written consent with a brief description about the importance of the study to the participants

The collected data were checked for completeness, accuracy and consistency. The collected data were cleaned, coded and entered in to Epi-Info version 3.5.3 software (Atlanta, Georgia) by an experienced data clerk with close supervision and support.

The cleaned data were analyzed using STATA 13. Bivariate and Multivariable binary logistic regression analysis was conducted. Factor variables having p-value 0.25 and less in the bivariate analysis were included in the multivariable analysis. For the relationship of outcome variable and explanatory variable 95% CI and $P < 0.05$ were considered as statically significant.

In this study, we assessed infection prevention practice in different components of questions that were responded by self-administered questionnaires. The questions addressed on blood borne diseases practice comprise of seven questions. Personal hygiene and personal protective equipment consists of five questions. Urinary catheters and surgical wounds consist of four questions each and five questions for intravenous catheters. Totally 26 questions were asked to answer infection prevention practice. Composite scores were conducted for each section based on the response of health care workers practice for each question. Composite score was constructed by adding “yes” as a value of one and the rest “no”, “missing” and, “not applicable” responses recorded a value of zero. Finally, below the median score were considered as poor practice and above and equal to the median were considered as having good practice.

Result

Sociodemographic Characteristics

A total of 422 questionnaires were distributed to healthcare workers working in two teaching hospitals. Three healthcare workers were not voluntary to make complete the questionnaire. Six questionnaires were excluded from the analysis due to incomplete information. Four hundred thirteen study participants were included in the analysis, giving a response rate of 98.7%. The median age of the respondents was 27 and the interquartile range of 25 to 30. The youngest was 20 and the oldest was 65 years. Year of service ranged from one year to 40 years, with median year of service 4 years. More than half of the respondents were nurses by profession (**Table 1**).

Table 1: Healthcare worker's sociodemographic characteristics in two teaching hospitals in Amhara region, Ethiopia, 2015

Characteristics		frequency	percent
Gender	Male	236	57.1
	female	177	42.9
Profession	Physicians	121	29.3
	Nurses	265	64.2
	Other*	27	6.5
Age categorized	<=30 years	326	78.9
	> 30 years	87	21.1
Year of service in the current institutions	<=5 years' service	356	86.2
	> 5 years' service	57	13.8
Marital status	Married	178	43.1
	Single	235	56.9

Nb: *= Health officer, Health assistants

Background of infection prevention condition

Exposure of blood or body fluids in the past one year among healthcare workers were high, it accounts 234(56.7%). While the Exposure of sharp or needle injury in the past one year was 150(36.3). One hundred seventeen healthcare workers exposed both blood and body fluids and needle or sharp object. One hundred forty-six (35.4%) of healthcare workers did not exposed any type of risks. Out of 267 risk exposed healthcare workers, only 40(14.99%) receive Post Exposure prophylaxis (Hepatitis B and HIV AIDS) (**Table 2**).

Table 2: Healthcare worker's s background of infection prevention condition in two teaching hospitals in Amhara region, Ethiopia, 2015

Characteristics		Frequency (%)	95% Confidence Interval
Receive formal training on Infection prevention	No	239(57.9)	(53.3-63.0)
	Yes	174(42.1)	(37.0-46.7)
Exposed to Blood /body fluids in the past one year	No	179(43.3)	(38.3-47.9)
	Yes	234(56.7)	(52.1-61.7)
Exposed to Blood /body fluids in the past one month	No	258(62.5)	(57.6-67.1)
	Yes	155(37.5)	(32.9-42.4)
Exposed to sharp or needle injury in the past one year	No	263(63.7)	(58.8-68.5)
	Yes	150(36.3)	(31.5-41.2)
Exposed to sharp or needle injury in the past one month	No	351(85.0)	(81.1-88.1)
	Yes	62(15.0)	(11.9-18.9)
Needle or sharp object visibly contaminated with blood prior to exposure	No	68(45.3)	(37.3-53.2)
	Yes	82(54.7)	(46.0-61.9)
Receive Post Exposure prophylaxis (Hepatitis B and HIV AIDS)? (n=267)	No	227(85.0)	(80.72-89.3)
	Yes	40(14.98)	(10.69-19.26)
Instructed about hospital guidelines on infection control	No	227(55.0)	(50.1-59.8)
	Yes	177(42.9)	(37.8-47.5)
	Missing	9(2.2)	
Instructed to report signs and symptoms of an infectious condition promptly to a supervisor	No	246(59.6)	(54.7-64.6)
	Yes	160(38.7)	(33.9-43.6)
	Missing	7(1.7)	

Infection prevention and control practice

The total composite score showed that 55% [95% CI: (50.1-59.6)] of the healthcare workers have good infection prevention and control practice in their activities. Healthcare workers practice better in blood borne diseases component compared to other components. Least proportion practice was observed in personal hygiene component (**Table 3**).

Table 3: Healthcare workers of infection prevention practice in two teaching hospitals in Amhara region, Ethiopia, 2015

Characteristics			Frequency (%)	95% CI
Blood Borne Diseases Practice	Good practice	No	157(38.0)	(33.7-43.1)
		Yes	256(62.0)	(56.9-66.3)
Personal Hygiene Practice	Good practice	No	205(49.6)	(45.0-54.5)
		Yes	208(50.4)	(45.5-55.0)
Urinary catheter practice	Good practice	No	181(43.8)	(39.0-48.4)
		Yes	232(56.2)	(51.6-61.0)
Surgical Wound Infection Practice	Good practice	No	186(45.0)	(40.2-49.6)
		Yes	227(55.0)	(50.4-59.8)
Intravenous Catheter Practice	Good practice	No	166(40.2)	(35.6-44.8)
		Yes	247(59.8)	(55.2-64.4)
Total composite score for infection prevention practice	Good practice	No	186(45.0)	(40.4-49.9)
		Yes	227(55.0)	(50.1-59.6)

Factor associated with r infection prevention and control practice

Multivariable analysis was conducted to see the association between the explanatory and the outcome variable. To control confounding variables all variables were inserted to the final model. The model fitness checked by Hosmer and Lemeshow (0.827). The final model showed that, the odds of infection prevention and control practice among nurses was e 2.09 times higher

than among physicians with 95% CI: 1.27-3.43. The result showed that other professions like Health officer and Health assistants were 69% less likely to practice infection control compared to physicians with (95% CI: 0.11-0.84) (Table 4).

Table 4: Healthcare worker’s infection prevention practice and associated factors in two teaching hospitals in Amhara region, Ethiopia, 2015

Characteristics	Infection Prevention control practice		Crude OR (95% CI)	Adjusted OR (95% CI)	
	Good	Poor			
Gender	male	130	106	1.01(0.68-1.49)	1.29(0.83-1.99)
	female	97	80	1	1
Age	<=30 years	172	154	0.65(0.40-1.06)	0.55(0.30-1.02)
	> 30 years	55	32	1	1
Service year	<=5 years’ service	138	123	0.79(0.53-1.19)	1.140(0.66-1.96)
	> 5 years’ service	89	63	1	1
Profession	Physicians	56	65	1	1
	Nurses	165	100	1.91(1.24-2.96) *	2.09(1.27-3.43) *
	Other [#]	6	21	0.33(0.12-0.88) *	0.31(0.11-0.84) *
Marital status	Married	100	78	1.09(0.74-1.61)	1.08(0.68-1.69)
	Single	127	108	1	1
Training of Infection prevention	Yes	102	72	1.29(0.87-1.92)	0.92(0.59-1.42)
	No	125	114	1	1

Notes: - * Statistically significant association P<0.05, # Health officer, health assistance

Discussion

Healthcare worker’s infection prevention practice is one of the major pillar for the prevention and control of hospital acquired infections. In this finding, infection prevention and control practice in the two teaching hospitals was 55% . Nurses practice better compared to physicians and other professionals. Healthcare worker’s exposure of Blood /body fluids and sharp or needle injury in the past one year were 56.7% and 36.3%, respectively.

Practice of healthcare workers regarding to prevention and control of Hospital acquired infection was high compared to a research conducted by Teshager(48.7%) in Ethiopia[11] and Hamed Sarani,(42%) in Iran[2]. The lower practice in the previous researches may be due to the research conducted only on surgical site infection and nurses. Our study was similar to a study conducted by Dimie(50.8) in Nigeria[3] and by Demissie(51.7%) in Ethiopia[14]. This practice was low compared to a research conducted by Reda(68%) of universal precaution practice to control HIV/AIDS in Ethiopia[15] and Duerink 60% in Indonesian island of Java[4]. This difference may be due to time gap between the two studies and focus only exposure of body fluids for the prevention and control of HIV/AIDS in the Ethiopian study.

For Nurses, the odds of practice was 2.09 times larger than the odds for physicians., . This finding was also supported by a research conducted in Italy emergency ward to perform hand hygiene measures after removing gloves[5] and Indonesian island of Java[4].

Health care workers are highly affected by hospital acquired infection through exposure of blood and body fluids[16]. In this study 56.7% of healthcare workers exposed to Blood /body fluids in the past one year. This prevalence was high compared to the previous researches conducted in Ethiopia[6,17]. This discrepancy may be due to the difference components of the items in the questionnaires.

Healthcare worker's exposure of sharp objects or needle stick injury may lead to serious and potentially fatal infections. In this study 36.3% of healthcare workers were exposed to sharp or needle injury in the past one year. The finding was similar to a study conducted by Aynalem Tesfay [7] and lower than a research conducted by Legesse [10] , but it was higher than a study

conducted by Yenesew [8] in Ethiopia. These variations may be due to study time difference and they included health centers, in addition to teaching hospitals.

The study has the following limitation. Healthcare workers respond to self-administered instrument, based on their behavior that may not be the real reflection of the practice they did in the actual work setup. Observation during the actual practice improves the actual measurement of practice.

Despite the limitations, this survey has generated an important evidence, that helps for healthcare managers and decision makers to improve the prevention and control of hospital acquired infections. The finding is generalizable and representative for healthcare workers practice in teaching hospitals of the region.

Conclusion

Hospital acquired infection prevention and control practice among healthcare workers was low. Considerable proportion of Healthcare workers were exposure to Blood /body fluids and sharp/needle stick injury in the past one year. Nursing professionals practice better compared to physician and other health professionals. Healthcare workers and managers should give more attention to infection prevention and control to all healthcare workers for the prevention and control of hospital acquired infection.

Ethical approval and consent

The study was conducted after ethical approval of Addis Ababa University College of Health Science Institutional Review Board. Data were collected after written consent with a brief description about the importance of the study to the participants

Competing interests

The authors declare that they have no any competing interests.

Authors' contributions

WW, AK and FM involved in literature review, proposal development, research design, data collection, data analysis and manuscript writing and all authors have read and approved the final manuscript.

Availability of data and materials

Data and materials are available to share

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12.4 Paper Four

PAPER IV

Barriers of Infection Prevention and Control Practice among Amhara Region teaching hospitals in Ethiopia: A Qualitative study

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Abstract

Back ground: Infection prevention and control practices leads to significant reductions in hospital acquired infection. Although, healthcare workers seem to have good perception towards infection prevention, the prevention practice is still a challenge to sustain it. The aim of this study was to explore the barriers practicing infection prevention and control in teaching hospitals of Amhara region.

Method: A phenomenological approach was used to explore the lived experience of healthcare workers and management staffs towards infection prevention practice. The data was collected in two teaching hospitals. Ten in-depth interviews and 23 focus group discussions were used to collect data. Data was entered in a text form using open code software version 4.03 and contents were analyzed thematically. Repeated reading was employed to sort out closely the main categories and themes of the research.

Results: We classified barriers in to three barrier related themes, organizational or institutional, healthcare workers and patients, and visitors. A total of ten different barriers were identified, such as availability of facilities, shortage of material supply, lack of maintenance of facilities and equipment's, high patient flow, experience, emergency situation, healthcare worker behavior and healthcare worker's knowledge, low awareness of patients and visitors and over flow of families and visitors to the hospital.

Conclusion: Barriers related to organizational, healthcare worker and patients and visitors should be considered for the effective prevention of hospital acquired infections

Key words: *Infection prevention and control, barriers, healthcare workers, teaching hospitals.*

Introduction

Health care-associated infections are one of the major public health problem worldwide with an impact on morbidity, mortality and quality of life [1]. According to WHO report that, out of every 100 patients, 7 in developed and 15 in developing countries acquired at least one hospital acquired infection in acute care hospitals [2]. In Ethiopia, the prevalence of hospital acquired infection in teaching hospitals was 14.9 percent [3].

Hospital acquired infection affects patients, visitors, family members and health workers. Patients are more vulnerable to infection because of invasive procedures[4]. Implementation of infection prevention and control practices leads to significant reductions in hospital acquired infection. Effective Infection Prevention and Control (IPC) programs lead to more than a 30% reduction in HAI rates[5].

However, Healthcare workers have good perception towards infection prevention,[6] but there were high prevalence of needle stick injury and exposure of blood and body fluids[7,8]. This may be due to poor infection prevention practices or unable to practice appropriate universal precaution by Healthcare workers[9].

Healthcare worker's behavior[10,11], environmental and organizational characters[12], occurrence of emergency situation[13,14], lack of available material[15], shortage of time[16], and poor communication between patients and healthcare workers[17] were some of the barriers to advance infection prevention practice.

Despite the availability of studies abroad, evidences to barriers of IPC to control hospital acquired infection were limited and the country, and specifically in teaching hospitals, where resources seem to be relatively better than other hospitals. Therefore, the aim of this study was to

explore barriers to practice of infection prevention and control practice in teaching hospitals in Amhara region.

Methods

Design

A phenomenological approach was used to explore the lived experience and barriers of infection prevention practice. These hospitals were found in Amhara Regional state of Ethiopia and serving as a referral and teaching hospital in the region. Healthcare workers were purposively selected for the qualitative data based on their experience and sufficient knowledge regarding to the hospital set up management experiences.

Data collection

A face to face interview with the informants were conducted in surgical, medical, pediatrics, obstetrics and gynecology and ophthalmology wards. The focal Office for the infection prevention was also include in the interview. The participants of focus group discussions were composed of health professionals with similar job positions.

In-depth interviews and FGDs were facilitated by the principal investigator. One additional note taker was used for the FGD. Consent was obtained from each participant. Confidentiality of the information was assured. Interviews and FGDs were tape-recorded that were run for full transcription.

Semi structured open ended interview guide was used for both in-depth-interview and FGD discussions. The interview guide was developed based on literature review in the area of concern. Interview guide questions were arranged with simple definition terms to the broader contextual definitions to the inter linked ideas.

A total of 33 healthcare workers and management staffs participated in this qualitative study. These were ten participants for in-depth interviews and 23 for focus group discussion. Interview were conducted in safe and quite places to prevent disturbances during discussion.

An average of 67 minutes for each group discussion and 38 minutes for in-depth interview were used to collect data. Level of information saturation determined the number of participants. Summary interview notes by key themes were written after each interview using field notes to explore the newly emerging ideas and concepts which whelped to formulate the next interview question guides.

Ethical consideration

Ethical approval was taken from Addis Ababa University College of Health Science Institutional Review Board. Data were collected after written consent with a brief description about the importance of the study to the participants.

Analysis

Data were gathered in the form of audio recordings and notes from the in-depth interview and FGD and the texts were analyzed thematically. Prior to analysis, all the collected data were transcribed into English. The field notes were checked for accuracy and completeness. The transcribed data were read more than three times to understand the context. Word transcript documents were changed to text files, then imported to open code software. Data analysis were conducted with open code software version 4.03 and the contents were analyzed thematically. Coding was conducted careful line by line reading several times then. The codes were grouped into categories then analyzed thematically.

Results

Characteristics of the respondents

A total of 33 healthcare workers and management staffs participated in this qualitative study. Seventeen participants were from Felege-Hiwot and 16 from the University of Gondar teaching hospitals. One health care worker was not volunteer to participate. Among the participants, 20 were males and the remaining 13 were females. Of the total participants, 17 were nurses, eight physicians, four environmental health officers, three laboratory technology and one occupational health and safety officers. The minimum and maximum age of the respondents were 23 and 48 respectively.

Understanding the problem

All participants in this discussion had adequate information regarding hospital acquired infection and infection prevention practice. Majority of the participants agreed that there had been movements and activities related to infection prevention and control in their hospital. Majority of the respondents agreed that, the activities were not adequate enough to prevent hospital acquired infection. Related infection prevention activities included: a monthly report on infection prevention and its discussion, death audit and needle stick injury survey, providing hepatitis B vaccination for healthcare workers for who had sharp and needle stick injury report, auditing surgical site infection, supplies check and balance system and health education for patient. One nurse regarding their activities expressed that:

“It has check and balance system for infection prevention activities. Regarding healthcare worker’s utilization of hand rub materials, following standard procedures, washing their hands

with soap, hand rub with alcohol available in the pockets of healthcare workers, presence of sinks in the room and utilization were some of the criteria”

Another nurse on their audit finding explained:

“Based on the audit result, we have seen sterility problem, some antibiotics were miss administered to the patient, or communication was identified as a problem”

In spite of adequate information and activities conducted in their hospitals, all participants admitted that noncompliance to universal precautions to IP practice were common in their wards.

Barriers to infection prevention and control practice to hospital acquired infection

The major themes developed in the analysis were organizational, healthcare workers and patients and visitor barriers to practice infection prevention. The themes were described in the following sections.

Barriers related to organizations (institutional, administrative and management)

Availability of facilities

Majority of participants described barriers to infection prevention practices were shortage of facilities in wards or hospitals in general. Thus, facilities are relevant for patients, healthcare workers and family caregivers. Some of the important facilities discussed by participants during the discussion were lack of toilets, hand washing facilities and shower. In some wards, although there were facilities, there was no water. The problem was aired by one female nurse in the following way. *“..... But in our case for 40 beds there is only one toilet and it is not cleaned regularly and there is continuous bad odor due to lack of water. When we see the shower, it is possible to say that there is no water in general and it is not functional at all, even if there is water, it is used for another purpose and not to wash patients”*

A physician in obstetrics ward expresses the seriousness of the issue like this: *“..... The problem is due lack of proper maintenance for handwashing basins, only three hand washing basins are working*

in our ward. So, we are forced to go to the next operation, simply with hand rub disinfection, without appropriate procedures for hand washing, including from arms to the elbows of the hand”

The problem was also paramount and witnessed by another physician. *“I have not seen a single patient who washed their bodies for the last 8 months in the ward, because though there is installed pipe, there was no water”*

Shortage of material Supply

Re-using materials and equipment's in resource limited countries are common. The materials are expected to be sterile before their re-using. In this discussion, majority of the participants raised the issue of material shortage to apply infection prevention practices in some procedures. A physician in the gynecology and an obstetrics ward shared his experience as follows:

“In our ward, some instruments are very few in number. For example, manual vacuum aspiration materials are limited in number in our ward, we have only four manual vacuum aspiration tools. Hence, we are forced to re-use without proper sterility procedure. Sometimes in one night, more than four abortion cases came at a time and to sterilize the material, it takes three to four hours, including cooling time. Due to this reason, sometimes we are forced to use the material without appropriate sterility technique, to save the life of the mother”

The material shortage was also reflected by the majority of the participants. A female nurse working in the surgery department expressed that,

“I remember in surgery ward we were forced to use one material several times without the proper sterility procedure. We use suction tips several times for many patients with light disinfection for less than 10 minutes, due to absence of the instruments in our ward, to save the life of the patient” Similar problems and concerns were transpired by several study participants.

Lack of maintenance

Regular inspection of materials and maintenance are very important phenomena to ensure the quality of the material. It helps whether the material is working properly or not. Specially highly

sensitive procedures and materials need such inspection and central supply. Such issues were discussed with participants. The problem was considered an obstacle to perform activities in infection prevention. One experience was shared by a physician in the surgery room

“To tell you frankly, I got a dirt on an operation room cloth, although it was sterilized by the central supply. This is due to an old laundry machine in our hospital”

Maintenance problem was raised by participants, in addition to equipment and building problems. The listed problems were like; latrine, rooms, drainages and hand washing basins. Majority of the participants reflected that age of building affects activities of infection prevention. due to lack of maintenance of buildings and latrines. A male Environmental health officer said that:

“..... buildings are old, for example latrine constructed with the help of Germany government was old and has no drainage system. In addition, even new constructed buildings were constructed without considering the space for drainage and sometimes when the latrines are full it was difficult to drain the latrine because of unable to access site to the car”

High patient flow

All participants agreed that the flow of patients in two hospitals were high and which stands to be a barrier for infection prevention practice. A physician expressed his feeling that *“..... after 60 years, we have seen our wards without increasing in number”* In addition a female nurse said that *“..... the patients flow increased without increasing the hospital facilities, that leads women forced to delivery and sleep in the floor with rubber sheet”*

In addition, patient flow increases the work burden to healthcare workers. A female nurse said

“..... There were no sufficient nurses in our ward, sometimes one nurse assigned to 24 patients”

Another female nurse expressed that “Sometimes I assigned for 30 beds to manage in one night. In addition to this there would be an emergency cases. Therefore, my focus would be to save lives of a patient rather than long impact of hospital acquired infection. I became unconscious and infection

prevention activities do not considered in my mind” This leads nurses for loss of intention and improper practice of universal precaution practices.

Barriers related to healthcare workers

Experience

Regarding experience, health care workers has generally two views regarding infection prevention practices. Majority of participants agreed that high occurrence of sharp and needle sticks injury in medical students in their wards. One physician expressed the problem in this way *“In our ward, in one group of internship students, four to five students are taking prophylaxis vaccination due to sharp and needle stick injury in one academic semester”* Another physician in medical ward said that *“Most activities are doing by intern physicians and they are always in pressure. Students are doing and linking activities with their pass and fell evaluation. Although they are busy, they should cover all patients and report to their senior on time. Unless to do so, they will be delayed for 3 months. So, students do not follow the appropriate procedures like, doing activities without glove”*

Another group of participants observe experience in a different way. Majority of discussants agreed that experienced health workers did not follow appropriate universal precaution procedures. One physician in surgery department, expressed his observation in operation room said that *“I observed a senior physician pick pins and insert into the human bone with simple alcohol rub without sterilization. I think this may be due to shortage of pins or senior physicians believe with their faced experience rather than science”* In addition female nurse expressed her observation on this way *“it is common seniors remove wounds without glove”* Another barrier agreed by healthcare workers regarding to experiences are no communication or exchange of ideas between seniors and juniors or other team members in the team.

Emergency situation

Sometimes physicians and nurses are in a hurry saving patients life in an emergency condition. Application of the normal procedure for universal precaution may not be performed. Most of the

participants agreed that there was an emergency condition unable to follow the normal procedure. One of the male nurses in the gynecology ward explained that *“I was forced to support the mother without a glove while she delivers the baby on the corridor. At that time, I didn’t think of infection prevention practice, but the lifesaving activity comes to my mind and I did it. If I were considered IP practice at that time, I would have lost the child or the mother”* Emergency situation creates shortage of time to act healthcare workers without appropriate precaution. A male nurse in the surgery ward explained that *“Sometimes shortage of time to act forced me to accept my mind. If there is no visible fluids and wounds in the patient, it would have risk for me”*

Behavior of health care worker

Majority of participants agreed that there was professional variation between nurses and physicians to proper utilization of universal precautions. Majority discussed that nurses practiced properly compared to physicians in some universal precautions. One female nurse expressed the variation in that *“Physicians more focus on treatment part rather than infection prevention practices”* Another female nurse added in line to this *“Every health care professionals had information towards five moments of hand hygiene practices, but majority of healthcare worker including me, wash our hands only at the beginning and end of our tasks. This may be due to an indication to negligent behavior of healthcare workers”* One physician added regarding challenges to utilization of hand rub *“Healthcare workers believe that, alcohol based hand rub provided to this hospital is not vaslin based, they afraid that the alcohol would dry their hands and causes skin breakage”*

Healthcare workers Knowledge

Healthcare workers understanding towards infection prevention and control practices are crucial in hospital environment. Majority participants agreed that knowledge gap was observed in some professionals and cleaners/janitors. One male management staff expressed the problem in this way *“cleaners have no information towards proper infection prevention practices. Because they are using soft glove for cleaning activities, although they should use hard glove for cleaning purpose. In addition, they don’t have adequate information towards solution proportion of water to chlorine formation for cleaning purpose”*

Barrier related to Patients and visitor's

Low awareness of patients and visitors.

Healthcare workers are expected to give information to patients towards infection prevention practices to protect infections by themselves in hospitals. Information provided to patients should also be provided to their families or caregivers. Though the patient expects that hospital environment is safe and clean, but there are risks of infection in healthcare environment. Majority participants observed that there were challenges in infection prevention practice in patients and families or caregiver's in wards.

One of the main challenge towards infection prevention practices by patients, families and visitors are poor perception towards hospital environment. A female nurse in a pediatric department said that *“hospital environment is considered as clean by patients and visitors, simply by observing the whiteness of the floor and the wall. Sometimes, they ate their food on it”* Another female nurse added on this *“inappropriate utilization of material and equipment by patients and visitors, shorten functionality of facilities in wards”*

Sometimes health education may not be sufficient to bring the appropriate infection prevention practice to patients and families or visitors. Majority of the participants agree on this. A female nurse explained that *“Infection prevention practice was given regularly to the patient but they didn't understand our health education, because they wash their dish, cloth and hands in the same sink in the ward, so it is difficult.* Another hospital management staff added also *“majority of our patients come to the rural part and they sleep inside the institution with cardboard, it is difficult for the health of the individual or to the facility”*

Overflow of families and visitors

Majority of the participants agreed that it was major obstacle to practice infection prevention activities in the two hospitals. One male nurse expressed the problem in the following way:

“For single patient, more than 4 to 5 family members/ visitors are coming to this hospital. I remember one event before a year, one family member was injured by needle in the ward” Another nurse at internal medicine also explained that *“high flow of visitors in the room disturb*

our normal activities. Sometimes for a single patient you may get five to six family caregivers in the room. and they disturb you. Presence of high number of visitors in the ward affects the behavior of health care workers”

Discussion

Healthcare workers, patients and families or visitors understanding of cause and barriers to infection prevention and control practice to hospital acquired infections are crucial and important to minimize infection in the hospital set up. This study identified barriers in infection prevention in to three sub teams, such as organizational, healthcare workers and patients or families’ perspective. Barriers identified in this finding were based on observed, perception and practice of research participants, considered highly influential to practice infection prevention and control.

Organizational Barrier (institutional, administrative and management)

Availability of toilet, shower, handwashing material and other facilities are very important to practice infection prevention in healthcare workers, patients and families or visitors in the hospital. Lack of the of facilities were considered to be barriers for the practice of infection prevention in this study. This was also supported by a similar study conducted in Cyprus on nurses that inhibit to compliance with the standard precaution[15]. A similar questionnaire based finding also supports this finding for practice of infection prevention [14].

Shortage of material supply and equipment were other important team identified as a barrier to infection prevention and practice. Regular maintenance of materials and equipment in wards were barriers to practice infection prevention in this study. It was reflected by majority of the participants, that, they were forced to practice inappropriate procedures and steps. The problem

was also explained by healthcare workers working in countries like USA and Netherland hospitals[14,16].

High patient flow in the hospitals lead health care workers with shortage of time to practice their activities, including infection prevention practice[15,16]. In our finding the high burden of patients in the two hospital leads healthcare worker's loss of intention to improper practice of universal precaution. A similar research was reported that, lack of time was a barrier to practice infection prevention in the work environment[14,18].

Healthcare workers related barriers

Experiences of healthcare workers were one of the barriers to practice infection prevention practice in this study. This was supported by a questionnaire survey conducted on healthcare workers, when experience increases, the risk of needle stick injury and exposure of blood and body fluids increase[7,8]. In contrary, experience regarding students, sharp and needle stick injuries were observed in medical students than experienced staffs. This may be experienced by healthcare workers develop a skill regarding this issue[15]. Students may be over loaded with work and focus only to pass their grade.

Health workers have priority of human life saving actions through emergency aid. Such actions were found to be a barrier to practice infection prevention activities. Participants stated that sometimes-emergency conditions were unable to follow the standard procedure in their institution. The same finding reported that emergency conditions does not create an enabling environment to wear gloves and follow appropriate procedures[14–16].

A study indicated that there was professional difference between physicians and nurses. Some researchers concluded that nurses practice more compared to physicians regarding to appropriate universal

precautions practice and physicians deviate the rule[16]. In this study majority of discussants agreed that nurses were practiced properly compared to physicians in s practice of infection prevention. In spite of this previous researches indicate that physicians have good knowledge regarding to universal precaution to hand hygiene [19] and physicians were also more utilized hand rub alcohol material compared to nurses[20]. This difference may be, attributed to the type of hospital, ours being teaching hospitals and that physicians were more experienced and have confidence to perform their activities[15]. The other reason may be sourness and dryness of hands using alcohol may inhibit physicians to practice[16]. In line with this study researches showed that, the behaviors of healthcare workers were a barrier to infection prevention practice hospitals[10,21].

Knowledge of healthcare workers is a core to practice infection prevention activities in the hospital. In this research, some participants reported that, there were no uniform understanding of infection prevention practice among healthcare workers. This knowledge gap was observed specially in cleaners or janitors regarding infection prevention. Although the research did not include cleaners and janitors, the practice gap was observed in thus workers by study participants. This type of gap was also observed in a similar research conducted by Ider on Perceptions of healthcare professionals effective hospital infection control[21].

Patients and visitor's barrier

Patients are believed to be at greater risk than non-patients to hospital acquired infection in hospital environment. Patients generally are expected to have adequate knowledge to care themselves, because healthcare workers are expected to give information to patients, how they can prevent from infection. A study showed that patients had poor communication with healthcare workers regarding infection prevention[17]. Studies conducted in different parts of the world to assess patient's knowledge and practice of infection prevention in the hospital were

poor[17,22–24]. In this study, majority of the participants observed that there was poor infection prevention practice by patients, families or caregivers. Therefore, poor perception of families, care giver or visitors, increases their number in the hospital wards unnecessarily. Healthcare workers unable to perform their task and creates a challenge to practice infection prevention in the study hospitals.

The paper was not free from limitations. The discussion includes mainly majority of healthcare workers, physicians, nurses, environmental health, occupational health, laboratory and other management staffs. This study focused only self-reported lived experiences of healthcare worker's behaviors. This study did not include the patients view of their perception and challenges to practice infection prevention practice. This limits the triangulation of information to increase the validity of information in addition to healthcare workers and management staffs.

Even if it is not possible to generalize to all teaching hospitals, but it is possible to transferable to other similar study settings. To assure this the study team try to discuss in deep till level of saturation of ideas and included different types of health professionals purposively in the ward. Thus, exploratory findings try to observe some of the challenges of infection prevention and control practice in teaching hospitals, and this observation should be promoted to healthcare managers, healthcare workers, patients and family care givers.

Conclusion

The majority of the participants had a good understanding of infection prevention practices. Understanding the practices does not give a guarantee to practice thus activities. More than ten barrier themes were identified that inhibit practice for infection prevention and control in

teaching hospitals in Amhara region. Thus, barriers should be addressed via identifying effective implementation in reference to organizational, healthcare worker and patients and visitor's target group barriers to improve infection prevention practice.

Ethical approval and consent

The research conducted after ethical approval of the Addis Ababa University College of Health Science Institutional Review Board. Written consent with a brief description about the importance of the study to the participants was assured from the participants.

Consent to publish

All authors agreed to publish the paper

Availability of data and materials

Data and materials are available to share

Competing interests

The authors declare that they have no any competing interests.

Funding

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Authors' contributions

WW, AK and FM involved in literature review, proposal development, research design, data collection, data analysis and manuscript writing and all authors have read and approved the final manuscript.

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12.6 Letter for Declaration

LETTER FOR DECLARATION (DISSERTATION WORK)

I, the under signed, declare that this is my original work, has never been presented in this or any other University, and that all the resources and materials used for the dissertation, have been fully acknowledged.

Name: Walelegn Worku Yallew

Signature: _____

Date: _____

Place: Addis Ababa

Date of submission: _____

This dissertation has been submitted for examination with my approval as University Supervisor.

Name: Dr. Abera Kumie

Signature: _____

Date: _____