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ORIGINAL RESEARCH

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

Video abstract

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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]

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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.

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

Characteristics	HAIs Yes	HAIs No	Crude OR (95% CI)	Adjusted OR (95% CI)
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 Hiowt 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.

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 (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 Rhame 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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