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IP Journal of Nutrition, Metabolism and Health Science

Journal homepage: https://www.jnmhs.com/

Original Research Article

The prevalence of hospital acquired infection and associated factors among patients admitted at Wolaita Sodo University Comprehensive Specialized Hospital, in Ethiopia

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ARTICLE INFO

Article history:
Received 16-09-2023
Accepted 02-04-2024
Available online 01-05-2024

Keywords:
Hospital-acquired infection
Prevalence
and risk factors
Ethiopia

ABSTRACT

Introduction: Hospital-acquired infection is an infection acquired a major global concern of well-being, affecting the quality of care in the healthcare setting. Routine surveillance of infection is an important part of infection prevention and quality assurance in hospitals.
Objective: to determine the prevalence and associated factors of hospital-acquired infection among inpatients, in Wolaita Sodo University Comprehensive Specialized Hospital.
Materials and Methods: A cross-sectional study was conducted among inpatients in Wolaita Sodo University Comprehensive Specialized Hospital. All eligible inpatients admitted at least more three days of the survey were included. The study was conducted from April 1 to July 30/2023. Environmental health professionals and nurses collected the data according to the Centers for Disease Control through observational assessments documented by physicians. Univariate and multivariable logistic regression analyses were used to determine the prevalence of hospital-acquired infections and the associations between independent and dependent variables.
Result : A total of 413 patients were included in this study, the median age of the participants was 26 years. A total of 352 (85.2%) patients were diagnosed with non-fatal disease during the survey. 49 patients had hospital-acquired infections developed, with a mean prevalence of 11.9 %. Coagulate-negative staphylococcus 27.27%), and E. coli (27.27) were the most frequently reported hospital-acquired infection-causing pathogens from the result of the study. The factors of patient admission diagnosis, length of hospital stay (more than five days of hospital stay), and absence of running tap water in the patient's room with the occurrence of hospital-acquired infection were statistically significant.
Conclusion: Surgical site infections and bloodstream infections were the most common types of hospital-acquired infections. Then, Hospital management and healthcare workers should give more attention to the practice of infection prevention to achieve a reduced prevalence of hospital-acquired infections in the study setting.

1. Introduction

Epidemiologically, infections that are related to surgical or other medical and/or procedural interventions and those that are caused by multidrug-resistant organisms are linked to healthcare settings.[1] Hospital-acquired infection is defined as a localized or systemic condition that results from adverse reactions to the presence of an infectious agent or its toxin,[2] and that patients get while receiving treatment for medical or surgical conditions and was not incubating at the time of

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https://doi.org/10.18231/j.ijnmhs.2024.008
2582-6301/© 2024 Author(s), Published by Innovative Publication.

admission.[3]

Hospital-acquired occur in all settings of Health care and the most common clinical focus of infection ranges from relatively mild cases of localized or upper respiratory infections to more systemic or disseminated infections of life-threatening bloodstream infections.[4] Of the multitude of Hospital-acquired infections that occur in a clinical setting, many of the highest proportions are associated with bacterial pathogens.[5] All hospitalized patients are susceptible to HAIs, however long hospital stays, invasive medical device exposure, surgical complications,[6] and overuse of antibiotics are more likely to get an infection.[4]

Hospital-acquired infections can lead to prolonged hospital stays, mortality, and additional costs to patients and the healthcare delivery system; For example, In American hospitals alone, the Centers for Disease Control estimates that HAIs account for an estimated 1.7 million infections and 99,000 associated deaths each year, where patients with HAI, who spend, an additional 6.5 days in the hospital, are twice as likely to die, surgical infections are believed to account for up to ten billion dollars annually in healthcare expenditures.[7]

The prevalence of HAI revealed high teaching hospitals in Africa such as the prevalence in Uganda 28%, Ghana14%,[8] and Ethiopia 7.4% to19.4% (9-11) were higher than the prevalence reported in the USA (8.7%)[9] and china (4.26%).[10] On top of that, extended-spectrum beta-lactamase-producing Gram-negative bacilli (1.9% to 53.0%) were the most reported antimicrobial-resistant pathogens for causing HAIs.[11] Hence, these pathogens displayed considerable resistance to treatment and are considered priority pathogens for research and development of new antibiotics.[12]

There have been advances in healthcare systems and technology in the prevention of HAI among the public and policymakers.[5] For instance, the CDC/NHSN planned a national target for improvement in 2013, with a goal of total elimination by 2020; as a result, it showed a 16% reduction in the United States of America from 2011 to 2015 and revealed to 3.2% for overall prevalence.[5] Despite this fact, it remains a great threat to the quality of healthcare delivery systems particularly in Africa, which is due to infection control and HAI prevalence reports are relatively not well recognized due to a lack of centralized guidelines and resources from most hospitals in Africa.[13]

Studies also identified the contributing factors for HAI and revealed that the patient's underlying medical condition[14–16] history of previous hospitalization,[14,17] severity of Illness,[18] and demographic characteristics such as age less than 14 years,[17] male gender[17] and type of ward such as ICU[14] were found to be important factors associated with increased risk of HAI. However, the burdens of HAI can be giant concerning complex routes of transmission,[4] and the dynamic nature of HAI concerning infection-control procedures in the healthcare environment.[19] On top of that most published studies on HAI conducted from the study setting were limited to specific ward[20] and patient age.[21] Hence, routine surveillance of hospital-acquired infection in inpatient wards is an integral part of infection prevention and quality assurance in hospitals.[1] Therefore, conducting comprehensive research was important to determine the magnitude and associated factors of hospital-acquired infection in Hawassa University Hospital.

2. Materials and Methods

2.1. Study Setting

A study was conducted at Wolaita Sodo University Comprehensive Specialized Hospital. The hospital has a total of 400 inpatient beds available in the hospital, which serves as a comprehensive specialized hospital in the Southern region and surrounding zones and regions. However, due to the renovation of the building only 233 beds were allowed for inpatient services in the selected hospital.

2.2. Study design and period

A cross-sectional study was conducted to determine the prevalence of hospital-acquired infection at Wolaita Sodo University Comprehensive Specialized Hospital from April 1 to July 30/2023.

2.3. Study population

2.3.1. The Source population

All patients admitted to inpatient wards in Wolaita Sodo University Comprehensive Specialized Hospital were the source population in 2023.

2.3.2. The study population

All patients who stayed for at least three days in the selected inpatient wards in Wolaita Sodo University Comprehensive Specialized Hospital who were selected during the data collection period were the participants of this study.

2.4. The eligibility criteria

All inpatients admitted to the hospital were included in the study. Wards of all specialties, including surgical, obstetrics and gynecology, internal medicine, pediatrics, ophthalmology, and intensive care units were included, whereas the wards associated with neonatal intensive care and oncology units, and emergency and recovery departments were excluded from the study.

2.5. The sample size and sampling procedure

The sample size was calculated by using a single population proportion formula. And after considering 10%

contingency,

a 422 sample size was required. $n = (z_{\frac{\alpha}{2}})^{2} * \frac{p(1-p)}{d^2}$, $n = (1.96)^2 \times \frac{0.5(0.5)}{(0.05)^2} = \frac{3.8416*0.25}{0.0025} = \frac{0.9604}{0.0025} = 384.16 = 384 + 10\% = 422$. Where; n sample size Z α/2 = critical value for standard normal distribution (Z-statistic) at 95% confidence level (z=1.96).

The sample size was proportionally allocated to the type of inpatient departments, according to the respective size of beds distribution, pediatric department (69 beds), surgery department (76 beds), internal medicine department (32 beds), gynecology ward (32 beds), and mixed wards (24 beds), which includes intensive care units (11beds) and ophthalmology department (13beds). Data were collected by five trained nurses (clinical and demographic data from medical charts) and three trained Environmental health professionals (reviewed infection prevention data documented from the ward weakly infection prevention follow-up checklists), which is assessed on every morning session or at 4:00 AM local time on Monday.

Data were collected for two months, which is from April 2 to July/ 30/2023in a weekly continuous way. Finally, the first study participant was selected randomly from the first room independently in each inpatient ward. All other allocated eligible participants were selected by using systematic random sampling or using every two other eligible patients' bed intervals and independently in each ward. Hence, the total number of in-patients expected per month (once per week) was 652.4, which was determined by taking a 70% bed occupancy rate of the hospital. It was a regular weekly-based procedure, until the achievement of the allocated sample size in each department. When incomplete data resulted from the eligible participant, it was replaced by the preceding eligible participant in the same ward. As a result, the prevalence of HAI was determined based on the United States CDC checklist used to confirm hospital-acquired infection. Data were collected after the ethical approval of the Wolaita Sodo University Institutional Review Board.

2.6. Data collection tools

Data were collected by using pretested observational tools having two parts (clinical and environmental part). The tool was adapted from the previous study,[22] and modified based on CDC standard.[3] The two-day training was given to all data collectors, and supervisors (one). Medical records and consultation with the person in charge of the patient were used for the identification of the infection. Data were collected based on the signs and symptoms and the specific site criteria, as recommended by Communicable Disease Control.

2.7. Data quality and management

After getting permission letters, two-day training was given for data collectors regarding the definitions and the study protocol before starting the study. The tools were pretested among 12 patients selected from three wards (gynecology, pediatric, and orthopedic wards); then the actual data were collected and a comparison was made. Intensive supervision was held for its completeness and corrective discussion among all the research team members was conducted at the end of each day. All independently collected data were immediately matched by date, room number, and ward. As a result, the missed and incomplete response in the questionnaire was corrected accordingly. The completed collected data were entered into Epi data version 3.5 after an immediate checkup. At the end of the study period, the completed data was transported into SPSS version 23 for analysis.

2.8. Data Entry and Analysis

Data were entered and coded by using Epi data version 3.5. Then the complete entered data was exported into SPSS version 23 for analysis. Descriptive statistics were used to calculate the prevalence of HAI. The prevalence of HAI was determined by conducting proportion, which is calculated by the number of infections divided by the total number of patients comprising the study population. Binary logistic regressions were conducted between the dichotomies of dependent and independent variables. Finally, independent variables that have a bivariate relationship of significance, $P<0.25$ in chi-square tests were entered into the multivariate binary logistic analysis. In multivariable binary logistic regression analyses variables with Odds ratio, estimated with a 95% confidence interval and $P < 0.05$ are considered the independent predictor of HAI. Model fitness was also checked by using Omnibus Tests of Model Coefficients, in which -2LL is Significantly different from the base model Hosmer-Lemeshow's Goodness of Fit test greater than 0.05 was considered a good model fit the final prediction. Cox & Snell and the Nagelkerke R Square (pseudo R square statistics) were also observed to model prediction (0 to 1 scale), in which the higher value indicated that the model predicts well.

3. Results

3.1. Socio-demographic characteristics of the participants

A total of 422 hospitalized patients were expected to be enrolled in this study. However, the clinical information obtained from 9 participants' medical records was incomplete and was excluded from the analysis. Hence, the complete data obtained from the 413 patients (97.86%) were included for final analysis. There were no active surveillance programs on HAIs in any of the participating wards. Participants enrolled from surgical (32.69%) and pediatric (30.27%) wards constituted the highest proportion and the least proportion (8.96%) were included from mixed wards (ICU and ophthalmology wards).

The mean age in years was 27.0. Almost half of the participants were younger years of age (Table 1). The median age of the participants was 26 years (varied from 3 months to 80 years) and the higher proportion (36.8%) of them were aged between 15–34 years. Of the total respondents, more than half (55.2 %) of the participants were female. According to the criteria for severity of the underlying medical condition (McCabe scores) or admission diagnosis, the majority (85.2%) of the study participants were diagnosed with a non-fatal disease. The mean length of hospital stay (24), in days was 6.37. The median length of stay of the total participant was 5 days. 54.2% of the participants stayed below or equal to five days (median length of treatment) (Table 1).

3.2. The General facility management of patient safety at WSUCSH

Almost half 51.6% of the study participants underwent surgical procedures. 80.15% of the participants received antibiotic therapy (either prophylaxis or therapeutic) for their diagnosis after admission (95%CI: 76.5-84.0). The overall prevalence of HAI was 11.9 % (n=49) (95%CI: 8.7-15.7). None of the participants were identified with more than one episode of HAIs. SSI (38.8%) and BSI (34.7%) were the most frequently reported clinical focus of HAIs. Microorganisms were also reported among 44.9% of the participants with HAI and the pattern of pathogens by specific clinical focus of infection varied from 9.1% in UTI to 77.3% in BSI. Of the reported causative bacterial species, 22.73 % of pathogens were not differentiated by specific genus level and were identified through gram stain. In addition, coagulate-negative staphylococcus (24) 27.27%), and E. coli (27.27) were the most frequently isolated pathogens from HAIs. The prevalence of HAIs differed across inpatient wards, which is 0 in the ophthalmology ward to 26.5% in orthopedic wards. As a result, the overall prevalence among the type of wards ranges from 2% in mixed-age wards to 36.7% in pediatric wards (Table 2).

3.3. Associated factors with hospital-acquired infections

There was a significant difference in the mean length of hospital stay between participants with hospital-acquired infections and those without HAI (mean difference=3.383; 95%CI: 2.291-4.474, P=0 .000 at t=6.090, assuming t-test for equality of means). The absence of a waste bin (labeled in yellow color) for segregation of contaminated waste in the room, the severity of underlying medical conditions such as admission with a rapidly fatal disease, admission with an ultimately fatal disease, length of hospital stays such as more than five days of hospital stay and absence of hand washing facilities were the four predictor variables associated with HAI in the b In multivariable logistic regression severity of underlying medical condition such as admit with rapidly fatal disease (P=0.001), admit with ultimately fatal disease (P=0.022); length of hospital stays such as more than five days of hospital stay, (P=0.028) and absence of hand washing facilities (P<0.001) were the three independent predictors of HAI. Thus, in this study, patients who were admitted with rapidly fatal disease were significantly at higher risk for developing HAI as compared to those admitted with non-fatal disease (P=0.022). Similarly, the odds of patients admitted with the ultimately fatal disease were significantly more at risk of developing HAI than their counterparts (P=0.001).

The finding from this study also revealed patients admitted to an inpatient room, which has no hand washing facilities were strongly associated with increased odds of acquiring infection in the health care setting (P<0.001). The odds of developing hospital-acquired infection among patients who stayed for more than five days (median hospital stay) were 2.056 times higher than those who stayed for less than five days (AOR=2.056, 95%CI: 1.082-3.908), (P<0.05)(Table 3).

4. Discussion

This study aimed to determine the prevalence of Hospital-Acquired infection and its associated factors among patients admitted to Wolaita Sodo University Comprehensive Specialized Hospital inpatient wards. Hence, the overall prevalence of HAI was 11.9%. It is in line with the study conducted in Ethiopia (14.9%)[23] and Ghana (14.4%).[8]

In contrast, the overall prevalence obtained from the current study was higher than the prevalence reported from a cross-sectional study in the country.[22,24,25] The reason for this high prevalence might be due to the comprehensive nature of the current study, which involved all admitted patients including those in intensive care, with debilitating medical conditions, and had a history of hospitalization, these might have contributed to the observed higher prevalence (11.9%); whereas there was not in the contrast study.[22] These might have contributed to the observed higher prevalence. This is in line with a study in the UK, given that additional intra-hospital transfer, increased the odds of acquiring HAI by 9%.[26]

When compared with other similar studies done in Africa, the findings of this study are higher than reports from Nigeria (2.6%), Morocco (10.3%), and Tanzania (14.8%).[27–29] This could be explained by the high patient load, overcrowding, poor infrastructure, and design of the hospital layout. Similarly, the overall prevalence identified in the current study was high compared to the prevalence

Table 1: Background and clinical characteristics of patients who participated in WSUCSH.

Variable	Characteristics	Number of patients (%)
Sex	Male	185 (44.8)
	Female	228 (55.2)
Age (years)	<1	15 (3.6)
	1-14	114(27.6)
	15-34	154(37.3)
	35-55	88 (21.3)
	≥56	42(10.2)
Ward type	Internal medicine	58 (14)
	Surgery ward	135 (32.7)
	Pediatric ward	125(30.3)
	Gynecology ward	58(14)
	General ward (ICU and ophthalmology unit)	37 (9)
The severity of the underlying medical condition (McCabe scores)	Non-fatal disease	352(85.2)
	Ultimately fatal disease	40(9.7)
	Rapidly fatal disease	21(5.1)
Previous hospital admission	Yes	298(72.2)
	No	115(27.8)
Surgical procedure on current admission	Yes	213(51.6)
	No	200(48.4)
Wounds other than the procedure	Yes	15(3.6)
	No	398(96.4)
Naso gastric tube inserted	Yes	31(7.5)
	No	382(92.5)
Peripheral catheter inserted	Yes	361(87.4)
	No	52(12.6)
Urethral catheter inserted	Yes	63(15.3)
	No	350(84.7)
Fracture fixative inserted	Yes	38(9.2)
	No	375(90.8)
Antibiotic therapy	Yes	331(80.1)
	No	82(19.9)
Length of stay (24)	above the median (5 days)	189(45.8)
	below or equal to the median (5 days)	224(54.2)

Table 2: The general facility management of patient safety at inpatient wards.

Element	Characteristics	Frequency (%)
Availability of hand washing facilities (running tap water)	Yes	276(66.8)
	No	139(33.2)
Availability of waste bin labeled by black color for segregation of non-contaminated waste in room	Yes	412(99.7)
	No	1(0.3)
Availability of waste bin labeled yellow color for segregation of contaminated waste in room	Yes	325(8.7)
	No	88(21.3)
Is there a sufficient ventilation system	Yes	377(91.3)
	No	36(8.7)

reported from high-income setting countries in the USA (3.2%),[5] and China 4.26%.[10]

On the other hand, the observed prevalence of Hospital Acquired Infections in this study is lower than the reported prevalence from Addis Ababa (35.8%) and Mekelle (27.6%), Uganda (28%).[30–32] The discrepancy in the result could be due to differences in the socio-economic status of countries, underlying medical conditions, and insufficient hand-washing facilities. This is supported by a meta-analysis study, conducted on the infection prevention practice of HCWs[13] and a cross-sectional study on compliance with standard safety precautions done in the study setting.[33] In line with this evidence, a meta-analysis study in sub-Saharan Africa revealed the impact of HAI in resource-poor countries, which was attributed to an overstretched health workforce and a high burden of community-acquired infection, variability of compliance with hand hygiene and scarcity of resources within the

Table 3: Predictive factors in Bivariable and Multivariable logistic regression analysis forthe Occurrence of HAI among study participants at inpatient wards in WSUCSH.

variable [a]	Category	HAI		COR(95%CI)	AOR (95%CI)
		Yes n (%)	No n (%)		
Sex	Male	27 (55.1)	158 (43.4)	1	1
	Female	22 (44.9)	206 (56.6)	0.625(0.343-1.139)	0.697 (0.363-1.337)
Peripheral catheter inserted	Yes	46 (93.9)	315 (86.5)	2.385(0.714-7.967)	1.9 (0.548-6.592)
	No	3(6.1)	49 (13.5)	1	1
Urinary catheter inserted	Yes	11(22.4)	52 (14.3)	1.737(0.835-3.613)	1.327(0.591-2.981)
	No	38 (77.6)	312 (85.7)	1	1
Fracture fixative inserted	Yes	8 (16)	30 (8.2)	2.172(0.933-5.055)	1.437(0.563-3.664)
	No	41(83.7)	334 (91.8)	1	1
The severity of the underlying medical condition (McCabe scores)	Non-fatal disease	33 (67.3)	319 (87.6)	1	1
	Ultimately fatal Disease	11(22.4)	29 (8)	3.667(1.679-0.008)*	3.791(1.672-8.597)*
	Rapidly fatal disease	5 (10.2)	16(4.4)	3.021(1.040-8.774)*	3.689(1.208-11.268)*
Length of hospital stay (24)	Below or equal to the median (≤5days)	18 (36.7)	206 (56.6)	1	1
	Above median (>5days)	31(63.3)	158 (43.4)	2.245(1.212-4.160)*	2.056(1.082-3.908)*
Availability of hand washing facilities (running tap water)	Yes	20 (40.8)	56 (69.8)	1	1
	No	29 (59.2)	110 (30.2)	3.347(1.863-6.341)**	3.49 (1.849-6.616)**
Availability of waste bin labeled yellow color for segregation of contaminated waste	Yes	33(67.3)	292 (80.2)	1	1
	No	16(32.7)	72 (19.8)	1.966(1.026-3.768)*	1.629(0.812-3.268)
Is there a sufficient ventilation system	Yes	42(85.7)	335(92)	1	1
	No	7(14.3)	29(8)	1.925(0.794 4.667)	0.712(0.234-2.171)

Note [a] =Candidate variables for multivariable analysis at p-value ≤0.20;*=Statistically significant association, P<0.05;**=very strong statistically significant association, P<0.001; 1=Reference category

region.[11]

In the current study, the prevalence of Hospital-Acquired Infections at major inpatient wards indicated a large variability that ranges from 2% in general wards to 36.7% in pediatric wards. The reason for the high proportion of infections in the pediatric ward could be due to their admission diagnosis that admitted with a fatal disease associated with Hospital-Acqured Infections. Thus pediatric patients are more prone to infection due to the immune susceptibility of the pediatric population. This was supported by a cross-sectional study in Addis Ababa, which revealed that patients aged less than 14 years were 72.7% more likely to develop HAI compared to older age patients[17] and also in southeast Ethiopia, children with underlying disease conditions in higher risk to develop HAIs.[13] In line with this, there was a significant difference in the length of hospital stay between patients developing HAI and those without infection (P=0 .000 at t=6.090). Thus, the high proportion of infection observed at orthopedic wards could be due to the type of surgery. This was also supported by studies in the UK, given that having orthopedic surgery was a high risk of infection was associated with a longer duration of hospital stay,[7] and also in Uganda, given that the higher proportion of infection (47%) were reported from surgery ward.[30]

The findings from the multivariate analysis showed, that more than five days of inpatient stay,[34] the severity of the underlying medical condition (McCabe score), and the absence of hand washing facilities (running tap water) were the three independent variables predicting HAI. Thus, the length of treatment in a given ward was significantly associated with the occurrence of hospital-acquired infections (P=0.028), where the odds of developing hospital-acquired infection among patients who stayed for more than five days (median hospital stay) were 2.056 times higher than those who stayed for less than five days. This is in line with the findings of a cross-sectional study in eastern Ethiopia,[22] southeastern Ethiopia,[15] and China.[18]

Similarly, the odds of patients admitted with the ultimately fatal disease were significantly at high risk of developing HAI (P=0.001). Consequently, patients who were admitted with rapidly fatal diseases were significantly associated with developing HAI as compared to those admitted with non-fatal diseases (P=0.022). The possible reason for the observed association in the current study might be due to the multiple comorbidity and immunosuppression effects of these diseases. This is in line with the findings from studies in Adama, where renal disease and type 2 diabetic mellitus (DM), were significantly associated with HAI.[16] And also supported by a study in China, where patients admitted with rapidly fatal diseases were significantly associated with the occurrence of hospital-acquired infections.[18]

In the current study availability of hand washing facilities (running tap water) was also inversely associated with HAI. Hence, patients admitted in an inpatient room, without hand washing facilities were strongly associated with the acquiring of infection (P<0.001). This result was supported by a case-control study in Ethiopia, which revealed that the presence of hand washing facilities in rooms was 19% less likely to acquire infection at the hospital.[35]

5. Strengths and limitations of the study

The strength of this study is that it included patients admitted to all inpatient wards of the hospital; however, the full burden of HAI could not be captured as our study was limited to in-hospital assessment leaving out patients who may potentially develop HAI after discharge. The second limitation should also be noted that our assessment was limited to only bacterial HAI without considering other causes such as fungal infection. As this is the first comprehensive assessment to report the prevalence of HAI at the hospital, we strongly believe that this finding may provide valuable input to plan for proper intervention.

6. Conclusion and Recommendations

Hospital-acquired infection is a significant problem at Wolaita Sodo Comprehensive Hospital. The prevalence of hospital-acquired infection showed variation between wards. Hence, a higher proportion was revealed from orthopedic and pediatric wards. Risk factors for HAI were the severity of admission medical condition (based on McCabe score), such as admission with ultimately fatal, and rapidly fatal disease; more than five days of hospital stay,[34] and absence of hand washing facilities (running tap water).

7. Ethics Approval and Consent to Participant

Ethical approval was obtained from the Wolaita Sodo University Research Review approval committee. The letter was written to Wolaita Sodo University Comprehensive Specialized Hospital to inform them about the purpose and deliverables of the research undertaking. All the methods in the present study were carried out by the guidelines and regulations of Hawassa University. All participants provided written informed consent.

8. Availability of Data and Materials

The data that support the findings of this study are available but some restrictions may apply to the availability of these data as there are some sensitive issues. However, data are available from the corresponding authors upon reasonable request.

8.1. Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper, and agreed to be accountable for all aspects of the work. Hence 1 wrote the manuscript with support from 2, 3, and also 2, and 3, helped supervise the project. 1, worked out almost all of the technical details. All authors discussed the results and contributed to the final manuscript.

9. Source of Funding

Wolaita Sodo University

10. Competing Interests

The authors declare that they have no competing interests.

Acknowledgment

We would like to express our deepest heartfelt thanks to Wolaita Sodo University for allowing us the conduct this study. Our special thanks go to the staff of Wolaita Sodo University Hospital for their permission and support, and for providing me the necessary information.

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Cite this article: Atalay YA, Gebeyehu NA, Gelaw KA. The prevalence of hospital acquired infection and associated factors among patients admitted at Wolaita Sodo University Comprehensive Specialized Hospital, in Ethiopia. *IP J Nutr Metab Health Sci* 2024;7(1):43-50.