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Incidence and risk factors for healthcare-associated infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Abstract

Objectives: Healthcare-associated infections are harmful and costly and can result in substantial morbidity and mortality for hospitalized children. In Ethiopia, data about the occurrence of healthcare-associated infections among hospitalized pediatric patients are lacking. Therefore, the study aims to determine the incidence and risk factors of healthcare-associated infections among admitted pediatric in Ethiopia.

Design: A prospective study

Setting: A teaching hospital in southeast Ethiopia

Participants: 448 hospitalized pediatric patients admitted between November 1, 2018 and June 30, 2019.

Primary and secondary outcome measures: Incidence and risk factors of healthcare-associated infections.

Results: A total of 448 pediatric patients were followed for 3,227 patient days. The median age of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of healthcare-associated infection was 17.7 per 1000 pediatrics days of follow up while the overall cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed greater than 6 days (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38), p-value< 0.001] and children with underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95% CI (1.61-4.97), p-value< 0.001] had higher risk of developing hospital-acquired infection.

Conclusions: The present study has revealed that healthcare-associated infections affected 13 in 100 admitted pediatric patients – which is a significant burden in the morbidity rate among pediatric patients. Length of stay in the hospital and the presence of underlying diseases increase the risk of developing a healthcare-associated infection. Avoiding unnecessary length of stay could save lives and minimize the occurrence of healthcare-acquired infections.

Keywords: Nosocomial infection, Healthcare-acquired infection, Pediatric patients, Ethiopia

Strengths and limitations of this study

- To the best of our knowledge, this is the first prospective study to examine the incidence and risk factors of healthcare-associated infection among pediatric patients in Ethiopia
- Pediatric and neonates inpatients were recruited and followed-up
- The full burden of healthcare-associated infections could not be captured in this specific study as our study, was limited to in-hospital assessment only and leaving outpatients who may potentially develop an infection after discharge.

Introduction

There is a "perfect storm" on healthcare-associated infections (HAIs) among hospitalized patients at any point in time throughout the globe. HAI is defined as an infection occurring in a patient during the process of care in a hospital or other healthcare facility that is not manifested or incubating at the time of admission[1]. Currently, it is a growing public health problem that concerns both the medical and the general community, and a rising issue for patient safety and quality of care at every level[2-8]. About 80% of the patients with HAIs are died, directly or indirectly connected to HAIs[9]. Available evidence also showed that financial burden, increased resistance of microorganisms to antimicrobials, prolonged hospital stay, and sometimes deaths are caused by HAIs [10, 11, 12].

Worldwide, it is estimated that hundreds of millions of patients every year, in both developed and developing countries, are affected by HAIs[7]. In some Australian public hospitals, HAIs affect one in every 74 hospitalizations[13]. In Europe, the total annual number of patients with HAI in 2011–2012 was estimated at 3.2 million. The prevalence of patients with at least one HAI in acute care hospitals was 6.0% (country range 2.3%–10.8%)[14]. Moreover, throughout Europe, HAIs accounted for 16 million additional days with total costs estimated at approximately €7 billion[14,15,16]. In the United States, approximately two million patients developed HAIs, and nearly a hundred thousand of these patients were estimated to die annually. This ranked HAI as the fifth leading cause of death in acute care hospitals and the risk of acquiring infection is 2 -20 times higher in some developing countries[17,18].

In some developing countries, the magnitude of HAIs remains underestimated and uncertain[12]. There is little information available on the epidemiology of HAI in African countries as well [19,20]. Although data are sparse, evidence suggested that HAIs are considerably adding to the available high burden of infections in some sub-Saharan African countries[21]. A systematic review by Nejad et al reported the hospital-wide HAI prevalence in Africa varied between 2.5% and 14.8%. This review has shown that published studies were only conducted in 10 African countries – highlighted there were paucities of information available among the epidemiology of HAI in many African countries[19]. In addition to this, a recent review by Irek et al (2018) indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

retrieved, more than half (n = 21, 60%) were from East Africa only [20]. In lieu of the paucity of data, most of the HAI literature just focused on adults, and data on HAIs among the pediatric population in sub-Saharan Africa are hardly available [15,19,22]. For example, a systematic review conducted by the World Health Organization (WHO) in the year 2010, identified no reports on pediatric nosocomial bacteremia in African countries between 1995 and 2008 [15].

In Ethiopia, HAIs can result in substantial morbidity for hospitalized children; however, little is known about the incidence and prevalence of HAIs in the neonatal and pediatric populations. Also, previously conducted studies by far focused only on adults, and many of these were limited to surgical site infections [23-28], with an estimated prevalence of 10.9% [24] to 66.5% [27]. And the overall incidence rate of 35.8 per 100 patients[26]. Furthermore, the urinary tract and bloodstream infections were found to be the commonest forms of HAIs in Ethiopia [29-33].

To the best of our knowledge, there is no single currently available published report on the incidence and risk factors of HAIs among pediatric patients in Ethiopia. Therefore, this study was designed to determine the incidence and risk factors of HAIs among pediatric patients in Goba Referral Hospital, Southeast Ethiopia.

Methods

Study design and setting

A hospital-based prospective follow up study was conducted from November 1, 2018, to June 30, 2019, at Madda Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city (Addis Ababa) of Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the average outpatient flow is over 96,661 and the annual admission is over 7,886 patients, of which 1,335 were admitted in the pediatrics ward and NICU. The hospital has a total of 127 inpatients beds – of which 30 and 15 were in pediatrics and NICU, respectively.

Study population and eligibility criteria

All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care unit (NICU) were enrolled and those who at least stayed for 48 hours were eligible for the study. Pediatric showed signs of infection and/or asymptomatic within the first 48 hours were excluded from the study.

Data collection procedures

Data were collected using a structured questionnaire and checklist after written consent from the parents/guardians was sought. Data were collected during the entire hospital stay of pediatric patients. Accordingly, socio-demographic and clinical data were collected. Following this, a detailed history from each patient was collected from available reports and the medical record folders. Data were collected by trained general physicians and one pediatrician. The Center for Diseases Control and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN) Surveillance Definition for hospital-acquired infections were used[34]. First, all patients were followed for the first 48 hours and pediatrics who have developed any form of infection within 48 hours of admission were excluded from the study. All the rest of the pediatric patients were followed until discharge for the occurrence of HAIs. HAIs were confirmed by senior physician specialists working in the respective NICU and pediatrics ward. In this study, the use of any

antimicrobials was recorded and information on different medical devices collected at the time of hospital admission and before the diagnosis of HAIs, respectively (**S1 File).**

Study variables

The outcome variable of the study was the occurrence of healthcare-associated infections (HAIs). Presence of HAIs were confirmed when the patients met the criteria for signs and symptoms determined by the Center for Disease Control and Prevention[34], wherein, the independent variables included: socio-demographic characteristics (age of the child, sex, place of residence, and previous hospitalization), and clinical and other related variables (duration of hospitalization, insertion of a urinary catheter, received anti-microbial, American Society of Anesthesiology (ASA) classification, presence of central vascular catheter, presence of peripheral vascular catheter, presence of peripheral intravenous line, intubation, surgery after admission, underline disease, mechanical ventilator, and HIV status).

Data processing and analysis

Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical software for further analysis. Descriptive statistics were computed to present the frequency distribution of important variables. The incidence rate of HAIs was reported per 1000 patient days. And cumulative incidence (incidence proportion) was calculated; it is the probability of developing HAIs over a stated period. A Generalized Linear Model (GLM) was used to identify the risk factors. An adjusted risk ratio (ARR) with a 95% confidence interval (CI) was used to determine the strength of association. A p-value < 0.05 was used to declare statistical significance. Multicollinearity diagnosis was performed between categorical variables by looking at values of variance inflation factor (VIF). The final model fitness was assessed by using the Hosmer-Lemeshow goodness of fit test.

Operational definition

Healthcare-Associated Infection (HAI) - localized or systemic condition that results from an adverse reaction to the presence of an infectious agent or its toxin and occurring 48 hours or longer after hospital admission that was not incubating at the time of admission.

Severe Anemia - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)

Late-Onset Neonatal Sepsis - sepsis reported after 72 hrs. of admission.

Patient and public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

Results

Socio-demographic characteristics of the study participants

A total of 487 pediatrics were enrolled in this study. However, 39 pediatric patients showed signs of infection and/or asymptomatic within the first 48 hours and were excluded from the study. The rest 448 pediatric patients were followed for the occurrence of HAIs until hospital discharge, referred to other healthcare facilities or death. Of the total patients included in the study, 201 (44.9%) were from the neonatal intensive care unit (NICU) and the remaining were from the pediatric ward. Two hundred fourthly eight (55.4%) of the study participants were male with an overall male-to-female ratio of 1.24: 1. The median age of the participants was 8 months (interquartile range (IQR): 2-26 months). Three hundred and ninety (71.2%) of the study participants were from rural areas. The median hospital stay of the patients was 6 days (IQR: 3-9 days) (**Table 1**).

Clinical characteristics of patients

In this study, 46 (10.3%) of the participants had a history of the previous hospitalization within the last 30 days. An underlying disease condition, which is severe acute malnutrition (SAM) was reported by 54 (12.1%) participants. Severe anemia was reported by 41 (9.2%) respondents. Overall, one hundred and seventy-one (38.2%) patients received antimicrobial at the time of the study (**Table 1**).

Incidence and type of healthcare-associated infection

During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A total of 57 patients experienced HAI. The mean onset of HAIs in Goba referral hospital is 7.20 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. The mean length of stay for the infected pediatric patients was 11.5 days (95% CI: 9.5-13.4), while it was lower for the remaining patients at 6.5 days.

Table 2 illustrates the proportion of HAIs among pediatrics in Goba referral hospital. Hospital-acquired pneumonia was the most common type of HAI that was observed among pediatrics with a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-onset neonatal sepsis 10.5% (95%CI: 3.5-19.3), and the least HAI observed was early onset of neonatal sepsis and surgical

site infections with an overall proportion of 1.8% each. In this study, the stratification of type of HAIs by ward of admission revealed significant variability (p-value= 0.007) (**S3 File**).

Risk factors of hospital-acquired infections

Table 3 showed the risk factors of HAIs among paediatric patients in Goba Referral Hospital. HAIs were statistically associated with children's hospital duration, receiving antimicrobial medications, presence of drainage tube, and presence of underlying diseases (SAM) in the bivariate analysis.

In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children who stayed longer than or equal to 6 days (median day) than to those children who stayed less [adjusted RR: 2.58, 95%CI (1.72-4.38)]. Patients with underlying disease conditions had 2.83 times higher risk of developing HAIs compared to their counterparts [adjusted RR: 2.83, 95% CI (1.61-4.97)]. Socio-demographic and some clinically related confounders could not show any statistically significant associations (**Table 4**).

Discussion

Healthcare-associated infections (HAIs) are a current global challenge with increased morbidity, mortality and massive economic cost [35-39]. Yet, there remain limited data on the occurrences of HAIs in hospitalized pediatric in Sub-Saharan African, including Ethiopia. This study was designed to determine the incidence and risk factors of HAIs among pediatric patients in a teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed longer than the median day (6 days) in the hospital and children with underlying disease conditions had higher risk of developing HAIs.

In this study, the risk of pediatrics HAIs was almost 18 per 1000 admissions. This finding is lower than a related study by Ali et al (2018) from Southwest Ethiopia, which reports the incidence of HAIs was 28·15 per 1000 patient days [39]. The difference might be associated with the nature of this study which involved only pediatrics patients including those in intensive care; however, a study by Ali et al includes adult study participants. Also, variation in studies could be attributed to differences in geographical locations and the setting of studies (specialized hospital). Our finding has also revealed that the overall cumulative incidence of HAIs was 12.7%; a finding which is comparable to those reported from the United States (11.9%) [36], 11.2% in Germany [37], and (13.3%) in Poland [38]. Also, the present 12.7% of HAIs noted in our study population fell in the ranges of 9.8-15.8% reported elsewhere [14, 40, 41] and the WHO pooled estimated for low-income countries 10.1% [18]. Conversely, other similar studies from Turkey reported a much higher prevalence of HAIs ranging between 22.2 and 68.4% [42,43], and in a multicenter prospective study from Europe reported 18.5% [44].

The present study also demonstrated that, the occurrence of HAIs was higher among male participants (52.6%) than females. This result was also supported by other studies conducted elsewhere [40, 45-47]. In the same vein, a study carried out by Luksamijarulkul et al in Thailand found that an infection rate of males was almost double that of the females (24.6% and 12.9%), respectively [48].

The most common type of HAI observed in this study was hospital-acquired pneumonia (HAP), which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such

a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates are immunologically immature, and in many cases, vulnerable [49,50]. The finding was similar to the study done in Tikur Anbessa Hospital, Ethiopia [33]. It is also true for other settings–in Iran 43.7% [51], India 50% [52], Vietnam 41.9% [53], Morocco 34.5% [54], Saudi Arabia 46.7% [55], 52.2% China [56], and in a European multicenter prospective study 53% [44]. The high burden of HAP among hospitalized pediatrics has an important implication in terms of hospital length of stay, healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as 30 to 50% [57].

In this study, the risks of developing HAIs were three times higher among children who stayed longer than or equal to the median six days than their counterparts. This was correlated with the findings of Sarvikivi et al in Finland, who disclosed the overall hospitalization of >7 days and were found to be associated with an increased prevalence of HAI by 8% [58]. It is also consistent with several findings conducted in Ethiopia [24] and studies conducted elsewhere [59, 60]. In our findings, the presence of underlying diseases such as SAM was recognized as the main risk factor for HAIs. This was consistent with the finding from another study in Ethiopia [24] underlying illnesses increased the susceptibility of patients, which predisposed them to infections secondary to the reduction of the patient's immune response that exacerbated the illnesses thru which in many cases had a significant factor that contributed more to the acquisition of HAIs in neonates and pediatric patients [41, 61, 62].

Limitations of the study

Several limitations on this prospective study need to be considered. First, we did not assess the healthcare workers' infection prevention practices that would have been associated with the prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the patients were discharged. Third, despite we followed patient until discharge the full burden of HAI could not be captured in this specific study as our study, was limited to in-hospital assessment only and leaving outpatients who may potentially develop HAI after discharge. Since the study was conducted in teaching referral hospital, generalization of the study findings is limited to these facilities.

Conclusions

The present study revealed that HAIs had affected 13 in 100 admitted pediatric patients, which is a major concern and burden in the morbidity rate of the community. And the overall incidence rate of HAIs was 17.75 per 1000 pediatrics days. Prolonged hospital length of stay and the presence of underlying diseases were predictors for HAIs. Avoiding unnecessary length of stay could save lives and minimize the occurrence of healthcare-acquired infections.

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Contributors

BS has made substantial contributions to conception and design, acquisition of data, analysis and interpretation of data. He has written the draft manuscript and provided final approval of the version to be published. FS, DA, EN, GN, AK, DW, YT, DZ, and BJ has made substantial contributions to design, acquisition of data and analysis, interpretation of data and revised the article critically for important intellectual content and provided final approval of the version to be published. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval

Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University Research Community Engagement and Technology Transfer Vice President Office was

submitted. Written consent from the parents/ legal guardians was obtained after explaining the objectives of the study. Identified pediatric patients having hospital-acquired infections were formally communicated to the physicians and nurses who were in charge of the patients for additional health care services. Throughout the data collection period, confidentiality and privacy of the patients were observed, and a unique identification code rather than their names were substituted.

Data sharing statement

Data will be available upon request from the corresponding authors.

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Table 1: Demographic and clinical characteristics of patients who participated in the study in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	Frequency	Percent
Age (months)	≤ 1	103	23.0
	2-5	77	17.2
	6-12	105	23.4
	13-24	51	11.4
	25-49	37	8.3
	> 49	75	16.7
Sex	Male	248	55.4
	Female	200	44.6
Ward	NICU	201	44.9
	Pediatrics	247	55.1
Resident	Urban	129	28.8
	Rural	319	71.2
Previous Hospitalization [a]	Yes	46	10.3
	No	402	89.7
Mechanical Ventilation	Yes	76	17.0
	No	372	83.0
Presence of Peripheral Intravenous Line	Yes	430	96.0
	No	18	4.0
Presence of Peripheral Vascular Catheters	Yes	9	2.0
	No	439	98.0
With Drainage	Yes	53	11.8
	No	395	88.2
Underlying Diseases [b]	Yes	54	12.1
	No	394	87.9
Surgery After Admission	Yes	47	10.5
	No	401	89.5
Patient Received Antimicrobials	Yes	171	38.2
	No	221	49.3
	Unknown	56	12.5
Severe Anemia	Yes	41	9.2
	No	375	83.7
	Unknown	32	7.1
HIV status	Positive	2	0.4
	Negative	393	87.7
	Not tested	53	11.8
American Society of Anesthesiology (ASA) Classification	Normally health patient	72	16.1
	Patient with mild systemic diseases	235	52.5
	Severe systemic disease that is not	100	22.3

	incapacitating		
	Incapacitating systemic diseases that is a constant threat to life	36	8.0
	Unknown	5	1.1

[a] History of the previous hospitalization for either the same as the current reason of admission or other ailments within the last 30 days

[b] Severe acute malnutrition (SAM)

Table 2: Proportion of healthcare-acquired infections among pediatric patients in Goba Referral Hospital, Ethiopia (n=57)

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ [a]	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

[a] including ventilator-associated pneumonia in pediatrics patients

Table 3: Factors associated with hospital-acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	Presence of HAIs		Crude RR	p-value
		Yes (57)	No (391)		
Sex	Male	30	218	0.88(0.55-1.45)	0.65
	Female	27	173	1	
Age (months)	1-12	33	252	0.78(0.48-1.28)	0.33
	>12	24	139	1	
Residence	Urban	12	117	0.65(0.36-1.20)	0.17
	Rural	45	274	1	
Hospital Duration	≤ 6	17	220	1	
	> 6	40	171	2.64(1.54-4.51)*	0.00
Admission Unit	NICU	27	174	1.10(0.68-1.79)	0.68
	Pediatrics	30	217	1	
Patient Received Antimicrobials	Yes	17	154	1	
	No	27	194	1.22(0.69-2.17)	0.48
	Unknown	13	43	2.33(1.21-4.50)*	0.01
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)	0.59
	No	50	352	1	
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)	0.38
	No	45	327	1	
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)	0.38
	No	55	384	1	
With Drainage Tube	Yes	14	39	2.42(1.42-4.12)*	0.00
	No	43	352	1	
Underlying Diseases ##	Yes	13	41	2.15(1.24-3.73)*	0.00
	No	44	350	1	
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)	0.36
	No	53	348	1	

Severe acute malnutrition (SAM); RR: Risk Ratio; * p-value< 0.05 (Crude)

Table 4: Multivariable logistic regression analysis on factors associated with hospital-acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)♣

Variables	Category	Patient with HAIs (n=57)	adjusted RR	P-value
Hospital Duration	≤ 6	17	2.58(1.52-4.38)**	< 0.001
	> 6	40	1	
Patient Received Antimicrobials	Yes	17	1	
	No	27	1.25(0.71-2.19)	0.430
	Unknown	13	1.93(0.84-4.42)	0.120
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	0.107
	No	43	1	
Underlying Diseases##	Yes	13	2.83(1.61-4.97)**	< 0.001
	No	44	1	

♣Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

Severe acute malnutrition (SAM)

Additional Files

S1 File: English version of the survey questionnaire

S2 File: Different types of HAIs cross-tabulation with number of cases in the NICU and the pediatric ward

Data collection tool

1. Patient ID/CODE _____
2. Ward_____ Bed number _____MRN_____
3. Age _____
4. Sex _____
5. Residence A. Urban_____ B. Rural_____
6. Reason for admission/Dx at the time of admission_____
   _____
   _____
7. Complete admission diagnoses _____
8. Date of admisstion_____
9. Patient health condition at the time of admission
   _____
   _____
   _____
10. Is there any other localized infection? Yes No
11. If yes, type of treatment given_____
12. Previous hospitalization Yes No
13. If yes for question 14:
    a. Place (including ward) _____
    b. Time (month/year) _____
    c. Duration_____
14. Previous antibiotic use for the current illness A. Yes_____ B. No_____
15. If yes for question 15, specify_____
16. If yes for question 15, for how many days? _____days
17. Being on mechanical ventilator? A. Yes_____ B. No_____
18. Presence of intravenous line? A. Yes_____ B. No_____
19. Presence of urinary catheters? A. Yes_____ B. No_____
    If yes, for how long_____
20. Indication for catheterization _____

21. Drainage inserted ? A. Yes_____ B. No_____

If yes, for how long _____

22. Indication for drainage _____

23. Presence of invasive medical devices? A. Yes_____ B. No_____

24. If yes for questions 20,21,22,26 (more than one answer is possible)

A. Endotracheal tube? A. Yes_____ B. No_____

B. NGT A. Yes_____ B. No_____

C. Chest tube A. Yes_____ B. No_____

25. Central vascular catheter A. Yes_____ B. No_____

26. Peripheral vascular catheter A. Yes_____ B. No_____

27. Peripheral intravenous line A. Yes_____ B. No_____

28. Urinary catheter A. Yes_____ B. No_____

29. Intubation A. Yes_____ B. No_____

30. Underlying diseases? A. Yes_____ B. No_____

31. If yes, underlying diseases (more than one answer is possible)

i. Diabetes mellitus vi. Cardiac disorders

ii. Chronic renal failure vii. Severe malnutrition

iii. Hypertension viii. TB

iv. Chronic liver disease ix. Cancer

v. HIV/AIDS x. Others (specify)

32. Surgery since admission A. Yes_____ B. No_____

33. Surgical procedure done? A. Yes_____ B. No_____

If yes for question 36,

A. Type of surgery A. Elective_____ B. Emergency_____

B. Type of the procedure_____

C. Date _____ Time_____

D. Duration of the surgery _____hours

E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D. Dirty

34. Antibiotic prophylaxis given? A. Yes_____ B. No_____

If yes for Q36, specify/name of antibiotic_____

If yes for Q36, how many doses? _____

35. Duration of stay hospital stay in days _____

36. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)]

A. Yes_____ B. No_____ C. Unknown/not tested_____

37. Immune deficiency A. Yes_____ B. No_____ C. Unknown/not tested_____

38. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4

39. Available hand washing material in ward A. Yes_____ B. No_____

40. Presence of medical waste container at room A. Yes_____ B. No_____

41. Available hand washing material in ward A. Yes_____ B. No_____

42. McCabe score

A. Non-Fatal diseases
B. Ultimately fatal diseases
C. Rapidly fatal diseases
D. Unknown

43. American Society of Anesthesiology (ASA) classification

a. Normally health patient
b. Patient with mild systemic diseases
c. Patient with severe systemic disease that is not incapacitating
d. Patient with incapacitating systemic diseases that is a constant threat to life
e. Unknown

44. HIV status A. Reactive B. Non-reactive C. Unknown

45. Presence of HAIs based on CDC definition:

_____

_____

46. Type of HAIs:

_____

_____

Name of data collectors : _____ Signature _____date

Name of supervisor_____ Signature _____ date

Table 3 : Cross tabulation between types of HAIs by ward in Goba referral hospital, 2019.

Type of HAIs	Name of ward type		Total	Chi-Square Tests, df, p-value
	NICU	Pediatrics		
Pneumonia/ Lower Respiratory Tract Infections	10	22	32	X^2(21.20), df=8, p-value=0.007
Late-Onset Neonatal Sepsis	6	0	6	
Intravenous Line (IV) Site Infections	4	1	5	
Urinary Tract Infections	1	3	4	
Systemic Infections	4	0	4	
Skin/Soft Tissue Infections	1	1	2	
Measles	0	2	2	
Early Onset Neonatal Sepsis	1	0	1	
Surgical Site Infections	0	1	1	
Total	**27**	**30**	**57**	

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	NA

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Abstract

Objectives: Epidemiological data on the incidence of hospital-acquired infections (HAIs) are necessary because without a valid and precise baseline, the problem remains unnoticed and interventions are not designed nor implemented. In Ethiopia, data about the occurrence of hospital-acquired infections among hospitalized pediatric patients are lacking. We aimed to determine the incidence and risk factors of hospital-acquired infections among pediatric patients in Ethiopia.

Design: A prospective cohort study

Setting: A teaching hospital in southeast Ethiopia

Participants: 448 hospitalized pediatric patients admitted between November 1, 2018 and June 30, 2019.

Primary and secondary outcome measures: Incidence and risk factors of hospital-acquired infections.

Results: A total of 448 pediatric patients were followed for 3,227 patient days. The median age of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of hospital-acquired infections was 17.7 per 1000 pediatrics days of follow up while the overall cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed greater than 6 days (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38)] and children with underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95% CI (1.61-4.97)] had a higher risk of developing a hospital-acquired infection.

Conclusions: The overall cumulative incidence of hospital-acquired infections was about 13 per 100 admitted children. Length of stay in the hospital and underling severe acute malnutrition were found to be important factors associated with increased risk of hospital-acquired infections.

Keywords: Nosocomial infection, Hospital-acquired infection, Pediatric patients, Ethiopia

Strengths and limitations of this study

- To the best of our knowledge, this is the first prospective study to examine the incidence and risk factors of hospital-acquired infection among pediatric patients in Ethiopia.
- We did not use laboratory culture to isolate organisms as a guide in addition to the clinical criteria to confirm the results of HAIs, which could affect our results.
- In this study, we focused on a small number of risk factors for hospital-acquired infections; some important variables were not included.

Introduction

There is a "perfect storm" on hospital-acquired infections (HAIs) among hospitalized patients at any point in time throughout the globe. HAI is defined as an infection occurring in a patient during the process of care in a hospital or other healthcare facility that is not manifested or incubating at the time of admission[1]. Currently, it is a growing public health problem that concerns both the medical and the general community, and a rising issue for patient safety and quality of care at every level[2-8]. A study by Sheng et al. reported that 80% of hospitalized patient's deaths were linked to nosocomial infection (NI)[9]. Available evidence also showed that financial burden, increased resistance of microorganisms to antimicrobials, prolonged hospital stay, and sometimes deaths are caused by HAIs [10, 11, 12].

Worldwide, it is estimated that hundreds of millions of patients every year, in both developed and developing countries, are affected by HAIs[7]. In some Australian public hospitals, HAIs affect one in every 74 hospitalizations[13]. In Europe, the total annual number of patients with HAI in 2011–2012 was estimated at 3.2 million. The prevalence of patients with at least one HAI in acute care hospitals was 6.0% (country range 2.3%–10.8%)[14]. Moreover, throughout Europe, HAIs accounted for 16 million additional days with total costs estimated at approximately €7 billion[14,15,16]. In the United States, approximately two million patients developed HAIs, and nearly a hundred thousand of these patients were estimated to die annually. This ranked HAI as the fifth leading cause of death in acute care hospitals and the risk of acquiring infection is 2 -20 times higher in some developing countries[17,18].

In some developing countries, the magnitude of HAIs remains underestimated and uncertain[12]. There is little information available on the epidemiology of HAI in African countries [19,20]. Although data are sparse, evidence suggested that HAIs are considerably adding to the available high burden of infections in some sub-Saharan African countries[21]. A systematic review by Nejad et al reported that hospital-wide HAI prevalence in Africa varied between 2.5% and 14.8%. This review has shown that published studies were only conducted in 10 African countries – emphasize there were paucities of information available among the epidemiology of HAI in many African countries[19]. In addition to this, a recent review by Irek et al (2018) indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

retrieved, more than half (n = 21, 60%) were from East Africa only [20]. And most of the HAI literature just focused on adults, and data on HAIs among the pediatric population in sub-Saharan Africa are hardly available [15,19,22]. For example, a systematic review conducted by the World Health Organization (WHO) in the year 2010, identified no reports on pediatric nosocomial bacteremia in African countries between 1995 and 2008 [15].

In Ethiopia, HAIs can result in substantial morbidity for hospitalized children; however, little is known about the incidence and prevalence of HAIs in the neonatal and pediatric populations. Also, previously conducted studies by far focused only on adults, and many of these were limited to surgical site infections [23-28], with an estimated prevalence of 10.9% [24] to 66.5% [27]. The overall cumulative incidence was 35.8 per 100 patients[26]. Furthermore, the urinary tract and bloodstream infections were found to be the commonest forms of HAIs in Ethiopia [29-33]. Surgery since admission[23,26], underlying medical conditions[23,25], patients' with catheter [23,25,26], the patient put on mechanical ventilation[26] , immune-deficient patients [23,25], patient age [26,32,33], hospital type [32], the type of ward, and prolonged hospitalization[33] were found to be important factors associated with increased risk of HAIs in Ethiopia.

To the best of our knowledge, there is no single currently available published report on the incidence and risk factors of HAIs among pediatric patients in Ethiopia. Epidemiological data on the incidence of HAI are necessary because without a valid and precise baseline, the problem remains unnoticed and interventions are not designed nor implemented, and neither can their impact be assessed. Therefore, this study was designed to determine the incidence and risk factors of HAIs among pediatric patients in Goba Referral Hospital, Southeast Ethiopia. The current study helps policymakers to improve their decision making and input for healthcare professionals for the improvement of patient care.

Methods

Study design and setting

A hospital-based prospective follow up study was conducted from November 1, 2018, to June 30, 2019, at Madda Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city (Addis Ababa) of Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the average outpatient flow is over 96,661 and the annual admission is over 7,886 patients, of which 1,335 were admitted in the pediatrics ward and Neonatal Intensive Care Unit (NICU). The hospital has a total of 127 inpatients beds – of which 30 and 15 are in the pediatric ward and NICU, respectively.

Study population and eligibility criteria

All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care unit (NICU) were enrolled and those who at least stayed for 48 hours were eligible for the study. Enrolled patients showed signs of infection and/or symptoms of infection within the first 48 hours were excluded from the study.

Data collection procedures

First, consent was sought from each child's parents/guardians before commencing any study procedures. On admission, all children were evaluated clinically to exclude community-acquired infections by a pediatrician. Afterward, socio-demographic and clinical data were collected by a structured questioner using an individual patient chart investigation approach-accordingly-a detailed clinical history of patients were taken and recorded. Patients presenting with no new signs or symptoms of infection after the first 48 hours of admission were included and followed prospectively for the development of HAIs during their stay in the hospital. Data were collected from enrolled patients on a daily bases: children were followed by a pediatrician daily, charts were reviewed and discussions with nurses and physician caring for the patient were held. HAIs

were confirmed by senior pediatrician specialists working in the respective NICU and pediatrics ward.

Data were collected by trained physicians and one pediatrician. The Center for Diseases Control and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN) Surveillance Definition for hospital-acquired infections were used[34]. In this study, the use of any antimicrobials was recorded and information on different medical devices collected at the time of hospital admission and before the diagnosis of HAIs, respectively **(S1 File).**

Data quality control

The data collection tool was adapted from different related pieces of literature based on the available evidence to HAIs[1,23,26,32]. To ensure the quality of data, the tool was pre-tested before the data collection period. The training was given for data collectors on study procedures and with practical exercise sessions. Data collection was closely supervised by a principal investigator and the collected data were checked for completeness, accuracy, and consistency.

Operational definition

Hospital-Acquired Infection (HAI) - localized or systemic condition that results from an adverse reaction to the presence of an infectious agent or its toxin and occurring 48 hours or longer after hospital admission that was not incubating at the time of admission.

Severe Anemia - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)

Study variables

The outcome variable of the study was the occurrence of hospital-acquired infections (HAIs). The presence of HAIs was confirmed when the patients met the criteria for signs and symptoms determined by the Center for Disease Control and Prevention[34], wherein, the independent variables included: socio-demographic characteristics (age of the child, sex, place of residence, and previous hospitalization), and clinical and other related variables (duration of hospitalization,

insertion of a urinary catheter, presence of peripheral intravenous (IV) catheter, received anti-microbial, American Society of Anesthesiology (ASA) classification, intubation, surgery after admission, underline disease-refers to Severe acute malnutrition (SAM) presenting at the time of admission, mechanical ventilator, and HIV status).

Data processing and analysis

Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical software for further analysis. Descriptive statistics were computed to present the frequency distribution of important variables. The cumulative incidence (incidence proportion) was calculated as the number of new HAIs cases per person in the population over a defined period; and it is the probability of developing HAIs over a stated study period (8 months). We estimated incidence rate as the number of HAIs cases per unit of time, and the denominator is the total amount of time "at-risk" without experiencing HAIs for all children who were being followed for 8 months. The incidence rate of HAIs was reported per 1000 patient days. Multivariable logistic regression was used to identify factors with an increased risk of HAIs. An adjusted risk ratio (ARR) with a 95% confidence interval (CI) was used to determine the strength of association. A p-value < 0.05 was used to declare statistical significance. Multicollinearity diagnosis was performed between categorical variables by looking at values of variance inflation factor (VIF). The final model fitness was assessed by using the Hosmer-Lemeshow goodness of fit test.

Patient and public involvement

Patients and the public were not involved in the planning, designing, and interpreting this data analysis. However, consent was sought from all patients involved in this study.

Results

Socio-demographic characteristics of the study participants

A total of 487 pediatrics patients were enrolled in this study. However, 39 pediatric patients showed signs of infection and/or symptoms of the infection within the first 48 hours were excluded from the study. The rest 448 pediatric patients were followed for the occurrence of HAIs until hospital discharge, referred to other healthcare facilities or death. Of the total patients included in the study, 201 (44.9%) were from the neonatal intensive care unit (NICU) and the remainder were from the pediatric ward. Two hundred forty-eight (55.4%) of the study participants were male with an overall male-to-female ratio of 1.24: 1. The median age of the participants was 8 months (interquartile range (IQR): 2-26 months). The age distribution of study participants by sex was presented in **Figure 1**. Three hundred and ninety (71.2%) of the study participants were from rural areas. The median hospital stay of the patients was 6 days (IQR: 3-9 days). Of the study participants, 24 (5.4%) died. Therefore, the overall incidence density rate of admitted pediatrics mortality was 7.44 per 1000 pediatrics days of follow up (**Table 1**).

Clinical characteristics of patients

In this study, 46 (10.3%) of the participants had a history of the previous hospitalization within the last 30 days. Fifty-four, (12.1%) of children were diagnosed with severe acute malnutrition (SAM) at the time of admission. Severe anemia was reported by 41 (9.2%) respondents. Overall, one hundred and seventy-one (38.2%) patients received antimicrobial at the time of the study (**Table 1**).

Incidence and type of hospital-acquired infection

During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A total of 57 patients experienced HAI. The mean time of diagnosis of HAIs in Goba referral hospital is 7.20 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. The mean length of stay for the infected pediatric patients was 11.5 days (95% CI: 9.5-13.4), while it was lower for the remaining patients at 6.5 days.

Table 2 illustrates the proportion of HAIs among pediatrics patients in Goba referral hospital. Hospital-acquired pneumonia was the most common type of HAI that was observed among

pediatrics patients with a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-onset neonatal sepsis 10.5% (95%CI: 3.5-19.3), and the least HAI observed was an early onset of neonatal sepsis and surgical site infections with an overall proportion of 1.8% each. In this study, the stratification of type of HAIs by ward of admission revealed significant variability (p-value= 0.007) (**Figure 2**).

Risk factors of hospital-acquired infections

Table 3 showed the risk factors of HAIs among pediatric patients in Goba Referral Hospital. Bivariate analysis of risk ratio has indicated that hospital duration (> 6 days), the patient received antimicrobial medications, presence of drainage tube, and children diagnosed for SAM were predispose for HAIs.

In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children who stayed longer than or equal to 6 days (median day) than to those children who stayed less [adjusted RR: 2.58, 95%CI (1.72-4.38)]. Patients with SAM conditions had a 2.83 times higher risk of developing HAIs compared to their counterparts [adjusted RR: 2.83, 95% CI (1.61-4.97)]. Socio-demographic and some clinically related confounders could not show any statistically significant associations (**Table 4**).

In this study, we estimated the attributable risk which estimates the excess risk of disease in those exposed compared with those non-exposed. The excess occurrence of HAIs among children with underlying SAM diseases attributable to their SAM condition is 13 per 100 (**Table 4**).

Discussion

Hospital-acquired infections (HAIs) are a current global challenge with increased morbidity, mortality, and massive economic cost [35-39]. Yet, there remain limited data on the occurrences of HAIs in hospitalized pediatric in Sub-Saharan African, including Ethiopia. This study was designed to determine the incidence and risk factors of HAIs among pediatric patients in a teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed longer than the median day (6 days) in the hospital and children with underlying disease conditions (Severe acute malnutrition) had a higher risk of developing HAIs.

In this study, the overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow up. This finding is lower than a related study by Ali et al (2018) from Southwest Ethiopia, which reports the incidence of HAIs was 28.15 per 1000 patient days [39]. The difference might be associated with the nature of this study which involved only pediatrics patients including those in intensive care; however, a study by Ali et al includes adult study participants. Also, variation in studies could be attributed to differences in geographical locations and the setting of studies (specialized hospital). One previous a before-and-after study conducted in a teaching hospital in Indonesia involving children admitted to the pediatric intensive care unit and pediatric wards reported the incidence density rate of HAI 29.1 per 1000 patient days, which is similar with our finding.[36]

Our finding has also revealed that the overall cumulative incidence of HAIs was 12.7%; a finding which is comparable to those reported from the United States (11.9%) [37] studies conducted in the pediatric intensive care unit, and (13.3%) in Poland [38] . Also, the present 12.7% of HAIs noted in our study population fell in the ranges of 9.8-15.8% reported elsewhere [14, 40, 41], and the WHO pooled estimated for low-income countries 10.1% [18]. Conversely, other similar studies from Turkey reported a much higher prevalence of HAIs among children ranging between 22.2 and 68.4% [42,43], and in a multicenter prospective study from Europe reported 18.5% [44] among pediatric patients.

The present study also demonstrated that the occurrence of HAIs was higher among male participants (52.6%) than females. This result was also supported by other studies conducted elsewhere [40, 45-47]. In the same vein, one study carried out by Koch et al in Norway reported that males present higher overall HAIs prevalence than females[48].

The most common type of HAI observed in this study was hospital-acquired pneumonia (HAP), which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates are immunologically immature, and in many cases, vulnerable [49,50]. The finding was similar to the study done in Tikur Anbessa Hospital, Ethiopia [33]. It is also true for other settings–in Iran 43.7% [51], India 50% [52], Vietnam 41.9% [53], Morocco 34.5% [54], Saudi Arabia 46.7% [55], 52.2% China [56], and in a European multicenter prospective study 53% [44]. The high burden of HAP among hospitalized pediatrics patients has an important implication in terms of hospital length of stay, healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as 30 to 50% [57]. In this study, ventilator-associated pneumonia (VAP) developed in 9.21% [7/76] of children undergoing mechanical ventilation. Our estimate is in line with studies conducted on children, reporting VAP occurs in 3 to 10% of ventilated pediatric ICU patients.[36,58,59,60]

In this study, the risks of developing HAIs were three times higher among children who stayed longer than or equal to the median six days than their counterparts. Despite this positive association, this is not proof that decreasing the length of stays neither increasing admission days decreased/increase the occurrence of HAIs. Possible revered causation may be one of the mechanisms why this prolonged length of stay is associated with HAIs. Moreover, there is evidence that HAIs cause a prolonged length of stay [61-65]. In our findings, the presence of underlying diseases such as SAM was recognized as the main risk factor for HAIs. This was consistent with the finding from another study in Ethiopia [24] underlying illnesses increased the susceptibility of patients, which predisposed them to infections secondary to the reduction of the patient's immune response that exacerbated the illnesses thru which in many cases had a significant factor that contributed more to the acquisition of HAIs in neonates and pediatric patients [41, 66, 67].

Limitations of the study

Several limitations on this prospective study need to be considered. First, we did not assess the healthcare workers' infection prevention practices that would have been associated with the prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the patients were discharged. Third, despite we followed patient until discharge the full burden of HAI could not be captured in this specific study as our study, was limited to in-hospital assessment only and leaving outpatients who may potentially develop HAI after discharge. Fourth, we focused on a small number of risk factors for hospital-acquired infections; some important variables were not included. Fifth, the used analysis does not take any time-varying risk into account. Finally, we did not use laboratory culture to isolate organisms as a guide in addition to the clinical criteria to confirm the results of HAIs because of financial constraints, laboratory facilities, and expertise. Given the lack of microbiology data, endogenous infections may be misclassified as HAIs. Since the study was conducted in a teaching referral hospital, the generalization of the study findings is limited to these facilities.

Conclusions

The present study revealed that the cumulative incidence of hospital-acquired infections (HAIs) was about 13 per 100 admitted children. And the overall incidence rate of HAIs was 17.75 per 1000 pediatrics days. Length of stay in the hospital and patients with severe acute malnutrition (SAM) conditions were associated with increased risk of hospital-acquired infections. Further studies are strongly recommended to identify other important factors including isolating the bacterial, fungal, and viral agents responsible for HAIs in the region.

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Contributors

BS has made substantial contributions to conception and design, acquisition of data, analysis, and interpretation of data. He has written the draft manuscript and provided final approval of the version to be published. FS, DA, EN, GN, AK, DW, YT, DZ, and BJEQ has made substantial contributions to design, acquisition of data and analysis, interpretation of data and revised the article critically for important intellectual content and provided final approval of the version to be published. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval

Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University Research Community Engagement and Technology Transfer Vice President Office was submitted. Written consent from the parents/ legal guardians was obtained after explaining the objectives of the study. Identified pediatric patients having hospital-acquired infections were formally communicated to the physicians and nurses who were in charge of the patients for additional health care services. Throughout the data collection period, confidentiality and privacy of the patients were observed, and a unique identification code rather than their names were substituted.

Data sharing statement

Data will be available upon request from the corresponding authors.

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Table 1: Demographic and clinical characteristics of patients who participated in the study in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	n (%)
Patient age, Median (IQR): 8 months (2-26 months)		
Sex	Male	248 (55.4)
	Female	200 (44.6)
Ward	Neonatal Intensive Care Unit (NICU)	201 (44.9)
	Pediatrics	247 (55.1)
Resident	Urban	129 (28.8)
	Rural	319 (71.2)
Previous Hospitalization[a]	Yes	46 (10.3)
	No	402 (89.7)
Mechanical Ventilation	Yes	76 (17.0)
	No	372 (83.0)
Presence of peripheral intravenous (IV) catheter[b]	Yes	430 (96.0)
	No	18 (4.0)
Presence of Urinary Catheters	Yes	9 (2.0)
	No	439 (98.0)
Drainage Tube Inserted[c]	Yes	53 (11.8)
	No	395 (88.2)
Underlying Severe acute malnutrition (SAM) Diseases[d]	Yes	54 (12.1)
	No	394 (87.9)
Surgery After Admission	Yes	47 (10.5)
	No	401 (89.5)
Patient Received Antimicrobials[e]	Yes	171 (38.2)
	No	221 (49.3)
	Unknown	56 (12.5)
Severe Anemia	Yes	41 (9.2)
	No	375 (83.7)
	Unknown	32 (7.1)
Hospital Duration (median day)	≤ 6	237 (52.9)
	> 6	211 (47.1)
HIV status	Positive	2 (0.4)
	Negative	393 (87.7)
	Not tested	53 (11.8)
American Society of Anesthesiology (ASA) Classification	Normally health patient	72 (16.1)
	Patient with mild systemic diseases	235 (52.5)
	Severe systemic disease that is not incapacitating	100 (22.3)
	Incapacitating systemic diseases that is a constant threat to life	36 (8.0)

	Unknown	5 (1.1)
Gestational age (n=191)	< 37 weeks	83 (43.5)
	≥ 37 weeks	108 (56.5)
Birth weight (n=191)[f]	< 2500gm	46 (24.1)
	≥ 2500 gm	145 (75.9)

[a] History of the previous hospitalization for either the same as the current reason of admission or other ailments within the last 30 days

[b]Peripheral intravenous (IV) catheter: A peripheral intravenous (IV) catheter is inserted into small peripheral veins to provide access to administer IV fluids and medications.

[C]Drainage tube: insertion of a chest tube, endotracheal, and nasogastric (NG) intubation.

[d] Severe acute malnutrition (SAM) diagnosed at the time of hospital admission.

[e] The use of antimicrobials before admission either through intravenous (IV), intramuscular (IM) or oral (PO) administration.

[f]Any neonate weighting less than 2500 gm at birth irrespective of gestational age was considered low birth weight (LBW).

Table 2: Proportion of hospital-acquired infections among pediatric patients in Goba Referral Hospital, Ethiopia (n=57)

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ [a]	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

[a] including ventilator-associated pneumonia (VAP) (n=7) & VAP developed in 9.21% [7/76] of children undergoing mechanical ventilation; CI: Confidence Interval

Table 3: Bi-variate association of factors for the occurrence of hospital-acquired infections among pediatric patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	Presence of HAIs		Crude RR
		Yes (57)	No (391)	
Sex	Male	30	218	0.88(0.55-1.45)
	Female	27	173	1
Age (months)	1-12	33	252	0.78(0.48-1.28)
	>12	24	139	1
Residence	Urban	12	117	0.65(0.36-1.20)
	Rural	45	274	1
Hospital Duration (median day)	≤ 6	17	220	1
	> 6	40	171	2.64(1.54-4.51)*
Admission Unit	NICU	27	174	1.10(0.68-1.79)
	Pediatrics	30	217	1
Patient Received Antimicrobials	Yes	17	154	1
	No	27	194	1.22(0.69-2.17)
	Unknown	13	43	2.33(1.21-4.50)*
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)
	No	50	352	1
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)
	No	45	327	1
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)
	No	55	384	1
Drainage Tube Inserted	Yes	14	39	2.42(1.42-4.12)*
	No	43	352	1
Severe acute malnutrition (SAM)	Yes	13	41	2.15(1.24-3.73)*
	No	44	350	1
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)
	No	53	348	1

RR: Risk Ratio; * p-value< 0.05 (Crude)

Table 4: Multivariable logistic regression analysis on factors associated with hospital-acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)♣†

Variables	Category	Patient with HAIs (n=57)	Adjusted RR	Attributable Risk (AR)[a]
Hospital Duration	≤ 6	17	1	
	> 6	40	2.58(1.52-4.38)**	0.12
Patient Received Antimicrobials	Yes	17	1	
	No	27	1.25(0.71-2.19)	
	Unknown	13	1.93(0.84-4.42)	
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	
	No	43	1	
Severe acute malnutrition (SAM)	Yes	13	2.83(1.61-4.97)**	0.13
	No	44	1	

♣Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

† Adjusted for age, sex, admission unit, mechanical ventilation, and presence of a urinary catheter

[a]Attributable risk is the difference between the risk HAIs in the exposed group and the unexposed group.

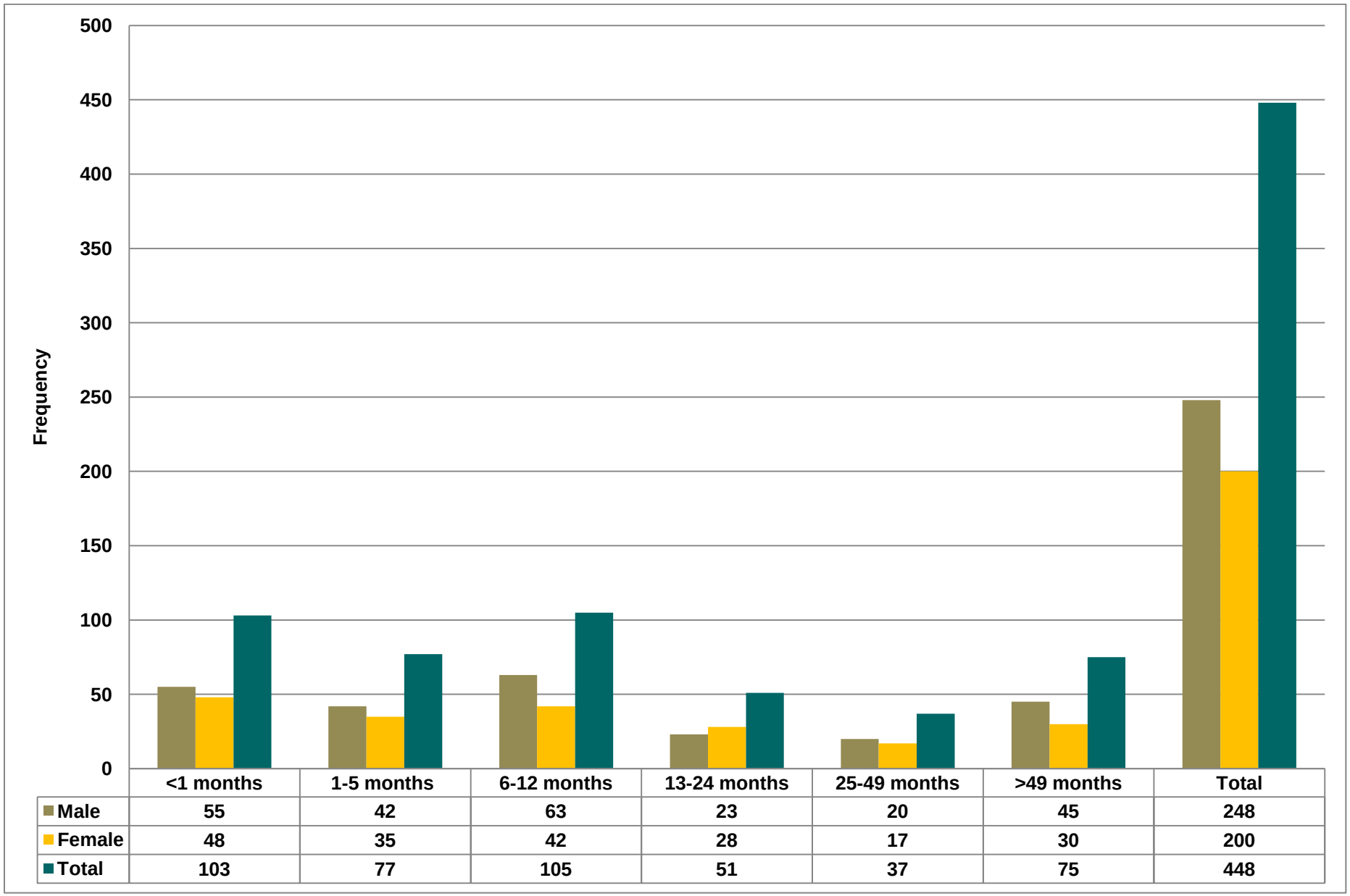
Figure Legends

Figure 1: Bar graph showing the age distribution of study participants by sex.

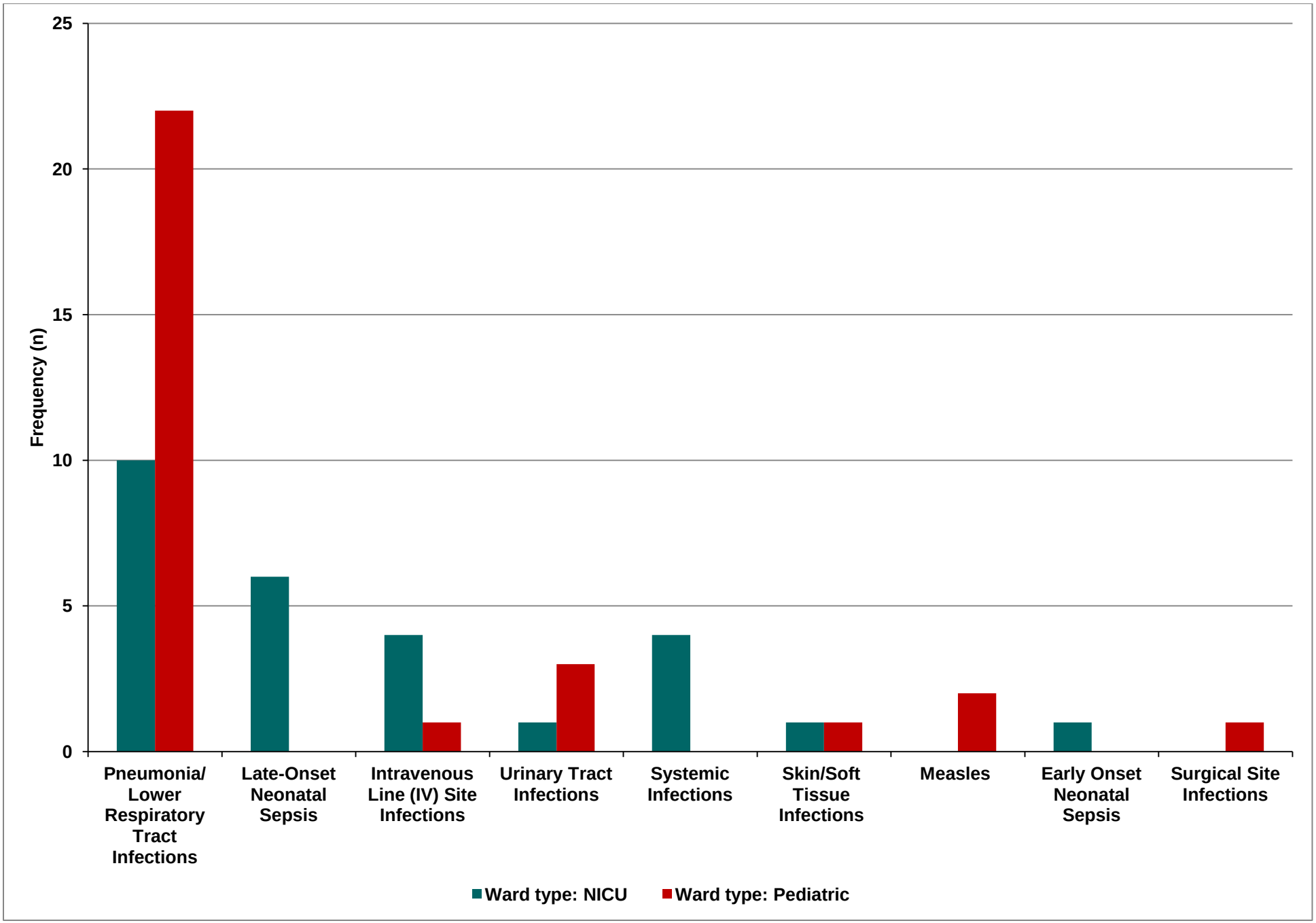
Figure 2: Bar graph showing the type of HAIs by type of admission ward.

Additional Files

S1 File: English version of the survey questionnaire



	<1 months	1-5 months	6-12 months	13-24 months	25-49 months	>49 months	Total
Male	55	42	63	23	20	45	248
Female	48	35	42	28	17	30	200
Total	103	77	105	51	37	75	448


25
20
15
10
5
0
Frequency (n)
Pneumonia/ Lower Respiratory Tract Infections
Late-Onset Neonatal Sepsis
Intravenous Line (IV) Site Infections
Urinary Tract Infections
Systemic Infections
Skin/Soft Tissue Infections
Measles
Early Onset Neonatal Sepsis
Surgical Site Infections
Ward type: NICU
Ward type: Pediatric

Data collection tool

1. Patient ID/CODE _____
2. Ward_____ Bed number _____MRN_____
3. Age _____
4. Sex _____
5. Residence A. Urban_____ B. Rural_____
6. Reason for admission/Dx at the time of admission_____
   _____
   _____
7. Complete admission diagnoses _____
8. Date of admisstion_____
9. Patient health condition at the time of admission
   _____
   _____
   _____
10. Is there any other localized infection? Yes No
11. If yes, type of treatment given_____
12. Previous hospitalization Yes No
13. If yes for question 14:
    a. Place (including ward) _____
    b. Time (month/year) _____
    c. Duration_____
14. Previous antibiotic use for the current illness A. Yes_____ B. No_____
15. If yes for question 15, specify_____
16. If yes for question 15, for how many days? _____days
17. Being on mechanical ventilator? A. Yes_____ B. No_____
18. Presence of intravenous line? A. Yes_____ B. No_____
19. Presence of urinary catheters? A. Yes_____ B. No_____
    If yes, for how long_____
20. Indication for catheterization _____

21. Drainage inserted ? A. Yes_____ B. No_____

If yes, for how long _____

22. Indication for drainage _____

23. Presence of invasive medical devices? A. Yes_____ B. No_____

24. If yes for questions 20,21,22,26 (more than one answer is possible)

A. Endotracheal tube? A. Yes_____ B. No_____

B. NGT A. Yes_____ B. No_____

C. Chest tube A. Yes_____ B. No_____

25. Peripheral intravenous line (IV) catheter A. Yes_____ B. No_____

26. Insertion of a urinary catheter A. Yes_____ B. No_____

27. Intubation A. Yes_____ B. No_____

28. Underlying diseases? A. Yes_____ B. No_____

29. If yes, underlying diseases (more than one answer is possible)

i. Diabetes mellitus
ii. Chronic renal failure
iii. Hypertension
iv. Chronic liver disease
v. HIV/AIDS
vi. Cardiac disorders
vii. Severe malnutrition (SAM)
viii. TB
ix. Cancer
x. Others (specify)

30. Surgery since admission A. Yes_____ B. No_____

31. Surgical procedure done? A. Yes_____ B. No_____

If yes for question 36,

A. Type of surgery A. Elective_____ B. Emergency_____

B. Type of the procedure_____

C. Date _____ Time_____

D. Duration of the surgery _____hours

E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D. Dirty

32. Antibiotic prophylaxis given? A. Yes_____ B. No_____

If yes for Q36, specify/name of antibiotic_____

If yes for Q36, how many doses? _____

33. Duration of stay hospital stay in days _____

34. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)]

A. Yes_____ B. No_____ C. Unknown/not tested_____

35. Immune deficiency A. Yes_____ B. No_____ C. Unknown/not tested_____

36. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4

37. McCabe score

A. Non-Fatal diseases
B. Ultimately fatal diseases
C. Rapidly fatal diseases
D. Unknown

38. American Society of Anesthesiology (ASA) classification

a. Normally health patient
b. Patient with mild systemic diseases
c. Patient with severe systemic disease that is not incapacitating
d. Patient with incapacitating systemic diseases that is a constant threat to life
e. Unknown

39. HIV status A. Reactive B. Non-reactive C. Unknown

40. Presence of HAIs based on CDC definition:

_____

_____

41. Type of HAIs:

_____

_____

Name of data collectors : _____ Signature _____date

Name of supervisor_____ Signature _____ date

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	NA

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Incidence and risk factors for hospital-acquired infection among pediatric patients in a teaching hospital: a prospective study in southeast Ethiopia

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Abstract

Objectives: In order to maximize the prevention of hospital-acquired infections (HAIs) and antimicrobial resistance, data on the incidence of HAIs are crucial. In Ethiopia, data about the occurrence of HAIs among hospitalized pediatric patients are lacking. We aim to determine the incidence and risk factors of hospital-acquired infections among pediatric patients in Ethiopia.

Design: A prospective cohort study

Setting: A teaching hospital in southeast Ethiopia

Participants: 448 hospitalized pediatric patients admitted between November 1, 2018 and June 30, 2019.

Primary and secondary outcome measures: Incidence and risk factors of hospital-acquired infections.

Results: A total of 448 pediatric patients were followed for 3,227 patient days. The median age of the patients was 8 months (interquartile range (IQR): 2-26 months). The incidence rate of hospital-acquired infections was 17.7 per 1000 pediatrics days of follow up; while the overall cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed greater than 6 days in the hospital (median day) [adjusted RR: 2.58, 95%CI (1.52-4.38)], and children with underlying disease conditions of severe acute malnutrition [adjusted RR: 2.83, 95% CI (1.61-4.97)] had higher risks of developing hospital-acquired infections.

Conclusions: The overall cumulative incidence of hospital-acquired infections was about 13 per 100 admitted children. Length of stay in the hospital and underlying conditions of severe acute malnutrition were found to be important factors associated with increased risk of hospital-acquired infections.

Keywords: Nosocomial infection, Hospital-acquired infection, Pediatric patients, Ethiopia

Strengths and limitations of this study

- To the best of our knowledge, this is the first prospective study that examines the incidence and risk factors of hospital-acquired infections (HAIs) among pediatric patients in Ethiopia.
- We did not use laboratory culture to isolate organisms as a guide in addition to the clinical criteria to confirm the results of HAIs-which could have affected our results.
- In this study, we focused on a small number of risk factors for hospital-acquired infections; some important variables were not included, as well.

Introduction

There is a "perfect storm" on hospital-acquired infections (HAIs) among hospitalized patients at any point in time throughout the globe. HAI is defined as an infection occurring in a patient during the process of care in a hospital or other healthcare facilities that is not manifested or incubating at the time of admission[1]. Currently, it is a growing public health problem which concerns both the medical and the general community, and a rising issue for patient safety and quality of care in every level[2-8]. A study by Sheng et al. reported that 80% of hospitalized patient deaths were linked to nosocomial infection (NI)[9]. Available evidences also showed that financial burden, increased resistance of microorganisms to antimicrobials, prolonged hospital stay, and sometimes deaths, are caused by HAIs [10, 11, 12].

Worldwide, it is estimated that hundreds of millions of patients every year in both developed and developing countries are affected by HAIs[7]. In some Australian public hospitals, HAIs affect one in every 74 hospitalizations[13]. In Europe, the total annual number of patients with HAIs in 2011–2012 was estimated around 3.2 million. The prevalence of patients with at least one HAI in acute care hospitals was 6.0% (country range 2.3%–10.8%)[14]. Moreover, throughout Europe, HAIs accounted for 16 million additional days, with total costs estimated at approximately €7 billion[14,15,16]. In the United States, approximately two million patients developed HAIs, and nearly a hundred thousand of these patients were estimated to die annually. This ranked HAIs as the fifth leading cause of death in acute care hospitals, and the risk of acquiring infection is 2 -20 times higher in some developing countries[17,18].

In some developing countries, the magnitude of HAIs remains underestimated and uncertain[12]. There is little information available on the epidemiology of HAIs in African countries [19,20]. Although data are sparse, evidence suggested that HAIs are considerably adding to the available high burden of infections in some sub-Saharan African countries[21]. A systematic review by Nejad et al reported that hospital-wide HAI prevalence in Africa varied between 2.5% and 14.8%. This review has shown that published studies were only conducted in 10 African countries – emphasized there were paucities of information available among the epidemiology of HAIs in many African countries[19]. In addition to this, a recent review by Irek et al (2018) indicated that there was a scarcity of studies on HAIs in Africa – of the 35 eligible articles

retrieved, more than half (n = 21, 60%) were from East Africa only [20]. In addition, most of the HAIs literatures only focused on adults, and the data on HAIs among the pediatric population in sub-Saharan Africa were hardly available [15,19,22]. For example, a systematic review conducted by the World Health Organization (WHO) in the year 2010, identified no reports on pediatric nosocomial bacteremia in some African countries between 1995 and 2008 [15].

In Ethiopia, little is known about the incidence and prevalence of HAIs in the neonatal and pediatric populations. Moreover, previously conducted studies focused only on adults, and many of these were limited to surgical site infections [23-28], with an estimated prevalence of 10.9% [24] to 66.5% [27]. The overall cumulative incidence was 35.8 per 100 patients[26]. Furthermore, urinary tract and bloodstream infections were found to be the commonest forms of HAIs in Ethiopia [29-33]. Surgery after admission [23,26], underlying medical conditions[23,25], patients with catheters [23,25,26], patient on mechanical ventilators[26], immune-deficient patients [23,25], patients age [26,32,33], hospital types [32], the types of ward, and prolonged hospitalizations[33] were found to be important factors associated with increased risks of HAIs in Ethiopia.

Up to date, there are no surveillance programs at the regional or national levels which targeted HAIs in Ethiopia. The available evidence on HAIs in the country was originated from primary studies. Moreover, to the best of our knowledge, there is not a single published report on the incidence and risk factors of HAIs among pediatric patients in Ethiopia. In order to maximize the prevention of hospital-acquired infections (HAIs) and antimicrobial resistance in Ethiopia, epidemiological data on the incidence of HAIs are crucial because without a valid and precise assessment of HAIs, the problem remains unnoticed. Therefore, this study was designed to determine the incidence and risk factors of HAIs among pediatric patients in Goba Referral Hospital, Southeast Ethiopia. The current study will help policymakers to improve their decision makings and inputs for healthcare professionals, for the improvement of patient care.

Methods

Study design and setting

A hospital-based prospective follow up study was conducted from November 1, 2018, to June 30, 2019, at Madda Walabu University Goba Referral Hospital, Southeast Ethiopia. Goba Referral Hospital is the only referral and teaching hospital in the Bale zone, serving over 1,787,575 million people. Goba Referral Hospital is located 445 km far from the capital city of Ethiopia. According to the 2018 annual report of Goba Referral Hospital, the average outpatient flow is over 96,661, and the annual admission is over 7,886 patients, of which 1,335 were admitted in the pediatrics ward and Neonatal Intensive Care Unit (NICU). The hospital has a total of 127 inpatients beds – of which 30 and 15 are in the pediatric ward and NICU, respectively.

Study population and eligibility criteria

All patients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care unit (NICU) were enrolled, and those who at least stayed for 48 hours, were eligible for the study. Enrolled patients who showed signs of infections and/or symptoms of infection within the first 48 hours were excluded from the study.

Data collection procedures

Firstly, consent was sought from each of the child's parent/guardian before commencing any study procedures. On admission, all children were evaluated clinically to exclude community-acquired infections by a pediatrician. Afterwards, socio-demographic and clinical data were collected through a structured questionnaire using individual patient chart investigation approach-accordingly-a detailed clinical history of patients were taken and recorded. Patients with no new signs or symptoms of infection after the first 48 hours from admission were included and followed prospectively for the development of HAIs during their stay in the hospital. Data were collected from enrolled patients on a daily basis: children were followed by a pediatrician daily, charts were reviewed, and discussions with nurses and physician caring for the

patients were held. HAIs were confirmed by senior pediatrician specialists working in the respective NICU and pediatrics ward (**Figure 1**).

Data were collected by trained physicians and one pediatrician. The Center for Diseases Control and Prevention (CDC)/ National Health Care Safety Network (CDC/NHSN) Surveillance Definition for hospital-acquired infections was used[34]. In this study, the usage of any antimicrobials and information on the use of different medical devices at the time of hospital admission and before the diagnosis of HAIs were recorded, respectively (**S1 File).**

Data quality control

The data collection tool was adapted from different related pieces of literatures based on the available evidences of HAIs[1,23,26,32]. To ensure the quality of data, the data collection tool was pre-tested before the data collection period. The training was given for data collectors on the study procedures, and with practical exercise sessions. Data collection was closely supervised by a principal investigator, and the collected data were checked for completeness, accuracy, and consistency. In order to minimize the potential effects of confounder variables, multivariable logistic regression model was used, and analyses were adjusted to known confounder, such as age. In addition, the researchers try to reduce selection bias by including all admitted patients in our follow ups. Moreover, to reduce the effect of observer bias the data collectors have no preconceived expectations of what they should find in an examination.

Operational definition

Hospital-Acquired Infection (HAI) – a localized or systemic condition that results from an adverse reaction in the presence of an infectious agent or its toxin, and occurring 48 hours or longer after hospital admission, which was not incubating at the time of admission [14,19,23,26,32 34]

Severe Anemia - haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)

Late-onset neonatal sepsis: Infection occurring after birth, but excluding infections known to have been transmitted across the placenta.

Study variables

The outcome variable of the study was the occurrence of hospital-acquired infections (HAIs). The presence of HAIs were confirmed when the patients met the criteria for signs and symptoms determined by the Center for Disease Control and Prevention[34], wherein, the independent variables included: socio-demographic characteristics (age of the child, sex, place of residence, and previous hospitalization), and clinical and other related variables (duration of hospitalization, insertion of a urinary catheter, presence of peripheral intravenous (IV) catheter, received anti-microbial, American Society of Anesthesiology (ASA) classification, intubation, surgery after admission, underline disease-refers to Severe acute malnutrition (SAM) presented at the time of admission, mechanical ventilator, and HIV status).

Data processing and analysis

Data were entered into Epi-data version 3.1 and exported to STATA version 14 statistical software for further analysis. Descriptive statistics were computed to present the frequency distribution of important variables. The cumulative incidence (incidence proportion) was calculated as the number of new HAIs cases per person in the population over a defined period of time; and it is the probability of developing HAIs over a stated study period (8 months). We estimated the incidence rate as the number of HAIs cases per unit of time, and the denominator represents the total amount of time "at-risk" without experiencing HAIs for all children whom were being followed for 8 months. The incidence rate of HAIs was reported per 1000 patient days. Multivariable logistic regression was used to identify factors with an increased risk of HAIs. Variables, that were assumed confounders based on their statistical significant result in the bivariate analysis, were included in the multivariable model. An adjusted risk ratio (ARR) with a 95% confidence interval (CI) was used to determine the strength of association. A p-value < 0.05 was used to declare statistical significances. Multicollinearity diagnosis was performed between categorical variables by looking at values of variance inflation factors (VIF). The final model fitness was assessed by using the Hosmer-Lemeshow goodness of fit test.

Patient and public involvement

Patients and the public were not involved in the planning, designing, and interpreting these data analyses.

Results

Socio-demographic characteristics of the study participants

A total of 487 pediatrics patients were enrolled in this study. However, 39 pediatric patients showed signs of infections and/or symptoms of the infection within the first 48 hours, and were excluded from the study. The remaining 448 pediatric patients were followed up for the occurrence of HAIs until their hospital discharge, referred to other healthcare facilities, or death. Of the total patients included in the study, 201 (44.9%) were from the neonatal intensive care unit (NICU), and the rest were from the pediatrics ward. Two hundred forty-eight (55.4%) of the study participants were male with an overall male-to-female ratio of 1.24: 1. Also, the median age of the participants was 8 months (interquartile range (IQR): 2-26 months). In addition, the age distribution of the study participants by sex was presented in **Figure 2**. Moreover, three hundred and ninety (71.2%) of the study participants were from rural areas. The median hospital stay of the patients was 6 days (IQR: 3-9 days), and among them, 24 (5.4%) died. The overall incidence density rate of the admitted pediatrics mortality was 7.44 per 1000 pediatrics days of follow ups (**Table 1**).

Clinical characteristics of patients

In this study, 46 (10.3%) of the participants had histories of previous hospitalizations within the last 30 days. Fifty-four, (12.1%) of the children were diagnosed with severe acute malnutrition (SAM) at the time of their admission. Severe anemia was reported among 41 (9.2%) respondents. Overall, one hundred and seventy-one (38.2%) patients received antimicrobials at the time of the study (**Table 1**).

Incidence and type of hospital-acquired infection

During the study period, 448 pediatric patients were followed for a total of 3,227 patient days. A total of 57 patients experienced HAIs, and none of the study participants were identified with more than one episode of HAIs. The mean time of diagnosis of HAIs in Goba Referral Hospital is 7.20 (95% CI: 6.72, 7.66) patient days. The overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow ups, while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. The mean length of stay for the infected pediatric patients was 11.5 days (95% CI: 9.5-13.4), while it was lower for the remaining patients, at 6.5 days.

Table 2 illustrates the proportion of HAIs among the pediatrics patients in Goba Referral Hospital. Hospital-acquired pneumonia was the commonest type of HAI which was observed among the pediatrics patients with a proportion of 56.1% (95%CI: 43.9-68.4), followed by late-onset neonatal sepsis 10.5% (95%CI: 3.5-19.3), and the least HAI observed were early onset of neonatal sepsis and surgical site infections, with an overall proportion of 1.8% each. In this study, the stratification of the types of HAIs by ward of admission revealed significant variability (p-value= 0.007) (**Figure 3**).

Risk factors of hospital-acquired infections

Table 3 showed the risk factors of HAIs among the pediatric patients in Goba Referral Hospital. Bivariate analysis of risk ratio has indicated that hospital duration (> 6 days), patients whom received antimicrobial medications, presence of drainage tubes, and children diagnosed for SAM, were predisposed to HAIs.

In the adjusted model, the risk of HAIs was 2.58 times more likely to be higher among children who stayed longer than or equal to 6 days (median day) than those who stayed less [adjusted RR: 2.58, 95%CI (1.72-4.38)]. Patients with SAM conditions had 2.83 times higher risks of developing HAIs compared to its counterparts [adjusted RR: 2.83, 95% CI (1.61-4.97)]. Socio-demographic and some clinically related confounders could not show any statistically significant associations (**Table 4**).

In this study, we estimated the attributable risk, which estimates the excess risk of disease in those exposed compared to those non-exposed. The excess occurrence of HAIs among children with underlying SAM diseases attributable to their SAM condition is 13 per 100 (**Table 4**).

Discussion

Hospital-acquired infections (HAIs) are current global challenges that increase morbidities, mortality, and massive economic cost [35-39]. Yet, there remain limited data on the occurrences of HAIs in hospitalized pediatric patients in Sub-Saharan African, including Ethiopia. This study was designed to determine the incidence and risk factors of HAIs among pediatric patients in a teaching hospital, southeast Ethiopia. The overall incidence rate of HAIs was 17.75 per 1000 pediatrics days of follow up while the cumulative incidence was 12.7% (95% CI: 9.8-15.8) over eight months. Children who stayed longer than the median day (6 days) in the hospital, and children with underlying disease conditions (Severe acute malnutrition), had higher risks of developing HAIs.

In this study, the overall incidence rate of HAIs was 17.7 per 1000 pediatrics days of follow ups. This finding is lower than a related prospective study by Ali et al (2018) from Southwest Ethiopia, which reported an incidence of HAIs of 28.15 per 1000 patient days [39]. The difference might be associated with the nature of this study which involved only pediatrics patients including those in intensive care; wheras, the study by Ali et al included adult study participants. Also, variations in some studies could be attributed to differences in geographical locations and the study settings (as in the case of Ali et al where the study they included a specialized hospital). A previous before-and-after study conducted in a teaching hospital in Indonesia involved children whom were admitted to the pediatric intensive care unit and pediatrics ward, reported the incidence density rate of HAI 29.1 per 1000 patient days, which is similar to our findings.[36]

One of our findings has also revealed that the overall cumulative incidence of HAIs was 12.7%; this is comparable to those reported from a study in the United States (11.9%)[37] which was conducted in the pediatric intensive care unit, and (13.3%) in Poland [38] . Also, the present 12.7% of HAIs noted in our study population fell in the ranges of 9.8-15.8% , and is reported elsewhere [14, 40, 41], and the WHO pooled estimated for low-income countries 10.1% [18]. Conversely, similar studies from Turkey reported a much higher prevalence of HAIs among children ranging between 22.2 and 68.4% [42,43], and in a multicenter prospective study from Europe reported 18.5% [44] among pediatric patients.

The present study also demonstrated that the occurrence of HAIs was higher among male participants (52.6%) than females. This result was also supported by other studies conducted elsewhere [40, 45-47]. In the same vein, one study carried out by Koch et al in Norway reported that males present higher overall HAI prevalence than females[48].

The commonest type of HAI observed in this study was hospital-acquired pneumonia (HAP), which contributed to a proportion of 56.1% of the total HAIs. It may not be a surprise to see such a high proportion of HAI in the NICU and pediatrics ward since most of the patients admitted in intensive care are incapacitated and critical. Moreover, compared to adults, infants and neonates are immunologically immature, and in many cases, vulnerable [49,50]. The finding was similar to the study done in Tikur Anbessa Hospital, Ethiopia [33]. It is also true for other settings–in Iran 43.7% [51], India 50% [52], Vietnam 41.9% [53], Morocco 34.5% [54], Saudi Arabia 46.7% [55], 52.2% China [56], and in a European multicenter prospective study 53% [44]. The high burden of HAP among hospitalized pediatrics patients has important implications in terms of hospital length of stay, healthcare cost, and mortality. The overall mortality attributed to HAP has been as high as 30 to 50% [57]. In this study, ventilator-associated pneumonia (VAP) developed in 9.21% [7/76] of children who underwent mechanical ventilation. Our estimate is in line with studies conducted on children reporting VAP, which occurred occurs in 3 to 10% of ventilated pediatric ICU patients.[36,58,59,60]

In this study, the risk of developing HAIs was three times higher among children who stayed longer than or equal to the median six days than their counterparts. Despite this positive association, this is not a proof that decreasing the length of stay neither increasing admission days increase/decrease the occurrence of HAIs. Possible revered causation may be one of the mechanisms why this prolonged length of stay is associated with HAIs. Moreover, there is evidence that HAIs cause a prolonged length of stay [61-65]. In our findings, the presence of underlying diseases, such as SAM, was recognized as the main risk factor for HAIs. This was consistent with the finding from another study in Ethiopia [24], that underlying illnesses increased the susceptibility of patients, and predisposed them to infections secondary to the reduction of the patient's immune response that exacerbated the illnesses thru which in many cases, had significant factors that contributed more to the acquisition of HAIs in neonates and pediatric patients [41, 66, 67].

Limitations of the study

Several limitations on this prospective study needed to be considered. First, we did not assess the healthcare workers' infection prevention practices that would have been associated with the prevalence of HAIs. Second, the researchers did not examine the number of HAIs after the patients were discharged. Third, despite that we followed the patients until their discharge, the full burden of HAI could not be captured in this specific study, and is limited to in-hospital assessment only, leaving outpatients whom may have potentially developed HAIs after discharge. Fourth, we focused on a small number of risk factors for hospital-acquired infections and some important variables were not included. Fifth, the used analysis does not take any time-varying risk into account. Sixth, since there were limited information on the patients' medical record folders more social determinant variables were not collected. In addition, this study is not free from the effects of information bias as we are not utilized 'blinding'. Another limitation of the study is that we could not adjust the results for the effect of social determinant variables on HAIs because the information on these social determinant variables was not collected in our study. Finally, laboratory cultures to isolate organisms as a guide were not utilized in addition to the clinical criteria to confirm the results of HAIs because of financial constraints, laboratory facilities, and expertise. Given the lack of microbiology data, endogenous infections may be misclassified as HAIs. Since the study was conducted in a teaching referral hospital, the generalization of the study findings was limited to these facilities.

Conclusions

The present study revealed that the cumulative incidence of hospital-acquired infections (HAIs) was 13 per 100 admitted children. And the overall incidence rate of HAIs was 17.75 per 1000 pediatrics days. Length of stay in the hospital and patients with severe acute malnutrition (SAM) conditions were associated with increased risk of hospital-acquired infections. Further studies are strongly recommended to identify other important factors including isolating of bacterial, fungal, and viral agents responsible for HAIs in the region.

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Contributors

BS has made substantial contributions to conception and design, acquisitions of data, analysis, and interpretation of data. He has written the draft manuscript and provided final approval of the version to be published. FS, DA, ENG, GN, AK, DW, YT, DZ, and BJEQ has made substantial contribution's as well, to design, acquisition of data and analysis, interpretation of data, and revisions of the the article, critically for important intellectual content and provided final approval of the version to be published. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval

Ethical clearance was obtained from the Ethical Review Committee of Madda Walabu University (Ref.No: RMW 14/66/64) and a formal letter from Madda Walabu University Research Community Engagement and Technology Transfer Vice President Office was submitted. Written consents from the parents/ legal guardians were obtained after explaining the objectives of the study. Identified pediatric patients having hospital-acquired infections were formally communicated to the physicians and nurses who were in charge of the patients for additional health care services. Throughout the data collection period, confidentiality and privacy of the patients were observed, and a unique identification code rather than their names were substituted.

Data sharing statement

Data will be available upon request from the corresponding authors.

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Table 1: Demographic and clinical characteristics of patients who participated in the study in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	n (%)
Patient age, Median (IQR): 8 months (2-26 months)		
Sex	Male	248 (55.4)
	Female	200 (44.6)
Ward	Neonatal Intensive Care Unit (NICU)	201 (44.9)
	Pediatrics	247 (55.1)
Resident	Urban	129 (28.8)
	Rural	319 (71.2)
Previous Hospitalization[a]	Yes	46 (10.3)
	No	402 (89.7)
Mechanical Ventilation	Yes	76 (17.0)
	No	372 (83.0)
Presence of peripheral intravenous (IV) catheter[b]	Yes	430 (96.0)
	No	18 (4.0)
Presence of Urinary Catheters	Yes	9 (2.0)
	No	439 (98.0)
Drainage Tube Inserted[c]	Yes	53 (11.8)
	No	395 (88.2)
Underlying Severe acute malnutrition (SAM) Diseases[d]	Yes	54 (12.1)
	No	394 (87.9)
Surgery After Admission	Yes	47 (10.5)
	No	401 (89.5)
Patient Received Antimicrobials[e]	Yes	171 (38.2)
	No	221 (49.3)
	Unknown	56 (12.5)
Severe Anemia	Yes	41 (9.2)
	No	375 (83.7)
	Unknown	32 (7.1)
Hospital Duration (median day)	≤ 6	237 (52.9)
	> 6	211 (47.1)
HIV status	Positive	2 (0.4)
	Negative	393 (87.7)
	Not tested	53 (11.8)
American Society of Anesthesiology (ASA) Classification	Normally health patient	72 (16.1)
	Patient with mild systemic diseases	235 (52.5)
	Severe systemic disease that is not incapacitating	100 (22.3)
	Incapacitating systemic diseases that is a constant threat to life	36 (8.0)

	Unknown	5 (1.1)
Gestational age (n=191)	< 37 weeks	83 (43.5)
	≥ 37 weeks	108 (56.5)
Birth weight (n=191)[f]	< 2500gm	46 (24.1)
	≥ 2500 gm	145 (75.9)

[a] History of the previous hospitalization for either the same as the current reason of admission or other ailments within the last 30 days

[b]Peripheral intravenous (IV) catheter: A peripheral intravenous (IV) catheter is inserted into small peripheral veins to provide access to administer IV fluids and medications.

[C]Drainage tube: insertion of a chest tube, endotracheal, and nasogastric (NG) intubation.

[d] Severe acute malnutrition (SAM) diagnosed at the time of hospital admission.

[e] The use of antimicrobials before admission either through intravenous (IV), intramuscular (IM) or oral (PO) administration.

[f]Any neonate weighting less than 2500 gm at birth irrespective of gestational age was considered low birth weight (LBW).

Table 2: Proportion of hospital-acquired infections among pediatric patients in Goba Referral Hospital, Ethiopia (n=57)

Hospital-acquired infections	Number	Proportion	95% CI
Pneumonia/ Lower Respiratory Tract Infections/ [a]	32	56.1	43.9-68.4
Late-Onset Neonatal Sepsis	6	10.5	3.5-19.3
Intravenous Line (IV) Site Infections	5	8.8	1.8-15.8
Urinary Tract Infections	4	7.0	1.8-14.0
Systemic Infections	4	7.0	1.8-14.0
Skin/Soft Tissue Infections	2	3.5	0.0-8.8
Measles	2	3.5	0.0-8.8
Early Onset Neonatal Sepsis	1	1.8	0.0-5.3
Surgical Site Infections	1	1.8	0.0-7.0

[a] including ventilator-associated pneumonia (VAP) (n=7) & VAP developed in 9.21% [7/76] of children undergoing mechanical ventilation; CI: Confidence Interval

Table 3: Bi-variate association of factors for the occurrence of hospital-acquired infections among pediatric patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)

Variables	Category	Presence of HAIs		Crude RR
		Yes (57)	No (391)	
Sex	Male	30	218	0.88(0.55-1.45)
	Female	27	173	1
Age (months)	1-12	33	252	0.78(0.48-1.28)
	>12	24	139	1
Residence	Urban	12	117	0.65(0.36-1.20)
	Rural	45	274	1
Hospital Duration (median day)	≤ 6	17	220	1
	> 6	40	171	2.64(1.54-4.51)*
Admission Unit	NICU	27	174	1.10(0.68-1.79)
	Pediatrics	30	217	1
Patient Received Antimicrobials	Yes	17	154	1
	No	27	194	1.22(0.69-2.17)
	Unknown	13	43	2.33(1.21-4.50)*
Previous Hospitalization	Yes	7	39	1.22(0.58-2.53)
	No	50	352	1
Mechanical Ventilation	Yes	12	64	1.30(0.68-2.71)
	No	45	327	1
Presence of Urinary Catheters	Yes	2	7	1.77(0.50-6.17)
	No	55	384	1
Drainage Tube Inserted	Yes	14	39	2.42(1.42-4.12)*
	No	43	352	1
Severe acute malnutrition (SAM)	Yes	13	41	2.15(1.24-3.73)*
	No	44	350	1
Surgery After Admission	Yes	4	43	0.64(0.24-1.69)
	No	53	348	1

RR: Risk Ratio; * p-value< 0.05 (Crude)

Table 4: Multivariable logistic regression analysis on factors associated with hospital-acquired infections among patients in Goba Referral Hospital, southeast Ethiopia 2019 (n=448)♣†

Variables	Category	Patient with HAIs (n=57)	Adjusted RR	Attributable Risk (AR)[a]
Hospital Duration	≤ 6	17	1	
	> 6	40	2.58(1.52-4.38)**	0.12
Patient Received Antimicrobials	Yes	17	1	
	No	27	1.25(0.71-2.19)	
	Unknown	13	1.93(0.84-4.42)	
Drainage Tube Inserted	Yes	14	1.77(0.88-3.54)	
	No	43	1	
Severe acute malnutrition (SAM)	Yes	13	2.83(1.61-4.97)**	0.13
	No	44	1	

♣Hosmer and Lemeshow Test (p=0.166); RR: Risk Ratio; ** p-value < 0.05 (adjusted)

† Adjusted for age, sex, admission unit, mechanical ventilation, and presence of a urinary catheter

[a]Attributable risk is the difference between the risk HAIs in the exposed group and the unexposed group.

Figure Legends

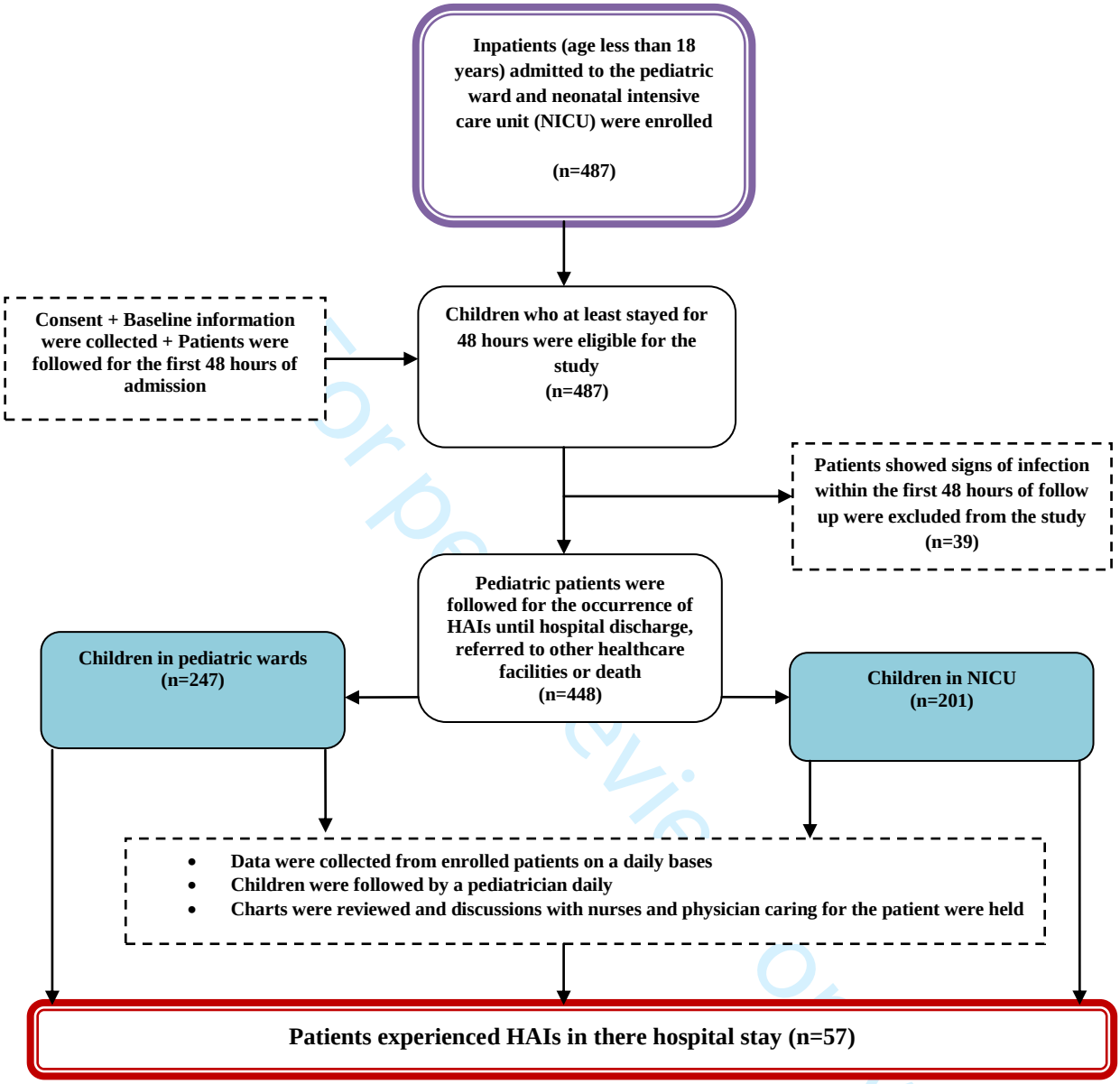
Figure 1: A flow chart of sampling procedure.

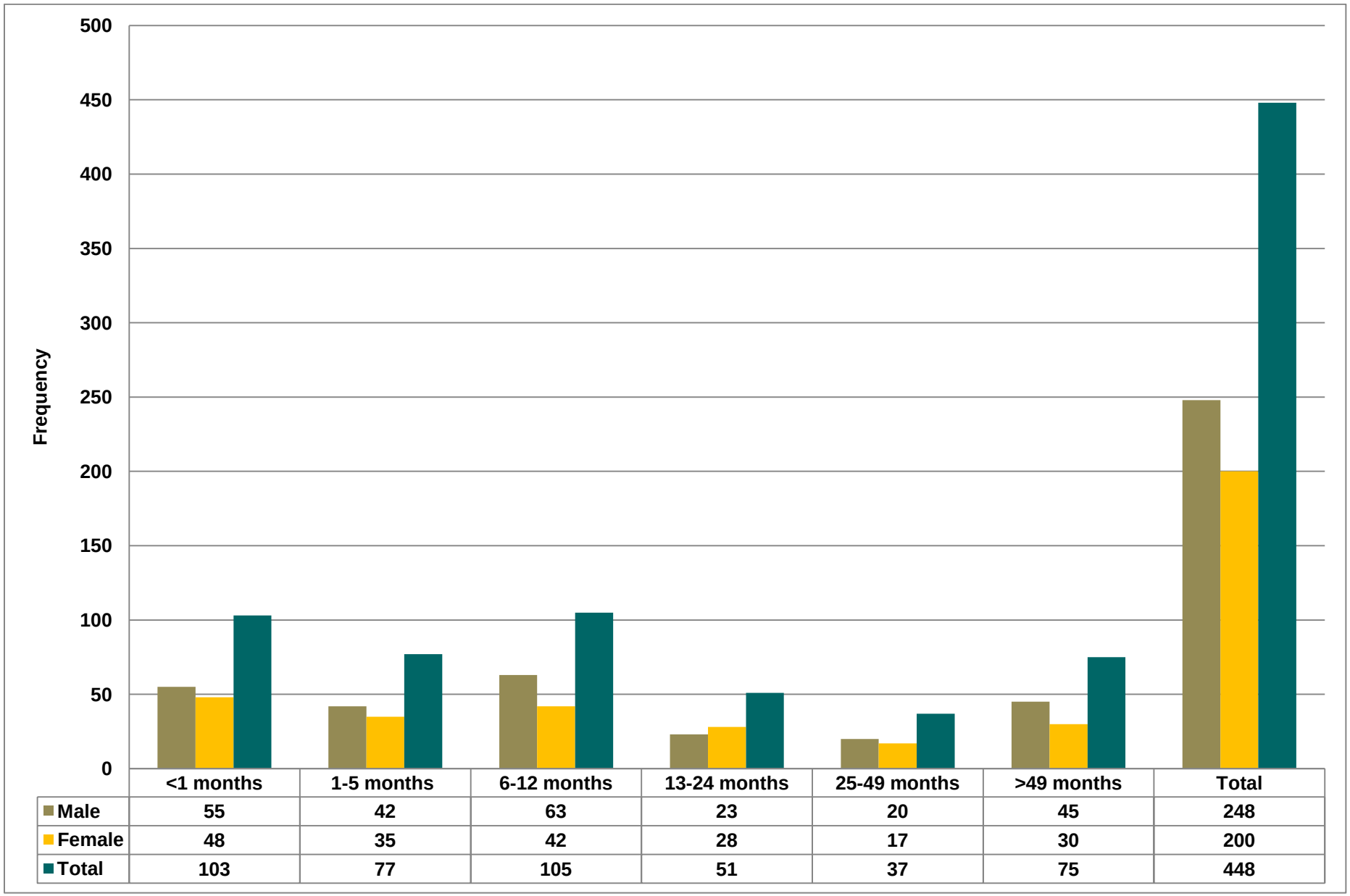
Figure 2: Bar graph showing the age distribution of study participants by sex.

Figure 3: Bar graph showing the type of HAIs by type of admission ward.

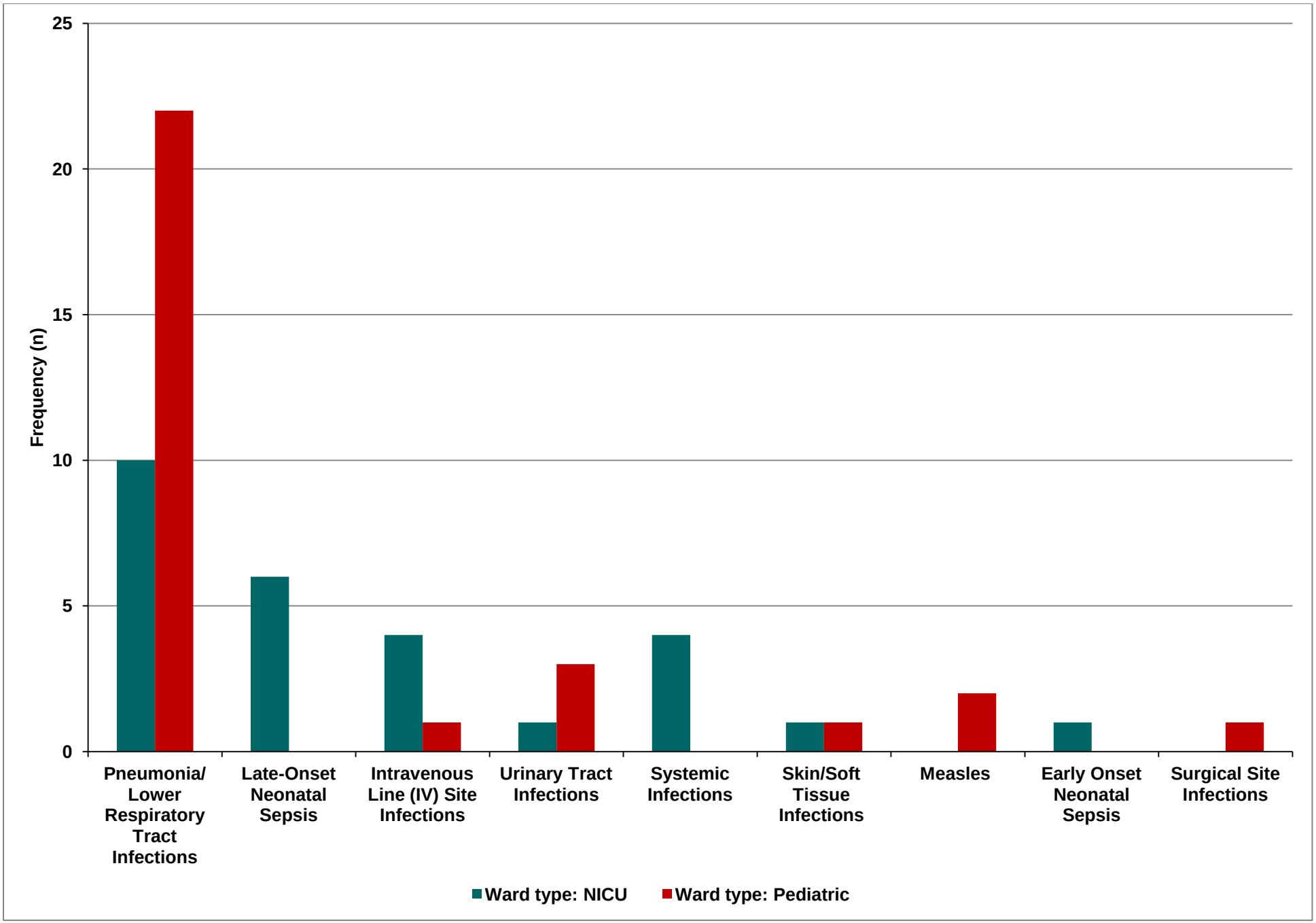
Additional Files

S1 File: English version of the survey questionnaire


Inpatients (age less than 18 years) admitted to the pediatric ward and neonatal intensive care unit (NICU) were enrolled
(n=487)
Consent + Baseline information were collected + Patients were followed for the first 48 hours of admission
Children who at least stayed for 48 hours were eligible for the study
(n=487)
Patients showed signs of infection within the first 48 hours of follow up were excluded from the study
(n=39)
Pediatric patients were followed for the occurrence of HAIs until hospital discharge, referred to other healthcare facilities or death
(n=448)
Children in pediatric wards
(n=247)
Children in NICU
(n=201)
Data were collected from enrolled patients on a daily bases
Children were followed by a pediatrician daily
Charts were reviewed and discussions with nurses and physician caring for the patient were held
Patients experienced HAIs in there hospital stay (n=57)



	<1 months	1-5 months	6-12 months	13-24 months	25-49 months	>49 months	Total
Male	55	42	63	23	20	45	248
Female	48	35	42	28	17	30	200
Total	103	77	105	51	37	75	448


25
20
15
10
5
0
Frequency (n)
Pneumonia/ Lower Respiratory Tract Infections
Late-Onset Neonatal Sepsis
Intravenous Line (IV) Site Infections
Urinary Tract Infections
Systemic Infections
Skin/Soft Tissue Infections
Measles
Early Onset Neonatal Sepsis
Surgical Site Infections
Ward type: NICU
Ward type: Pediatric

Data collection tool

1. Patient ID/CODE _____
2. Ward_____ Bed number _____MRN_____
3. Age _____
4. Sex _____
5. Residence A. Urban_____ B. Rural_____
6. Reason for admission/Dx at the time of admission_____
   _____
   _____
7. Complete admission diagnoses _____
8. Date of admisstion_____
9. Patient health condition at the time of admission
   _____
   _____
   _____
10. Is there any other localized infection? Yes No
11. If yes, type of treatment given_____
12. Previous hospitalization Yes No
13. If yes for question 14:
    a. Place (including ward) _____
    b. Time (month/year) _____
    c. Duration_____
14. Previous antibiotic use for the current illness A. Yes_____ B. No_____
15. If yes for question 15, specify_____
16. If yes for question 15, for how many days? _____days
17. Being on mechanical ventilator? A. Yes_____ B. No_____
18. Presence of intravenous line? A. Yes_____ B. No_____
19. Presence of urinary catheters? A. Yes_____ B. No_____
    If yes, for how long_____
20. Indication for catheterization _____

21. Drainage inserted ? A. Yes_____ B. No_____

If yes, for how long _____

22. Indication for drainage _____

23. Presence of invasive medical devices? A. Yes_____ B. No_____

24. If yes for questions 20,21,22,26 (more than one answer is possible)

A. Endotracheal tube? A. Yes_____ B. No_____

B. NGT A. Yes_____ B. No_____

C. Chest tube A. Yes_____ B. No_____

25. Peripheral intravenous line (IV) catheter A. Yes_____ B. No_____

26. Insertion of a urinary catheter A. Yes_____ B. No_____

27. Intubation A. Yes_____ B. No_____

28. Underlying diseases? A. Yes_____ B. No_____

29. If yes, underlying diseases (more than one answer is possible)

i. Diabetes mellitus
ii. Chronic renal failure
iii. Hypertension
iv. Chronic liver disease
v. HIV/AIDS
vi. Cardiac disorders
vii. Severe malnutrition (SAM)
viii. TB
ix. Cancer
x. Others (specify)

30. Surgery since admission A. Yes_____ B. No_____

31. Surgical procedure done? A. Yes_____ B. No_____

If yes for question 36,

A. Type of surgery A. Elective_____ B. Emergency_____

B. Type of the procedure_____

C. Date _____ Time_____

D. Duration of the surgery _____hours

E. Type of surgical wound A. Clean B. Clean contaminated C. Contaminated D. Dirty

32. Antibiotic prophylaxis given? A. Yes_____ B. No_____

If yes for Q36, specify/name of antibiotic_____

If yes for Q36, how many doses? _____

33. Duration of stay hospital stay in days _____

34. Severe anaemia [haemoglobin <50 g/L (for patients older than 28 days) or haemoglobin <90 g/L (for neonates)]

A. Yes_____ B. No_____ C. Unknown/not tested_____

35. Immune deficiency A. Yes_____ B. No_____ C. Unknown/not tested_____

36. Nutritional status WAZ score (Weight-for-age Z score) A. >-3 B. -3 to 4 C.<-4

37. McCabe score

A. Non-Fatal diseases
B. Ultimately fatal diseases
C. Rapidly fatal diseases
D. Unknown

38. American Society of Anesthesiology (ASA) classification

a. Normally health patient
b. Patient with mild systemic diseases
c. Patient with severe systemic disease that is not incapacitating
d. Patient with incapacitating systemic diseases that is a constant threat to life
e. Unknown

39. HIV status A. Reactive B. Non-reactive C. Unknown

40. Presence of HAIs based on CDC definition:

_____

_____

41. Type of HAIs:

_____

_____

Name of data collectors : _____ Signature _____date

Name of supervisor_____ Signature _____ date

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	NA

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.