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Incidence and Risk factors of Hospital-Acquired Infections in Pediatrics Patients. A Prospective Study at Tibebe Ghion Specialized Hospital, Ethiopia, 2022

Yibeltal, Liben

BAHIRDAR UNIVESITY

COLLEGE OF MEDICINE AND HEALTH SCIENCE,

SCHOOL OF MEDICINE, DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

INCIDENCE AND RISK FACTORS OF HOSPITAL-ACQUIRED INFECTIONS IN PEDIATRICS PATIENTS. A PROSPECTIVE STUDY AT TIBEBE GHION SPECIALIZED HOSPITAL, ETHIOPIA, 2022

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A RESEARCH THESIS SUBMITTED TO COLLEGE OF MEDICINE AND HEALTH SCIENCE, DEPARTEMENT OF PEDIATRICS AND CHILDHEALTH IN THE PARTIAL FULFILMENT OF THE REQUIREMENTS FOR SPECIALTY CERTIFICATE IN PEDIATRICS AND CHILD HEALTH.

ADVISORS:

DR SENAY ZERIHUN (MD, ASSISTANT PROFFESSOR OF PEDIATRICS & CHILD HEALTH)

Mr. AMSALU BIRARA (ASSISTANT PROFFESSOR, MPH)

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Candidate's Declaration Form

This is to certify that the thesis entitled **"Incidence and risk factors of hospital-acquired infections in pediatrics patients. A prospective study at Tibebe Ghion specialized hospital, Ethiopia, 2022"** in partial fulfillment of the requirement for certificate of specialty in pediatrics and child health in College of Medicine and Health Sciences, Department of pediatrics and child health, Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation have been duly acknowledged.

Name of the student: Dr Yibeltal Liben (MD, Pediatrics & Child Health resident)

Signature _____ Date: _____

[redacted]

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COLLEGE OF MEDICINE AND HEALTH SCINCES

DEPATMENT OF PEDIATRICS AND CHILD HEALTH

Approval of Thesis for Defense

We hereby certify that we have supervised, read, and evaluated this thesis titled **"Incidence and risk factors of hospital-acquired infections in pediatrics patients. A prospective study at Tibebe Ghion specialized hospital, Ethiopia, 2022"** by **Dr Yibeltal Liben** prepared under my guidance. I recommend the thesis be submitted for oral defense.

Advisors Name	**Signature**	**Date**
Dr. Senay Zerihun (MD, Assistant Professor of Pediatrics & Child Health)		05/03/2015
	Signature	**Date**
Mr. Amsalu Birara (MPH, Assistant Professor)	_____	_____
Department Head Name	**Signature**	**Date**
Dr. Senay Zerihun (Assistant Professor of Pediatrics & Child Health)		05/03/2015

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ABBREVIATIONS

AMR	Anti-Microbial Resistance
BSI	Blood Stream Infection
CPAP	Continuous Positive Airway Pressure
CSF	Cerebrospinal Fluid
HAIs	Hospital Acquired Infections
HCAIs	Hospital Care Associated Infections
ICU	Intensive Care Unit
MDR	Multi-drug Resistance
NGT	Naso-Gastric Tube
NI	Nosocomial Infection
NICU	Neonatal Intensive Care Unit
PICU	Pediatric Intensive Care Unit
SPSS	Statistical Package for Social Science
SSI	Surgical Site Infection
TGSH	Tibebe Ghion Specialized Hospital
USA	United States of America
UTI	Urinary Tract Infections
WHO	World Health Organization

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ABSTRACT

Background: Hospital-acquired infections occur worldwide and affect both developed and resource-poor countries. Certain patients are at increased risk because of the severity and possible immunosuppressive nature of their illness, and their need for invasive monitoring and life support equipment.

Objectives: This study is aimed to determine the incidence and risk factors of hospital-acquired infections among admitted Pediatrics patients in Tibebe Ghion specialized Hospital in 2022.

Methods: A hospital-based prospective follow-up study was conducted from May1- August 1 2022 among pediatrics age group patients in Tibebe Ghion Specialized Hospital. All pediatrics patients admitted in (Pediatrics intensive care unit, Neonatal intensive care unit and General Ward) during the study period were included in the study. Data was collected through a structured checklist using an individual patient chart investigation approach after verbal assent was taken and data was coded and entered using Epinfo7 statistical software and exported to SPSS version 25 for analysis. Descriptive statistics and logistic regression were computed. Odds ratio with 95% confidence interval was computed to assess the presence and degree of association between dependent and independent variables by using multivariable logistic regression analysis.

Result: A total of 591 Pediatric patients were followed for 5805 patient days. The median age of the patients was 1.8 months. The incidence rate of hospital acquired infection was 17.4 per 1000 Pediatric days of follow- up; while the overall cumulative incidence was 17.1 % over 3 months. Children who stayed greater than 8 days in the hospital (median day) (AOR: 28.1, 95% CI 9.71-81.38), children with underlying disease conditions (AOR: 4.93, 95% CI 2.44 to 9.97) and children with invasive medical device (AOR= 9.4, 95% CI: 5.04-17.68) had higher risks of developing HAIs. The most common type of hospital acquired infection was hospital acquired pneumonia and the most common etiologic agents were CONS & Klebsiella pneumoniae.

Conclusion& recommendation: The overall cumulative incidence of HAIs was 17.1 per 100 admitted children. Length of stay in the hospital, underlying health conditions and presence of invasive medical devices were found to be important factors associated with increased risk of hospital acquired infection. Therefore the hospital management and clinicians should give

attention to patients with underlying chronic medical condition for the prevention and control of hospital-acquired infections.

1. INTRODUCTION

1.1 Background

Hospital-acquired infections (HAIs) occurring in hospitals are defined as infections not present or incubating at the time of admission that develops during admission or less than one incubation period after discharge. In practice, infections with an onset 48 h or more after admission are assumed to be HAI unless the infection is community-acquired and follow-up surveillance one week after discharge should be sufficient to detect infections that were not apparent during admission(1).

Hospital-acquired infection (HAIs) is a global health challenge, not only as an issue of patient safety but also as a major driver of antimicrobial resistance (AMR). The emergence and spread of AMR threaten effective control and treatment of various infections worldwide(2, 3).

These infections, often caused by multidrug-resistant organisms, take a heavy toll on patients and their families by causing illness, prolonged hospital stay, potential disability, excess costs, and sometimes death(4, 5).

Certain patients are at increased risk because of the severity and possible immunosuppressive nature of their illness, and their need for invasive monitoring and life support equipment(1).

Although prevention and evolution of HCAI and the reduction of the occurrence of AMR globally have been a primary focus of WHO little has been done to combat it in Africa (6, 7).

Thus, HCAIs are major causes of preventable morbidity and mortality in low- and middle-income countries where infection rates are relatively higher due to poor infection control practices, inappropriate use of limited resources, under-staffing of healthcare facilities and overcrowding of hospitals(8).

A study on epidemiologic surveillance of nosocomial infections in a Pediatric Intensive Care Unit of a developing country concluded that, one of every 5 children acquires an NI in the PICU. Its presence was associated with increased mortality and length of stay. At the same time a longer stay was associated with an increased risk of developing NI. The median length of stay (LOS) in ICU for children without NI was 6 days whilst in those with NI it was 23 days(9).

Different studies conducted in Gabon and Ethiopia showed that most common type of HAIs are urinary tract infections (usually catheter associated) (31%) followed by surgical site infections (SSIs) (17%), primary bloodstream infections (BSIs) (usually associated with the use of an intravascular device) (14%), and pneumonia (usually ventilator associated) (13%) (10, 11).

1.2 Statement of the problem

Hospital-acquired infections occur worldwide and affect both developed and resource-poor countries. Infections acquired in health care settings are among the major causes of death and increased morbidity among hospitalized patients. They are a significant burden both for the patient and for public health. They add to the functional disability and emotional stress of the patient and may, in some cases, lead to disabling conditions that reduce the quality of life(12).

Hospital-acquired infections are also one of the leading causes of death. The economic costs are considerable, the increased length of stay for infected patients is the greatest contributor to cost(13).

Hospital-acquired infections increase morbidity, mortality, long-term disability, upsurges the financial burden on the healthcare system, hospital stay, microbial resistance to antibiotics, and healthcare costs for patients and their families (14-17).

Children admitted to the pediatric intensive care unit (PICU) are particularly vulnerable to HAI because of their immunocompromised and the high prevalence of use of invasive devices during their stabilization(18).

Hospital-acquired infection (HAI) is the most frequent complication of hospitalization affecting 4-8% of pediatric admissions in high-income settings (19-21). Studies of pediatric inpatients in low/middle-income countries (LMIC) since 2000 also document substantial HCAI prevalence and incidence densities: 22.6% and 29 per 1000 patient-days in Indonesia, 15.4% and 9.2 per 1000 patient-days in Brazil, 15 per 1000 patient-days in Mexico, 21% in Uganda and 12.7% in Ethiopia(22-25)

Globally, it is estimated that hundreds of millions of patients every year in both developed and developing countries are affected by HAIs(26). According to 2019 WHO HCAI fact sheet report, a hundred million patients were affected each year globally and the point prevalence of HCAI was estimated in the ranges between 3.5–12% and 5.7–19.1% in developed and low- and middle-income countries, respectively(27).

In Europe, in 2011–2012 the total annual number of patients with HAIs was estimated at around 3.2 million and prevalence of patients with at least one HAI in acute care hospitals was 6.0% (country range 2.3%–10.8%) (28). Moreover, throughout Europe, HAIs accounted for 16 million additional days, with total costs estimated at approximately 7 billion Euro (29, 30)

In the USA, approximately 2 million patients developed HAIs, and nearly a hundred thousand of these patients were estimated to die annually(31). Hospital-acquired infection (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(32).

In some developing countries, the magnitude of HAIs remains underestimated and uncertain and there is little information available on the epidemiology of HAIs in African countries (6, 29, 33). Although data are sparse, evidence suggested that HAIs are considerably adding to the available high burden of infections in some sub-Saharan African countries (34).

A systematic review by Nejad et al reported that hospital wide HAI prevalence in Africa varied between 2.5% and 14.8% (29). This review has shown that paucities of information available among the epidemiology of HAIs in many African countries and concluded as there is an urgent need to identify and implement feasible and sustainable approaches to strengthen HAI prevention, surveillance and control in Africa. In addition to this, a review by Irek et al indicated that there was a scarcity of studies on HAIs in Africa (6). Moreover, most of the HAIs literature only focused on adults, and the data on HAIs among the pediatric population in sub-Saharan Africa were hardly available (29, 30, 35). For example, a systematic review conducted by the WHO in the year 2010 identified no reports on pediatric nosocomial bacteremia in some African countries between 1995 and 2008 (30).

In Ethiopia, little is known about the incidence and prevalence of HAIs in the neonatal and pediatrics populations. Moreover, previously conducted studies focused only on adults, and many of these were limited to surgical site infections (14, 17, 36-39) with an estimated prevalence

of 10.9%(37) to 66.5%(17).

Till now, there are no surveillance programs at the regional or national levels that targeted HAIs in Ethiopia. Moreover, to the best of my knowledge, there is only a single published report on the incidence and risk factors of HAIs among pediatric patients in Ethiopia. To maximize the prevention of 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 is designed to determine the incidence and risk factors of HAIs among pediatric patients in Bahir Dar, TGSH, and North West Ethiopia.

1.3 Significance of the study

Hospital-acquired infections (HAIs) cause significant morbidity and mortality so that it becomes a serious problem in the health care facility throughout the world due to the emerging of antibiotic resistant organisms and the increasing financial cost for treatment and staying in the hospital.

So, a study in this area in Ethiopia specifically in TGSH will help to know the magnitude of the disease and the possible source of health care related infection.

Up on that, it provides information for Tibebe Ghion specialized hospital, to take appropriate measures to prevent the infection and the type of antibiotic that is used to treat the commonly existing bacteria in the hospital.

Besides, it will help to develop institution level policy and guidelines for the overcoming of health care-related challenges as a country

The current study will help policymakers at TGSH to improve their decision-making and inputs for healthcare professionals, for the improvement of patient care

2. LITERATURE REVIEW

Hospital-acquired infections (HAIs) are a significant public health problem around the world. According to published national or multicenter studies of systematic reviews of the literature on endemic HCIs from 1995 to 2010 in high- and low/ middle-income countries showed HAIs prevalence in mixed patient populations was 7.6% in high-income countries and in low/middle income countries varied from 5.7% to 19.1% with a pooled prevalence of 10.1%.(15).

In 2002, in U.S. hospitals, adjusted to include federal facilities, the estimated number of HAIs was approximately 1.7 million: The estimated deaths associated with HAIs in U.S. hospitals were 98,987 of these, 35,967 were for pneumonia, 30,665 for blood stream infections, 13,088 for urinary tract infections, 8,205 for surgical site infections, and 11,062 for infections of other sites(31)

The second study also conducted in USA between February 2010 and October 2010 in cardiac surgery patients, among 4,320 cardiac surgery patients, 119 (2.8%) experienced a major HAI during the index hospitalization. The most common HAIs were pneumonia (48%), sepsis (20%), and Clostridium difficile colitis (18%). The incremental LOS was 14 days. The cost of readmissions due to major HAIs was, on average, nearly threefold that of readmissions not related to HAIs (40)

The European Centre for Disease Prevention and Control (ECDC) estimated that the prevalence of HAIs varied from 4.8% in primary hospitals to 7.2% in tertiary hospitals. HAI prevalence was highest in patients admitted to ICU, where 19.5% patients had at least one HAI compared with 5.2% on average for all other specialties combined. According to this study the most frequently reported HAI types were respiratory tract infections (pneumonia 19.4%), surgical site infections (19.6%), urinary tract infections (19.0%), bloodstream infections (10.7%) and gastro-intestinal infections (7.7%)(28).

A study conducted in Bangladesh among the Pediatric Patients in Tertiary Level Hospitals of Dhaka City, showed that the prevalence of HAI was10.9%. A higher prevalence (14.0%) of Hospital-acquired Infections (HAI) was found in surgery ward and the lower prevalence (9.2%) of HAI was found in the medical ward(41).

A study in Brazil on risk Factors for developing nosocomial infections among pediatric patients the overall incidence of NI cases was 9.2 per 1,000 patient-days, with higher rates among children aged less than 1 and those with nonsurgical clinical diseases. The factors most closely associated with higher incidence of NI were respiratory disease on admission, another disease associated with admission diagnosis, nonsurgical clinical disease and pediatric intensive care unit residence. The lengths of hospital stay for patients with and without nosocomial infection were, respectively, 14.1 days and 5.1 days. The study concluded that Nosocomial infections are not necessarily related to invasive procedures but certainly are related to a group of factors that have particular characteristics in the pediatric age group(42).

Another study conducted in Brazil showed that, underlying conditions, chronic neuropathy (18.1%) congenital heart disease (14.0%) and neoplasia (10.3%) were significantly associated with HAI. According to this study the most common sites of HAIs were bloodstream infection (BSI), pneumonia and urinary tract infection (UTI), responsible for 31%, 20% and 20% of all cases, respectively(43).

A study on healthcare-associated infections in Pediatric and neonatal intensive care units conducted Brazil and Italy in 2016 shows, the cumulative incidence of HAI was 3.6/100 ICU admissions. In this study factors independently associated with an MDR-HAI were previous antibiotics, transplantation, major surgery, and colonization by an MDR strain(44).

Study conducted on prevalence of Hospital acquired Infections in pediatric wards in Iran revealed that the average prevalence of HAIs in pediatric wards was 7.77%, while it was 11.38% for the whole hospital. The most prevalent HAIs in the whole hospital and in pediatric wards were urinary tract and blood stream infections, respectively(45).

A Prospective Cohort Study in USA on Risk Factors for Nosocomial Infections in a Critically Ill Pediatric Population showed that device-utilization ratio, total parenteral nutrition and length of stay were associated with nosocomial infections(46).

In the General Pediatric Wards of a Hospital in Turkey showed that, the NI rate was 3.02, and the NI density was 3.17/1,000 patient days. The most frequent NIs were lower respiratory system infections, blood stream infections, and urinary tract infections. Gram-negative organisms were the most frequently isolated agents (47).

A study conducted in Hospital Acquired Infections in Pediatrics Unit at Butare University Teaching Hospital showed that the prevalence of HAI was 12.1 % and pneumonia were the most prevalent(48).

In South Africa, in the non-ICU, PICU and NICU setting, there were an incidences of 7, 15.3 and 21.6 HAIs per 100 admissions respectively(49).

The study in Kenya showed the overall risk of nosocomial infections during the study period was 5·9/1000 admissions, mortality in patients with nosocomial infection was 53%, compared with 24% in community-acquired infections. Nosocomial infection was significantly associated with severe mal nutrition and blood transfusion in children without severe anemia(50).

A study conducted in southeast Ethiopia showed that, the overall cumulative incidence was 12.7% over 8 months. Children who stayed greater than 6 days in the hospital and children with underlying disease conditions of severe acute malnutrition had higher risks of developing HAIs (25).

A study conducted in Jimma on HCAIs, showed that the incidence rate of hospital acquired infection was 28.15 per 1000 patient days while the overall prevalence was 19.41%. This study also showed that HAIs was significantly associated with presence of underlying diseases and longer duration of hospital stay (51).

A multicenter study in Europe, revealed that, the overall incidence of NI was 2.5%, ranging from 1% in general pediatric units to 23.6% in PICUs(52).

A four year surveillance in Turkey showed that, the overall HAI rate was 22.24%, and the incidence density was 20.71 per 1,000 patient-days. The most commonly observed HAIs were bloodstream infection (35.7%), pneumonia (21.4%), and urinary tract infection (20.5%)(53).

A study Prevalence, Clinical Profile and Risk Factors of Nosocomial Infection in Ayder Pediatric Intensive Care Unit showed that the total prevalence of HAIs was 20% and presence of invasive

medical devices and longer duration of hospital stay were significantly associated with development of HAIs(54).

The Prevalence of Nosocomial Infections and Associated Risk Factors in Pediatric Patients in Tikur Anbessa Hospital revealed that, the commonest infection was pneumonia 39.8% (55).

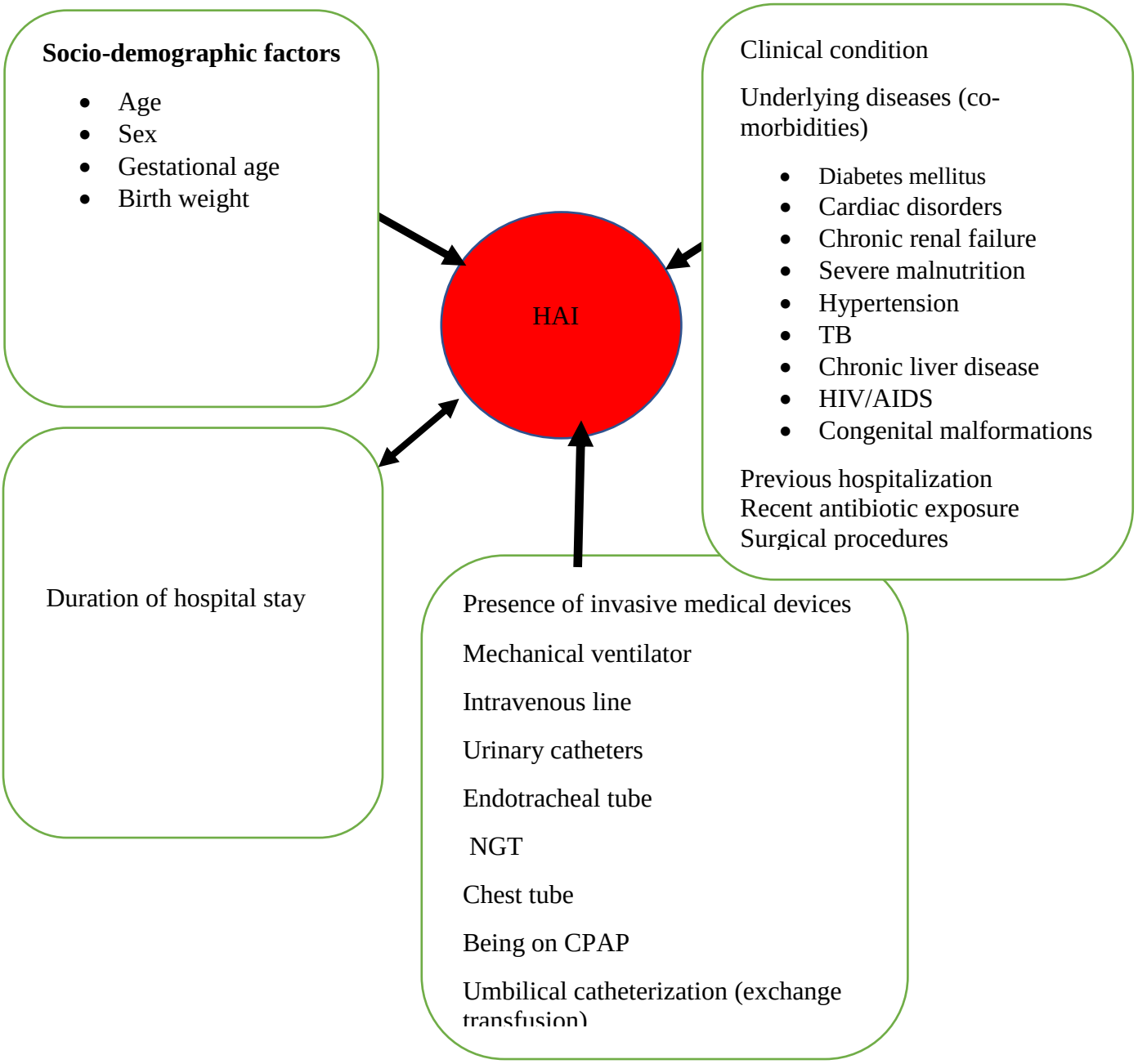

Figure 1: Conceptual frame work in the assessment of incidence and risk factors of hospital acquired infections among admitted pediatrics patient in TGSH in 2022

3. OBJECTIVE

3.1 General objective

To assess the incidence and risk factors of hospital-acquired infections among admitted pediatrics patient in TGSH

3.2 Specific objectives

To assess the incidence of hospital-acquired infection among admitted pediatrics patients in TGSH

To identify the risk factors for hospital-acquired infection among admitted pediatrics patients in TGSH

4. METHODS AND MATERIALS

4.1 Study design and setting

A hospital-based prospective follow-up study was conducted from 1 May 2022 to 1 August2022, at Tibebe Ghion specialized Referral Hospital, North West Ethiopia. Tibebe Ghion Referral Hospital is one of the two referral and the only teaching hospital in Bahir Dar town, serving over 5 million people. Tibebe Ghion Referral Hospital is located 645 km far from Addis Ababa the capital city of Ethiopia. According to the 2012 E.C annual report of Tibebe Ghion Referral Hospital, the average annual admission is over 93,000 patients, of which 3720 were admitted in the pediatric ward, PICU and neonatal intensive care unit (NICU). The hospital has a total of 459 inpatient beds—of which 52, 58 and 2 are in the pediatric ward PICU and NICU, respectively.

4.2 Study population and subject

4.2.1 Source Population

All pediatric patient (<15years) who admitted at Tibebe Ghion Referral Hospital

4.2.2 Study subject

Patients younger than 15 years of age with a minimum inpatient stay of 48 hours and admitted in Pediatric ward, PICU and NICU were the study population.

4.3 Inclusion and exclusion criteria

4.3.1 Inclusion Criteria

Pediatric patient with age <15 years admitted to pediatrics ward, NICU, PICU and stayed for at least for 48 hours.

4.3.2 Exclusion Criteria

Pediatric patient with age <15 years who are diagnosed to have HAIs and referred from other health institutions.

4.4 Study variables

4.4.1 Dependent variable

Incidence of Hospital-acquired infections

4.4.2 Independent variable

Socio-demographics characteristics

Age

Sex

Gestational age

Birth weight

Residency

Clinical and other related variables

Previous hospitalization

Duration of hospitalization

Insertion of a urinary catheter

Presence of peripheral intravenous catheter

Mechanical ventilator (Intubation

Nutritional status

Major or minor surgery after admission

Chronic co-morbidities

Received recent antimicrobial within three months

Being on continuous positive airway pressure

Exchange transfusion procedures

4.5 Measurement and Data collection

4.5.1 Sample Size determination

All patients admitted and full fill the inclusion criteria in the study period were included.

4.5.2 Sampling method

All patients who full fill the inclusion criteria were included (figure 2).

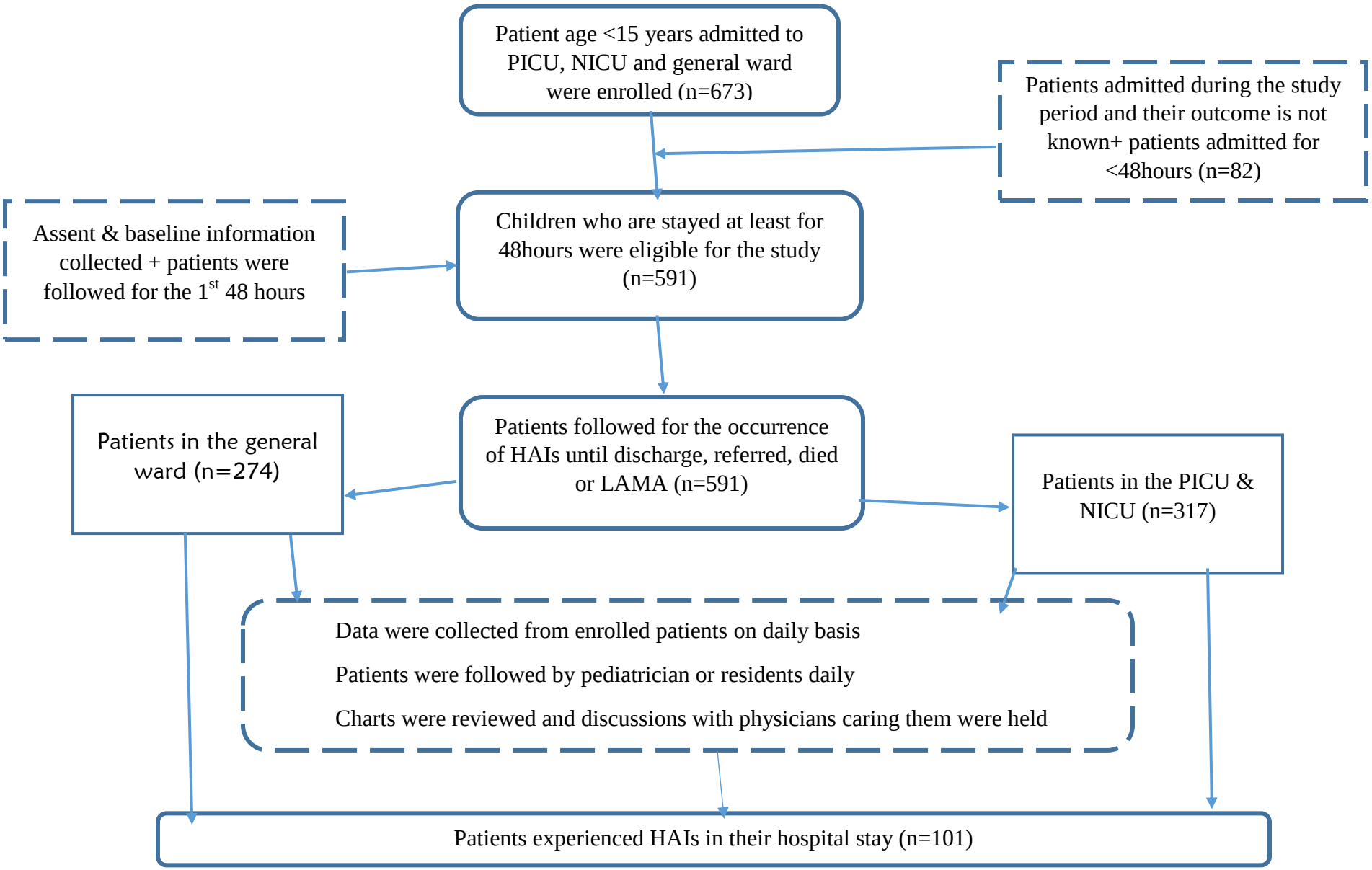

Figure 2: A flow chart of sampling procedure. HAIs, hospital- acquired infections

4.5.3 Data collection procedures

First, assent was taken from each of the child's parents/ guardians before commencing any study procedures.

On admission, all children were evaluated clinically. Afterwards, socio-demographic and clinical data were collected through a structured checklist using an individual patient chart investigation approach, accordingly, a detailed clinical history of patients was 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 was collected from enrolled patients daily: children were followed daily, charts were reviewed, and discussions with physician caring for the patients were held. HAIs were confirmed by pediatrician specialists or residents working in the respective NICU, PICU and Pediatric ward.

Data was collected by trained medical internship students. The Centers for Disease Control and Prevention (CDC)/National Health Care Safety Network surveillance definition for HAIs and physician clinical judgments what is practiced is in the hospital were used. 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.

4.6 Data quality control

The data collection tool was adopted from different related pieces of literature based on the available evidences of HAIs. To ensure the quality of data, the data collection tool was pretested at FHCSH with 10% of the sample size, before the data collection period. Training was given a half day 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 was checked for completeness, accuracy and consistency. In order to minimize the potential effects of confounder variables, multivariable logistic regression model was used, and analyses was adjusted to known confounders.

4.7 Data analysis method & interpretation

Statistical analysis was done by using SPSS 25 software. Descriptive statistics were computed to present the frequency distribution of important variables. The cumulative incidence (incidence proportion) was calculated as the number of new HAI 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 (3 months). The incidence rate was estimated as the number of HAI 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 3 months. The incidence rate of HAIs was reported per 1000 patient days.

The association between the dependent and independent variables were examined by binary logistic regression. Variables that showed significant association in bivariate logistic regression with P value <0.25, were a potential candidate for multivariable logistic regression analysis to control confounders in regression models.

All these analysis methods were help to determine the risk of infection due to health care service and the incident rate of infection in the hospital.

4.8 Ethical Consideration

Ethical clearance was sought from Bahir Dar University, college of medicine and health science, ethical review committee. After explaining about the purpose and the possible benefit of the study, permission to gather data was obtained from the medical directors of Tibebe Ghion referral hospital and head of each unit. Parents/guardians were informed about the objective and purpose of the study and oral assent obtained from each respondent. Confidentiality of information were maintained.

4.9 Dissemination plan

The result of the study will be submitted to Bahir Dar University, college of medicine and health science.

It will also be disseminated to the TGSH and the respective health institutions & other concerned and interested organizations through presentations, hard and soft copy.

4.10 Operational definition

HAIs: Is an infection develops after 48 hours of admission which was not present at the time of admission.

Presence of invasive medical devices: the presences of one or more of the following medical device; mechanical ventilation, umbilical catheterization, chest tube, NG tube, urethral catheterization, ventriculo-peritoneal shunt.

Under lying medical condition: the presence of one or more of the following chronic medical conditions; congenital or acquired cardiac conditions, systemic hypertension, sever acute malnutrition, retroviral infection, CKD, CLD, congenital malformations (neural tube defects, omphalocele, gastroschiasis)

Previous admission: history of admission for the current or any other problems with in the past three months at any health institution at least for 48 hour.

Previous use of antibiotics: use of any form of antibiotics for the current problem.

5. RESULT AND DISCUSSION

5.1 Result

As shown in the table below, a total 591 Pediatric patients were included during the study period of which 76.1 % of them were from rural areas. Males cover the majority of admission 323(54.7%). During the time of admission majority of patients were admitted before 5th years of their age which accounts 89.3%. The minimum age of admission is 7 hours and the maximum was 14 years. The mean age of admission was 1.8 years. In terms of place of admission during the study period about 47 .7% were admitted in the neonatal intensive care unit and 5.9% were admitted to PICU (Table1).

Table 1: Sociodemographic characteristics of Pediatrics patients who were admitted in TGSH from May1- August 1 /2022

Variables	Frequency, n=591	Percent
Address		
Rural	450	76.1
Urban	151	23.9
Sex		
Male	323	54.7
Female	268	45.3
Age		
<1 month	282	47.7
1-12 month	109	18.5
1-5 years	127	21.4
5-10 years	47	8
>10years	26	4.4
Place of admission		
NICU	282	47.7
Ward	274	46.4
PICU	35	5.9

Clinical characteristics

Most patients during the study periods do not have previous history of hospitalization which accounts 81.7%. Only 18.3% patients were having previous hospitalization in the past three months with a mean day of 6.8 days. Off those who had history of hospitalization majority of patients were admitted in primary hospitals which accounts 84.2% and the remaining 15.8% were admitted at TGSH. Among the admitted patients 125(21.2%) of the patients were having one or more invasive medical devices like, Mechanical ventilations, CPAP, Chest tube, nasogastric tubes, urinary catheter and umbilical catheter. The majority of invasive medical device was NGT accounted by 41.8% followed by CPAP, and the least was umbilical catheter which was 1.6%.

Regarding to underlying medical diseases 16.6% were had one or more chronic underlying medical problems at the time of admission. Off which 35.2%, 29.6%, 24.1% were having cardiac conditions, congenital malformations and sever acute malnutrition respectively.

Among the admitted patients during the study period 6.4% were underwent surgical procedures, off which 79% were emergency and 21% were elective surgery.

With regard to the length of hospital stay majority of the patients during the study period were stayed less than 7 days which accounts about 60%. The minimum length of hospital stay is 3 days and the maximum was 60 days. The median day of total hospital stay during the study period was 8 day (Table 2).

Table 2: Clinical characteristics of Pediatrics patients who were admitted in TGSH from May1-August 1 /2022

Variables	Frequency, n=591	Percent
Previous hospitalization		
Yes	108	18.3
No	482	81.7
Presence of invasive medical device		
Yes	125	21.2

No	466	78.8
Presence of underlying diseases		
Yes	98	16.6
No	493	83.4
Surgical procedure done		
Yes	38	6.4
No	553	93.6
Length of hospital stay		
<8 days	353	59.7
>8days	238	40.3

Incidence and type of Hospital acquired infection

During the study period, 591 Pediatric patients were followed for a total of 5805 patient days. A total of 101 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 is 6.4 patient days.

The overall incidence rate of HAIs was 17.4 per 1000 Pediatric days of follow- ups, while the cumulative incidence was 17.1% over 3 months. The mean length of hospital stay for the infected Pediatric patients was 18.2 days, while it was lower for the remaining patients, at 8.1 days.

Table 3 illustrates the proportion of HAIs among the Pediatric patients in Tibebe Ghion specialized Referral Hospital. Hospital acquired pneumonia (HAP) was the most common type of HAI which was observed among the Pediatric patients with a proportion of 55.5%, followed by meningitis 16.9%, and the least HAIs observed was IV site thrombophlebitis, with an overall proportion of 4.9%.

Culture was done for 38(37.6%) of pediatric patients who develop hospital acquired infection, off which 30(78.9%) where having an isolated organism. The two most common isolated organisms were CONS and K. Pneumoniae each accounts 30 percent and the least was staphylococcus aureus which accounts 6.7 percent (Table3). But the difficulty here to conclude

CONS are the most common is that, it is a known contaminant bacteria in cultures and the study did not differentiate whether it is contaminant or not.

Table 3: Incidence, type and etiologies of HAIs in Pediatrics patients who were admitted in TGSH from May1- August 1 /2022

Variables	**Frequency**	**Percent**
Develop HAIs		
Yes	101	82.9
No	490	17.1
Type of hospital acquired infection		
Pneumonia	56	55.5
Meningitis	17	16.9
UTI	16	15.8
SSI	7	6.9
Thrombophlebitis	5	4.9
Culture done		
Yes	38	37.6
No	63	62.4
Was organism grow from the culture		
Yes	30	78.9
No	8	21.1
Isolated organism		
CONS	9	30
K.Pneuminae	9	30
Enterococcus	6	20
A.Boumani	4	13.3

Staph	2	6.7

Outcome of the admitted pediatrics patients

As shown below the figure among admitted pediatrics patients during the study period 513(86.8%) were improved and discharged, whereas 51(8.6%) were died. Among those who develop HAIs about 25% of patients were died and 10% of patients were left against medical advice; whereas in those who were not having HAI about 5% and 0.14% died and left against medical advice respectively.

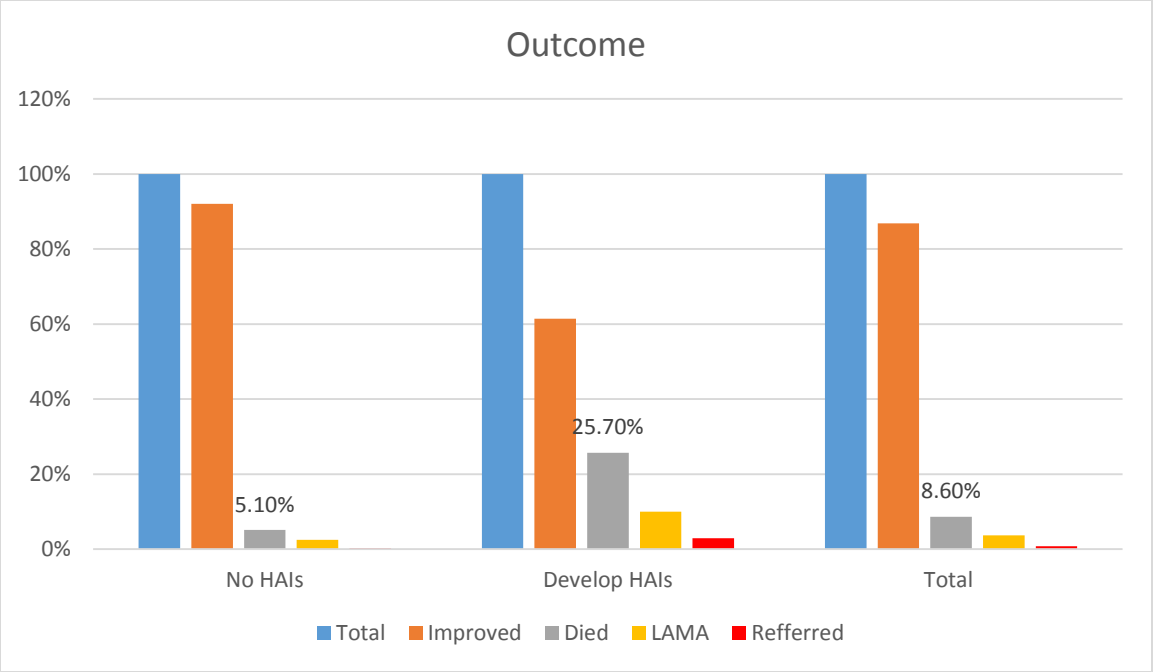

Figure 3: Outcome of Pediatrics patients who were admitted in TGSH from May1- August 1 /2022

As shown the figure below among the total patients admitted during the study period 86.8% of them were improved and discharged and about 8.6%were died.

Off those who were admitted in NICU 82.1 % were improved and discharged where as 13.1% were died during the study period. Among those patients admitted in PICU about 17.1% were died and 8.6% were left against medical advice. In those patients admitted in the general ward 93.4% were improved and discharged, 2.9% and 2.6 % were died and LAMA respectively.

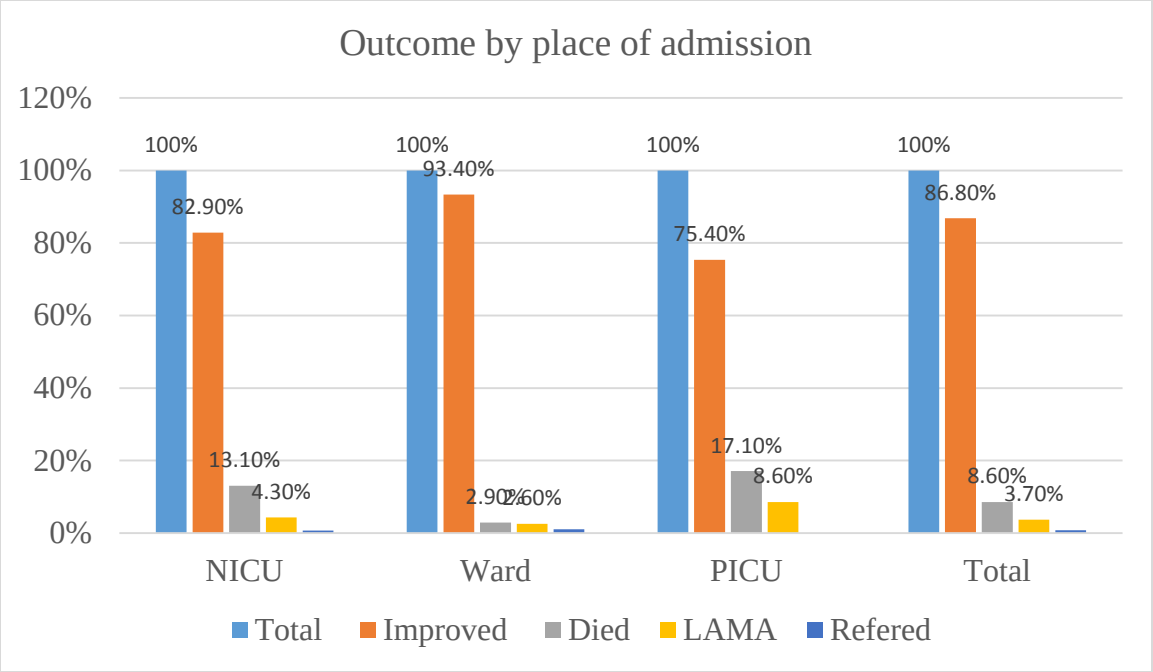

Figure 4: Outcome of Pediatrics patients with their place of admission in TGSH from May1-August 1 /2022

Risk factors for hospital acquired infection

Bivariate logistic regression was used to examine the individual effects of each of the selected variables on the development of HAIs. The results given in Table 4 show that, presence of invasive medical device, underlying chronic health conditions, previous hospitalization, surgical procedures and total length of hospital stay were significantly associated with hospital acquired infections at 5% level of significance. That is, the individual contribution of each of these variables to HAIs is significant. The covariates residence, sex, age and place of admission are not

significantly associated with development of HAIs at 5% level of significance in this bivariate logistic regression analysis.

Hence, on the basis of the bivariate results, the variables that were considered as candidates for multiple logistic regression analysis were presence of invasive medical device, underlying chronic health conditions, previous hospitalization, surgical procedures and total length of hospital stay. Based on the results of bivariate logistic regression analysis, 5 selected variables were included in the multiple logistic regression analysis to assess their net effect. Out of the 5 variables considered in this section, 3 variables were significantly associated with development of HAIs in TGSH. The variables, presence of invasive medical device, underlying chronic health conditions and total length of hospital stay were found to have significant net effect on hospital acquired infection. The remaining 2 variables were not significantly associated with HAIs, which were previous hospitalization and surgical procedures.

Pediatric patients with one or more of the invasive medical device (MV, CPAP, NGT, Chest tube, urinary and umbilical catheter,) are 9.4 times more likely to develop HAIs than patients without such invasive medical device (AOR= 9.4, 95% CI: 5.04-17.68).

Patients having underlying chronic medical conditions are 4.93 times more likely to develop HAIs than patients who were not having such underlying medical conditions (AOR=4.93, 95% CI: 2.44-9.97).

Compared to patients stayed less than 8 days (the median hospital stay during the study period) in the hospital, patients stayed more than 8 days are more likely to acquire hospital infections (AOR=28.1, 95% CI: 9.71-81.38). But it is difficult to conclude that longer duration itself is a risk factor for the development of HAIs in this study. Because this length of stay in the study considers the total duration of hospital stay which includes before and after they develop HAIs.

Table 4: Bi-variable and multivariable logistic regression test for the associated factors of Hospital acquired infection in TGSH from May1 –August 1/2022

Variables	**Hospital acquired infection**	**Odds ratio**	**p- value***

		Yes	No	Unadjusted	Adjusted	
Residency	Rural	70	380	0.654(.407-1.409)		
	Urban	31	110	1		
Sex	Female	52	216	1.346(.887-2.067)		
	Male	49	274	1		
Age	>5years	15	48	1.606(.860-2.998)		
	<5years	86	442	1		
Place of admission	General ward	43	229	0.845(.584-1.302)		
	NICU&PICU	58	261	1		
Presence of invasive medical device	Yes	71	54	19(11.45-31.88)	9.4(5.04-17.68)	<.001
	No	30	436	1	1	
Presence of underlying diseases	Yes	45	53	6.6(4.07-10.761)	4.93(2.44-9.97)	<.001
	No	56	437	1	1	
Previous hospitalization	Yes	40	68	4.069(2.53-6.54)	1.72(.863-3.444)	0.123
	No	61	422	1	1	
Surgical procedures	Yes	18	20	5.09(2.59-10.04)	2.09(.786-5.574)	0.139
	No	83	470	1	1	
Length of hospital stay	>8 days	97	141	60.02(21.6-166.2)	28.1(9.71-81.38)	<.001
	<8 days	4	349	1	1	

* -is the p value of AOR

5.2 Discussion

The main objective of this study was to assess the incidence and risk factors hospital acquired infection in pediatric wards of TGSH by prospective cross sectional study design from May 1 to August 1/2022. A total 591 pediatric patients were included in the study. Out of these pediatrics patients 101(17.1%) develops HAIs. The overall incidence rate of HAIs was 17.4 per 1000 pediatric days of follow- up while the cumulative incidence was 17.1% over 3 months.

Descriptive and bivariate logistic regression statistical methods of data analyses were employed to identify risk factors of HAIs in TGSH. Multivariate logistic analysis was used to assess the association between HAIs and independent variables. The results revealed that presence of invasive medical device, chronic underlying medical conditions and longer stay in the hospital were significantly associated with HAI at 5% level of significance.

Underwent surgical procedures and previous hospitalization were not significantly associated with HAIs at 5% level of significance in multivariate logistic analysis.

In this study, the overall incidence rate of HAIs was 17.4 per 1000 pediatric days of follow- ups. This finding is lower than a related prospective study by done in southwest Ethiopia, which reported an incidence of HAIs of 28.15 per 1000 patient days (51). The difference might be due to the nature of the study, our study involves only pediatric patients who had small number of co-morbid conditions; whereas, the study done in south east Ethiopia, included adult study participants. This finding is also lower than a previous before- and- after study conducted in a teaching hospital in Indonesia involved children whom were admitted to the Pediatric intensive care unit (ICU) and pediatric ward, reported the incidence density rate of HAI 29.1 per 1000 patient days (22). This variations could be attributed to differences in geographical locations, the study settings, and study periods, as which the study done in Indonesia was in a hospital having more than ten PICU beds and took longer duration accounting 27 months from 2010-2013 (22).

The finding of this study was having comparable results done in Brazil 15.4 per 1000 patient-days (23), Mexico 15 per 1000 patient-days (24) and Madda Walabu University Goba Referral Hospital, southeast Ethiopia 17.7 per 1000 patient-days (25).

One of our findings has also revealed that the overall cumulative incidence of HAIs was 17.1%; this study finding was higher than studies conducted by WHO with pooled estimated HAIs in low- income countries 10.1%(15), Italy 3.6%(44), Iran 7.77%(45) and Butare University Teaching Hospital, HAI was 12.1 %(48). The difference may be due to infrastructure (high patient burden, lower human resources, overcrowding) and infection prevention policies and strategy differences.

Conversely, studies from Turkey and Europe reported a higher incidence rate of HAIs among children; Turkey 22.2% (53) and Europe 23.6% (52). These differences may be attributed from

setting difference, population difference and difference in the nature of the study as in Europe includes multicenter. Compared with adults, infants and neonates are immunologically immature, and in many cases, vulnerable, thus it may not be a surprise to see such a high proportion of HAI in the NICU, PICU and Pediatric ward since most of the patients admitted in intensive care are critical.

The most common type of HAI observed in this study was HAP, which contributed to a proportion of 55.5% of the total HAIs. The finding was similar to the study done in Tikur Anbessa Hospital, Ethiopia (55). It is also true for other settings USA 48 %(40), Europe 19.4% (28), Brazil(23, 42).

In this study, the risk of developing HAIs, in the presence of underlying diseases, such as SAM, cardiac problems and congenital malformation was, 4.9 times higher than their counterparts. This was consistent with the finding from another study in Ethiopia, Kenya and Brazil (25, 42, 50, 51), that underlying illnesses increased the susceptibility of patients and predisposed them to infections secondary to the reduction of the patient's immune response.

Another finding in our study showed that, hospital acquired infection and length of hospital stay has statistically significant association between them. Studies conducted in different countries also supported this findings; stayed longer in the hospital is associated with the development of HAIs; and the vice versa; Europe (29), USA(40), developing countries(9) and in Ethiopia(25, 51). Those additional days in the hospital results in challenges in terms of human resource, material resource and additional fee costs for the family, institution, community and country as whole.

The association between HAIs and presence of invasive medical device is statistically significant, which reveals those pediatrics patients having invasive medical devices are 9 times more likely to acquire infection in the hospital than their counter parts. This study is in line with studies done in Madda Walabu, Jimma and Mekele (25, 51, 54).

6. CONCLUSION

This study revealed that the overall incidence of HAIs was17.1 per 100 admitted children which was higher compared to some developing countries.

Hospital acquired pneumonia (55.5%) was the most common infection types observed in this study and CONS and K. pneumoniae were the leading etiologies.

Length of stay in the hospital underlying medical conditions of (severe acute malnutrition, cardiac problems and congenital malformations) and presence of invasive medical devices were found to be important risk factors associated with increased risk of HAIs.

7. LIMITATION OF THE STUDY & STRENGTH

Several limitations on this prospective study needed to be considered.

First, because of its wide and complex nature which will be one area of research, it did not assess the healthcare workers' infection prevention practices that would have been associated with the development of HAIs.

Second, because of absence of Pediatrician & Pediatric resident at surgical ward patients who were admitted in surgical ward were not included in this study.

Third, it focused on a small number of risk factors for HAIs and some important variables were not included (environmental and health worker related factors).

The study did not differentiate the isolated microorganisms (CONS) from culture, whether its contaminant or real pathologic.

In addition, this study is not free from the effects of information bias as we do not use 'blinding'

Since the study was conducted in a teaching specialized referral hospital, the generalization of the study findings is limited to this facility.

Being a prospective is the strength of this study; because we can correlate clinical finding which suggests HAIs with laboratory and imaging results and important study variables will be followed without missing.

8. RECOMMENDATIONS

Further studies should be conducted to assess the healthcare workers' infection prevention practices that would have been associated with the prevalence of HAIs.

The hospital management and clinicians need to follow the appropriate safe medical procedures for use of external devices and give attention to patients with underlying chronic medical condition for the prevention and control of hospital-acquired infections.

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