ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE SCHOOL OF MEDICINE

DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

RESEARCH THESIS

PREVALENCE AND OUTTCOME OF HEALTH-CARE ASSOCIATED INFECTION IN NEONATES ADMITTED TO NEONATAL INTENSIVE CARE UNIT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA ETHIOPIA

BY

ELHAM SANY (MD)

A RESEARCH THESIS TO BE SUBMITTED TO TIKUR ANBESSA SPECIALIZED HOSPITAL, DEPARTMENT OF PEDIATRICS AND CHILD HEALTH IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR FELLOWSHIP PROGRAM IN PEDIATRICS INFECTIOUS DISEASE.

AUGUST 2023

PREVALENCE AND OUTCOME OF HEALTH- CARE ASSOCIATED INFECTION IN NEONATES ADMITTED TO NEONATAL INTENSIVE CARE UNIT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA ETHIOPIA

RESEARCH THESIS

BY

ELHAM SANY (MD)

ADVISOR:

PROFESSOR WORKEABEBA ABEBE, MD, MPH

CONSULTANT PEDIATRICIAN, INFECTIOUS DISEASE SUBSPECIALIST

DR ASRAT DEMTSE, MD

CONSULTANT PEDIATRICIAN, NEONATOLOGIST

DECEMBER, 2023

ADDIS ABABA, ETHIOPIA

ACKNOWLEDGEMENTS

I would like to express my appreciation to the TASH division of infectious disease for giving me this opportunity to conduct research on a topic of my interest. I would also like to express my heartfelt gratitude to my mentors Professor Workeabeba Abebe and Dr. Asrat Demtse for their continuous support and constructive feedback. Finally, I would like to thank my colleagues Dr. Melat Tesfaye and Dr. Addishiwot Melese for their assistance.

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ACRONYMS

AAU	Addis Ababa university
APGAR	Appearance, Pulse, Grimace, Activity, and Respiration
ARM	Anorectal Malformation
BSI	Blood Stream Infection
CHD	Congenital Heart Disease
CLABSI	Central Line Associated Blood Stream Infection
CONS	Coagulase Negative Staphylococcus
CRE	Carbapenem Resistance Enterobacteriaceae
CRKP	Carbapenem Resistance *Klebsiella Pneumoniea*
CVC	Central Venous Catheter
DM	Diabetes Mellites
DTR *P. aeruginosa*	Difficult to Treat *Pseudomonas aeruginosa*
EONS	Early Onset Neonatal Sepsis
EOS	Early Onset Sepsis
ESBL	Extended Spectrum B-Lactamases
HAI	Health Care Associated Infection
ICU	Intensive Care Unit
KMC	Kangaroo mother care
LMIC	Low- and Middle-Income Country
LOS	Late Onset Sepsis
MAS	Meconium Aspiration Syndrome
MDR	Multi Drug Resistance
MDRO	Multi Drug Resistance Organism
MV	Mechanical Ventilator
NICU	Neonatal Intensive Care Unit
PNA	Perinatal Asphyxia
PI	Principal Investigator
RDS	Respiratory Distress Syndrome

SGA	Small for Gestational Age
STX	Sulfamethoxazole
TASH	Tikur Anbessa Specialized Hospital
TEF	Tracheo-Esophageal Fistula
Spp	Species
XDR	Extensively drug resistance

Executive Summary

Background: Health care–associated infections are infections acquired in the hospital while receiving treatment for other conditions. Healthcare-associated infection (HAI) is a serious problem in neonates who are admitted to the neonatal intensive care unit (NICU) because of impaired host-defense mechanisms, limited amounts of protective endogenous flora on skin and mucosal surfaces at time of birth, reduced barrier function of their skin, use of invasive procedures and devices, and frequent exposure to broad spectrum antibiotic agents. Due to variations in definitions and reporting, the exact global burden of HAI cannot be accurately estimated. There exists wide variation in the bacteriological profile and antibiogram of microorganisms in different NICUs which changes consistently with time.

Objective: To assess the prevalence and outcome of HAI in neonates.

Study Setting: The study will be conducted in NICU of Tikur Anbessa Specialized Hospital, Addis Ababa from December 2023 to January 2023.

Method: A hospital based retrospective cross-sectional study will be conducted on prevalence and outcome of HAI in neonates. A data collection sheet will be designed to include baseline and progress data for each admitted neonate who develops HAI. Data collection protocol will be prepared, and data collectors will be trained as per the protocol. After data cleaning and entry, analysis will be done using the Statistical Package for Social Sciences (SPSS). Descriptive and analytical statistics will be used as applicable. Statistically significant association will be taken for p values of <0.05.

Work Plan and Budget: This study will be conducted from December 2023 to January 2024. This period will be utilized to finalize the research proposal, collect, and analyze the data. A total of 40,000 birr will be used to cover the costs for data collection and supplies.

INTRODUCTION

Background

Health care–associated infections are infections acquired in the hospital while receiving treatment for other conditions. HAI is a serious problem in neonates who are admitted to the neonatal intensive care unit (NICU). HAI in NICU result in higher rate of morbidity and mortality, increases lengths of stay, and medical costs(1).

Since neonates have impaired host-defense mechanisms, limited amounts of protective endogenous flora, decreased barrier function of the skin and exposure to broad spectrum antibiotics, put them at higher risk of acquiring HAI (1).

The accurate global burden of HAI can't be exactly estimated because of variations in definitions and reporting. The rate of HAI in developing countries are 3-to20 fold higher than developed world and reported rates of HAIs per admission in the literature range from 6% to 50%(2). The overall mortality rate varies between 20% and 80% depending on the risk factors(3) .

The site of HAIs in NICU varies where central line-associated bloodstream infections (CLABSI) being the most common followed by pneumonia, infections of the skin and soft tissues, urinary tract, and the central nervous system(1,4).

There are large number of bacterial and fungal pathogens that harborenvironmental surfaces of NICU. From these genera there are different species which are normal flora of healthy humans and don't necessarily represent pathogenic strains (13). The bacteriologic profile and antibiogram of microorganisms also differ in different NICU setup and it changes consistently with time (3).

Statement of the problem

Due to different risk factors as mentioned above neonates are vulnerable to HAI's and it's one of the major problems in neonates admitted to NICU.Multi-drug resistant microorganisms with poor IPC practice and diagnostic challenges make it more challenging to cope with HAIs.

In developing countries where the predominant pathogens being gram-negative, the prevalence of infection is higher(5).

Worldwideoutbreaks due multi drug resistant organisms (MDRO) continue to occur in NICU due to efforts to eradicate neonatal infection have had limited success in some areas, but many remain intransigent(6).

To provide safe and high quality healthcare services monitoring HAI rates for each medical center individually and generally in a country level is essential(7).

Significance of the study

Though the rate of health care associated infection is quite high, there is no study in our setup that was done to assess the magnitude of HAI, bacteriologic profile, pattern of resistance and outcome in pediatrics in general and in NICU.

Therefore, the aim of this research will be to assess the magnitude of health care related infection in NICU, and to evaluate the prevalence, bacteriologic profile, and outcome of neonates with health care associated infection. To recommend the way forward on how to tackle this emerging concern in our NICU.

LITERATURE REVIEW

Prevalence of Health care associated infection in NICU.

Healthcare-associated infections (HAIs) are infections that are not present during admission rather patients acquire within a healthcare setting. These include perinatally acquired infections in hospitalized neonates(8). Likeother critically ill patients' neonates admitted to NICU are at risk of HAIs because of their immature immunity, exposure to invasive devices and broad-spectrum antibiotics (1).

The exact incidence and financial impact of HAIs in NICUs are difficult to estimate and global figures are uncertain due to the wide scope and inconsistentreporting (9).

Different literaturessuggestthe burden of HAIs is greater for neonates than other intensive care units (12). Epidemiologic study to assess pediatricsHAIs and a study that assess strategies to prevent nosocomial infection in NICU showed 56.6% of all types of HAIs were found to be neonatal HA- sepsis and the pooled incidence of HA-sepsis in neonates was 112.9 cases per 1000 ICU treated neonates(10,11).

Comparing high income setting with low-and middle-income countries HAIs in neonates is nine times higher in LMIC with an incidence estimated to be 15.2 to 62.0 per 1000 patient-days (13).

A review from nine studiesconducted in Brazil to assess the incidence of HAIs among infants admitted to neonatal intensive care units (NICU) showedan incidence density with a median of 23.6 (range from 15.1 to 62.0) infections per 1000 patient-days. Pooled HAI incidence density was 23.5 (95% CI 16.3–33.9) per 1000 patient-days(14).

A point prevalence survey conducted in NICUs of 31 hospitals from different geographic regions in Turkey showed the point prevalence of HAIs was 7.6%, where central line associated blood stream infection being andventilator associated pneumonia being 1.2% and 2.1% respectively(15). The prevalence of HAIs in neonates in a study conducted in Athens, Greecewas 3.9% (16).Every year in neonatal intensive care units in the USA approximately 33,000 infants are diagnosed with HAI(17).In a study conducted by S. Kumar et al.to assess the correlation of HAIs in NICU with environmental surveillance showed; from 297 cases in the studygroup about

37% develop clinical sepsis, among the study groups localization of infection site showed 36% of blood stream infection, 12% of pneumonia, 10% of meningitis, 2% of skin & soft tissue infection, 2.6% of conjunctivitis and 0.4% of UTI (18).M.A.H. Gadallah et al.found 149 episodes of HAIs making the rate of HAI among admitted neonates 28% which corresponds approximately to 17 infections per 1,000 patient-days, studied twenty-eight percent of the admitted neonates developed HAI. Among the site of infections BSI being the comments with 127 (85%) cases followed by pneumonia with 15 (10%) of cases. In addition the incidence of CLABSI was 158 per 1,000 CVC-days, and that of VAP was 7 per 1,000 MV-days(2).

In 17 hospital basedstudies with comprehensive review of community and facility-based data, death during neonatal period due to neonatal infection as a proportion of all causes of death ranged from 4% to 56%, and 8–84% in 24 community-based studies (19).

In a systematic review done to assess HAI in developing countries, the reported of rateneonatal sepsis differs from 1.7 to 33 per 1000live hospital born babies. In this review any infection that occurs in the hospital even developing infection for being born in the hospital considered as health care associated infection(19) .

The rates of blood stream infection are 3-20 times higher than developed countries with the rates ranged from 1.7 to 33 per 1000 live births, which is around 20 per 1000 live births in Africa and 15 per 1000 live births in south Asia. The actual rate of neonatal infections in hospital born babies in developing countries is underestimated due to several reasons like inadequate laboratory resources, insufficient surveillance system and lack of post-discharge monitoring(19).

A Systematic review and meta-analysis that was done in Ethiopia to evaluate the burden of HAI doesn’t show the prevalence of HAI in Neonates.

Risk factors of HAI in NICU

Different factors are associated with the development of HAIs in the NICU result such as Prematurity, multiple underlying diseases, immature immune system , exposure to broad-spectrum antibiotics, anda high likelihood of cross-infections owing to close contact with a multidisciplinary care team (20,21).

In a surveillance data in United States showed prematurity being the most important risk factor for neonatal infection. This surveillance data collected from the from the National Institute of Child Health and Human Development (NICHD) Neonatal Network for over 20 years showed that 20-25% of very low birth weight neonates who survived beyond 3 days were found to have culture proven blood stream infection coagulase negative staphylococcus being the most common isolated pathogen(22,23).

As the gestational age and birth weight decreases the rate of infection will increases, where half of infection occurs in neonates born at <25 weeks of gestation and those with birth weight < 750 grams. Despite adjusting for birth weight, gestational age, sex and race, the incidence of LOS varies from center to center ranging from 10.6 to 31.7%(23).

There are also other factors that lead to the development of HAI in neonates such as delaying enteral nutrition, being on ventilator for a prolonged duration, use of intravascular catheterization for longer time, use of broad spectrum antibiotics and invasive procedures including major surgeries(23).

Apopulation-based cohort studyin the California Perinatal QualityCollaborativetaking 20,692 VLBW infants born between 2011 and 2015 showed birth year, gestational age, birth weight , and 5-minute Apgar score were significant independent risk factors for HAI(1).

In a study done by S. Kumar et al. on identifying the risk factor for HAI showed male gender, prematurity, and Apgar score at 5 minute less than 7 was significantly associated. But birth weight and hyaline membrane disease didn’t show association on multivariate logistic regression.In those patients who undergo intervention those who had peripheral vascular catheter had highest association to develop HAI followed by mechanical ventilation use (1).

In a prospective cohort study, that was done between January- December 2012 in the NICU of Ain Shams University Hospital of Obstetrics and Gynecologythose patients with VLBW, gestational age below 38 weeks, use of mechanical ventilator, and surgical procedure are identified as significant predictor of HAI on multivariable analysis. Whereas those factors like having congenital heart diseaseand use of central venous catheter doesn’t show association on multivariate analysis(2).

In a systematic review done to assess HAI in developing countries showedinverse relation of birth weight and risk of developing infection, though few studies were done to assess infection rates in high-risk infants who are very low birth weight. The overall rate of infection in this review was 68% from which blood stream infection accounted for 20% to 41%. This review showed a significant high rate of hospital-acquired infection among very low birth weight neonates as compared to neonatal care units in developed countries which ranges from 15 to 20%(19).

This review also showeddeveloping countries have less information on the rate of infectionper hospital day or device days. The information towards standard epidemiological measures that correlate with exposure to hospital environment and invasive procedure is also limited(19).

Considering correlation between environmental factors and incidence of HAI different study showed that the NICU setup, inadequate staff members, overcrowding, and poor infection control practices has association (1,4).

Bacteriologic profile and antibiogram of HAI in NICU

The bacteriologic profile and antibiogram of different NICU is different which also consistently changes even in the same setup.

In a systematic review and meta-analysis conducted in Brazil to assess the incidence and pathogens of HAI in NICU in Brazil showed gram positive bacteria were the major pathogens accounting for 51.1% of the case followed by gram negative pathogen 40.1% and fungi accounting for 8.8% from 3803 bloodstream samples, and only one study differentiated EOS from LOS cultures. Among the gram-positive bacteria Coagulase negativestaphylococci (1275; 33.5%), Staphylococcus aureus (503; 13.2%) were the major pathogens and among the gram-negatives Klebsiella sp. (456; 12.0%), and Escherichia coli (197; 5.2%) andCandida sp. (227; 6.0%) from fungal pathogens were the main pathogens identified (24)

In the same review to evaluate the antimicrobial resistance pattern only eight studies were found.Five studies reported the rate of Methicillin resistant S. aureus (MRSA) among S. aureus isolates ranged from 1.2 to 28.3% and only one study reportedvancomycin resistant

Enterococcus sp. on a single sample. Among Enterobacteriaceae Klebsiella spp. being the most common, six studies reported resistance to 3rd-generation cephalosporin,and it ranged from 23.3 to 36.6%.There were no reports of carbapenem resistant Enterobacteriaceae (CRE)(24).

In multi center point prevalence Turkeys study unlike the Brazil's systematic review gram-negative rods were the most common causative agents in HAIs accounting for 43% from which Klebsiella species being the most common followed by gram-positive species where staphylococci accounted for 10.7% of cases (15).

In this study around 81.2% of these gram-negative species were ESBL (+)and among the isolated staphylococci species methicillin resistance was 85.7% (15).

The bacteriological profile causing healthcare-associated infections in an observational study conducted in NICU at New Delhi India showed the predominant pathogen were gram positive where staphylococcus aureus being the most common isolate which was methicillin resistant. Among the gram-negative pathogen*Acinetobacter baumanii* was the majororganism followed by Enterobacter and Escherichia coli. The antibiotic sensitivity of organisms shows emergence of resistant strains against Penicillin, Ciprofloxacin and Erythromycin but maintain susceptibility to Vancomycin and Gentamycin. Gram-negative organisms also have resistance to most antibiotics and only sensitive to newer antibiotics(18).

M.A.H. Gadallah et al. studied *klebsiella*spp was the most common which was isolated in 54 of the 127 BSIs and in 8 of 15 cases of pneumonia. The second isolated pathogen was coagulase-negative staphylococci (CONS)(2).

In a study done in West China second hospital showed *Klebsiellapneumoniea*accounted for 26.94% of health care associated infection in the NICU. Among these klebsiella species isolates 15% were carbapenem resistant. CRKP (Carbapenem resistant *Klebsiellapneumoniea*) strains accounted for 15.00%. Among the 80 health care associated infection Kp strains, CRKP strains accounted for 33.3% and 53.3% in 2017 and 2018 respectively(25).

In the developing regions of the world, in a review of 11,471 blood steam samples gram-negative rods are major pathogens of neonatal sepsis accounting for at least 60% of positive blood

cultures. Of which klebsiella pneumoniae is the major pathogen which is responsible for 16-28% of blood culture confirmed sepsis. In this review among gram positive pathogens Africa and south Asia have high rates of S aureus infections, whereas Latin America, south east Asia, and the middle east have high reported rates of coagulase-negative staphylococcal infections(19).

In developing countries, the pattern of antimicrobial resistance in NICUbecomes devastating with multidrug resistance gram negative pathogens in different outbreaks.In this review most of the isolated *Klebsiella*spp are intrinsically resistant to ampicillin, and gentamicin. And among the isolated species 70% of them can't be covered by the first line WHO recommended empiric regime of ampicillin and gentamycin. The resistance pattern also expands to more expensive second- and third-line drugs due to extended spectrum beta lactamase producing bacteria which causes a great concern in managing neonatal sepsis in developing countries(19).

Outcome of HAI in neonates admitted to NICU

HAI is one of the common reasons for neonatal morbidity and leading to unsatisfactory outcome and prolonged hospital stay which causes increased medical cost. In a study conducted in New Delhi, India showedan increased case fatality rate as high as 50% and 17 days increment in the length of hospital stay after diagnosed with health care associated infection(18).

A study that was done in Egypt tertiary care NICU showed excess mortality due to HAI with a rate of 11.75% making mortality 1.64- fold higher in neonates with HAI than neonates without HAI.Similarly the median length of hospital stay after diagnosed with HAI increased by 8 days(2).

An Italian study done by Orsi et. al on HAI surveillance in NICU showed 35 neonates (6.1%) died, and the attributable mortality due to HAI was 5.7%. In these group of patients those with HAI of blood streamdue to gram-negative organisms had higher rate of mortality than those with gram-positive organisms(26).

Objective

General objective

- Prevalence and outcome of health care- associated infection in neonatal intensive care unit.

Specific objectives

- To assess the prevalence of HAI in NICU.
- To assess bacteriologic profile and antibiogram of HAI.
- To assess all-cause mortality of HAI diagnosis and length of stay after the diagnosis of HAI.
- To determine factors associated with outcome of HAI.

Materials and Methods

Study Setting

The study was conducted in Addis Ababa, Ethiopia at TASH, Department of Pediatrics and Child Health. TASH was established in 1974. It is the teaching hospital of Addis Ababa University, College of Health Sciences, and School of Medicine. It is also the largest referral hospital in Ethiopia with multiple specialties and sub-specialties. It has around 600 beds and from these 172 accounts for the pediatrics side.

TASH NICU is level III NICU which has 41beds. The ward is divided into different rooms such as term critical, term stable, preterm critical, preterm subcritical, KMC, and fluid preparation room but has no isolation room. The average admission per day is 8-12 and approximately 200 admissions every month. The discharge rate is 77%-83%. The ward has one neonatologist and two neonatology fellows. There are around twelve pediatric and child health residents who make round every day with their respective seniors. The nurse number in average 12-15 (during the daytime) and 10-14 in the night shift with nurse-to-patient ratio of 1:2 in HDU (high dependence unit) and 1:5 in stable room.

Study Population

All neonates admitted to NICU in the past 1 year who develop health care associated infection.

Study Design and Study Period

The study was a hospital based retrospective cross-sectional study conducted between December 2023 – January 2024.

Inclusion and Exclusion Criteria

Inclusion criteria

- All neonates, with HAI was included.

Exclusion criteria

- Those patients who do not have HAI clinically or etiologically.
- Those patients diagnosed with HAI and transferred to other setup or discharged against medical advice.
- Those patients with incomplete documentation

Sample size determination and sampling method

		P	Study Sample size	Calculated Sample Size	Corrected sample Size
Gadallah MD	Incidence of HAI	28%	434	310	206
	Mortality rate	11.75%			
Orsi, MD	Incidence of HAI	13.2%	575	177	136
	Mortality rate	6.1%			
Djordjevic MD	Incidence of HAI	18.6%	381	233	166

Sample size correction formula was used for finite population with N< 10,000 S=n/(1+n/N)

We include all newborns consecutively admitted to the NICU of TASH during the study period. Even though we include all the neonates consecutively admitted to the NICU, we checked the adequacy of the sample size based on our objectives. Accordingly, for our objectives, the minimum required sample size calculated using a single population proportion formula by considering the following statistical assumptions: P = proportion which was obtained from different studies (please see the table above), Z α/2 = corresponding Z score of 95% CI and d = margin of error (5%). In our study, $N = Z\alpha/2$

Finally, after assuming a 10% loss to follow-up, the final sample size required for the first objective was 226 neonates.

A consecutive sampling technique was used. All neonates with HAI who met the inclusion criteria were included in the study.

Data collection

A pretested questioner was designed to include baseline and follow-up data for each admitted neonate who develops HAI. As per the hospital protocol all patients with suspected HAI undergo septic workup for health care related infection such as complete blood count, urinalysis, CRP, CSF analysis, blood, urine, and CSF culture. Patient information, including birth weight, gestational age, underlying diagnosis and pregnancy and delivery history were included as a baseline information.The follow up data includes the risk factor for HAI, site of infection,

bacteriologic profile and AST identified at the microbiology laboratory of TASH using CLSI-2023 breakpoints for disc diffusion method, and outcome of the patient.
Health professional (a clinical pharmacist) was trained in how to collect the data using a pretested questioner and data collection was followed by the primary investigator.
A training about the data collection procedure was given to the data collector as per the protocol.

Data Quality Assurance

The primary investigator undertook periodic evaluation during the data collection to assure for completeness and quality data.

Data analysis and Interpretation

After data cleaning and entry, analysis was done using the Statistical Package for Social Sciences (SPSS) version 25 by the primary investigator. Data analysis was performed to describe numbers and percentages of the variables. To measure central tendency for continuous variables the mean with standard deviation or median with interquartile range was used. Categorical variables were described as frequency or percentages. Bivariate analysis was performed to identify potential associated factors for outcome of HAI. Variables with $p < 0.25$ on bivariate analysis were entered on multivariate logisticregression to identify independent associated factors affecting the outcome of HAI. Statistically significant association was taken for 95% CI and p values of <0.05.

Variables

Independent variables

- Age, Sex, gestational age, birth weight, APGAR score, resuscitation after delivery, underlying morbidity, Invasive procedures, use of suctioning equipment, cesarean section, congenital disease, place of delivery, use of antibiotics (type and duration), length of hospital stay, surgical procedure, premature rupture of membrane, preeclampsia, gestational DM, any maternal chronic illness.
- Health care associated infection.

Dependent variables

- Length of hospital stay.
- All causes of mortality of HAI diagnosis.

Operational definitions

HAI-Are infection which neither present or incubating at the time of admission rather it occurs at least 48 hour after admission to hospital which results in localized or systemic condition with clinical features depends on the site of involvement and/or a positive culture of biological material from the newborn should be there.

- Bloodstream infection (BSI)- defined as the presence clinical sign and symptoms of sepsis including fever, hypothermia, frequent apnea, bradycardia, lethargy, hypotonia, unstable vital signs, and feeding intolerance with laboratory evidence of leukocytosis with left shift, raised acute phase reactant and/or positive blood culture.
- Pneumonia -defined as a clinically unstable respiratory condition with chest radiography showing new or progressive infiltrate and/or an infectious organism isolated from blood culture or from specimens obtained by endotracheal aspirate, and/or pleural flid collection
- Urinary tract infection was defined as the presence of clinical signs and symptoms with positive urinalysis result (> 5 leukocytes and or nitrite and leukocyte esterase positive) and/or a urine culture of 10^5 colonies/mL urine from bladder catheterization.
- Meningitis- clinical signs and symptoms of sepsis with positive CSF analysis finding (CSF leukocyte count ≥20 cells with ≥ 25% PMN, CSF glucose < 60% of serum glucose, CSF protein >100mg/dl) and/or microbiologically confirmed meningitis (bacterial or fungal) with detection of pathogen in cerebrospinal fluid cultures.

Resistant- Resistant to <3 groups of antibiotics.

MDR- Resistant to ≥ 3 groups of antibiotics

XDR- Resistant to ≥ 3 groups and sensitive to ≤ 2 groups of antibiotics.

ESBL- Enzymes that confer resistance to most beta-lactam antibiotics, including penicillins, cephalosporins, and monobactam aztreonam.

CRE- Enterobacterales resistant to at least 1 carbapenem or producing carbapenemase.

DTR *P. aeruginosa*- Resistant to piperacillin/tazobactam, ceftazidime, cefepime, aztreonam, meropenem, imipenem/cilastatin, ciprofloxacin, and levofloxacin.

Antimicrobial susceptibility pattern- is an appropriate test whenever a specimen is collected from a suspected infection site.

Sever Acute Malnutrition (SAM) – World Health Organization (WHO) defines Severe acute malnutrition in infants who are 0–5 months of age as:

- weight-for-length <–3 Z-scores of the WHO Child Growth Standards median, or
- presence of bilateral pitting oedema.

Outcome measures

- Discharge- a patient leaves the hospital to home and not to other health care facility.
- Early neonatal death- The death of a newborn between 0 and 7 days of life.
- Late neonatal death- The death of a newborn after 7 days of life.

Ethical considerations

As per the requirement of fellowship program in pediatrics and child health department, Pediatrics and Child Health Department's Research and Publications Committee of the School of Medicine, College of Health Sciences, and Addis Ababa University gave the ethical clearance to proceed with the research. Participant confidentiality was assured. All participants included in the study were kept anonymous during subsequent analysis and dissemination.

Dissemination of results

The study will be disseminated to key stakeholders, including CHS, AAU, TASH, division of infectious disease and department of pediatrics and child health. The result will further be disseminated to the wider scientific community through abstract presentation at conferences and through publication in peer-reviewed scholarly journals. The study will continue prospectively for one year period to assess the antibiogram of HAI in NICU and to identify the empiric antibiotic for neonates with HAI and to use it as quality improvement data.

Results

Sociodemographic characteristics

In the present study, a total of 959 medical cards of neonates were examined, out of which 152 met the specified criteria and were subsequently included in the study. Most of these neonates, 92 cases (60.5%), were admitted to the hospital within 72 hours of birth. Among the participants, the predominant gender was male, with 84 neonates (54.3%). Additionally, a significant proportion of mothers, specifically 139 (91.4%), had received antenatal care follow-up. Furthermore, more than two-thirds of the neonates, a total of 107 (70.4%), were residing outside of Addis Ababa. (table 1).

Table 1: Sociodemographic characteristics of the study participants

Variable	Frequency (%)
Gender	
Female	68 (44.7)
Male	84 (54.3)
Age at admission	
< 72 hours	92 (60.5)
>72 hours	60 (39.5)
Residency	
Addis Ababa	45 (29.6)
Regional states	107 (70.4)

History of antenatal care	
No	13 (8.6)
Yes	139 (91.4)
Place of delivery	
TASH	52 (34.2)
Other hospitals	71 (46.7)
Health center	8 (5.3)
MCH clinic	15 (9.9)
Home	6 (3.9)
Gestational age	
Preterm (<37weeks)	55 (36.2)
Term (37-42 weeks)	97 (63.8)

Clinical characteristics

In the present study, over half of the participants (78 or 51.3%) were found to fall within the weight range of 2500-4000g. Moreover, most of the mothers (128 or 84.2%) experienced a labor duration of less than 18 hours, and a significant number (24 or 15.8%) had a known medical condition. Furthermore, a substantial proportion (38.2%) of participants underwent a Cesarean section for childbirth.

The most prevalent respiratory signs and symptoms included oxygen saturation below 92%, observed in 143 cases (94.1%), and subcostal or intercostal retractions, present in 112 cases (73.7%). Similarly, reduced activity and lethargy were identified as the primary contributors to central nervous system signs and symptoms, with frequencies of 83 cases (54.6%) and 70 cases (46.1%), respectively (table 2).

Table 2: Clinical characteristics of the study participants

Variables	Frequency (%)
Weight at birth	
1000-1499g	22 (14.5)
1500-2500g	51 (33.6)
2500-4000g	79 (51.8)
Labor duration in hours	
<18hr	128 (84.2)
≥18hr	24 (15.8)

Prolonged rupture of membranes (≥12 hr)	
Yes	129 (84.9)
No	23 (15.1)
Any other known Maternal illness	
Yes	24 (15.8)
No	128 (84.2)
Mode of delivery	
Vaginal	94 (61.8)
C/S	58 (38.2)
Bilateral pitting edema	
No	119 (78.3)
Yes	33 (21.7)
Temperature	
<37°C	71 (46.7)
>37°C	81 (53.3)
Respiratory symptom	
Respiratory >60bpm	122 (80.3)
SaO2 <92%	143 (94.1)
Flaring of ala nasi	19 (12.5)
Grunting	26 (17.1)
S/C or I/C retraction	112 (73.7)
Crepitation	76 (50.0)
CNS symptom	
Decreased activity	83 (54.6)
Lethargy	70 (46.1)
Irritability	21 (13.8)
Tremors or seizure	15 (9.9)
Any surgical procedure	
No	82 (53.9)
Yes	70 (46.1)

Resuscitation after Delivery	
No	137 (90.1)
Yes	15 (9.9)
Suction machine	
No	110 (72.4)
Yes	27 (27.6)
CBC	
WBC (cells/µL)	
$<9\times10^3$	15 (9.9)
$9.1\text{-}34\times10^3$	29 (19.1)
$>34\times10^3$	108 (71.1)
Hct (%)	
<44	95 (62.5)
44-70	57 (37.5)
Platelet (cells/µL)	
$<150{,}000\times10^3$	103 (67.8)
$150{,}000\text{-}300{,}000\times10^3$	20 (13.2)
$>300{,}000\times10^3$	29 (19.1)

Culture and antimicrobial related characteristics

In our study from a total of 152 patients 77 (55.7%) of them have blood stream infection with positive blood culture. The bacteriologic profile shows the most isolated pathogen being gram negative organisms accounting for 32 (41.6%) followed by gram positive pathogen 29 (37.7%) and yeast isolated from 5 (6.5%) patients.

From the gram-negative pathogen*Acinetobacter* species is the commonest 12 (15.6%), followed by *klebsiella pneumoniae11* (14.3%). And from the gram-positive pathogens *CONS* accounts for 24 (31.2%) of cases and *Staphylococcus aureus* is the second 5 (6.5%).Similarly, *K.Pneumoniae* and *K.Rhinoscleromatis* were identified from CSF cultures.

The majority (91.4%) of admitted neonates received antibiotics, with the combination of Ampicillin + Gentamycin being used in over half (54.8%) of these cases (table 3).

Table3: Culture and antimicrobial related characteristics

Variables	Frequency (%)
Blood culture and gram stain, organism isolated	
Yes	77 (50.7)
No	75 (49.3)
Isolated spices (n= 77)	
CONS	24 (31.2)
Acinetobacter	12 (15.6)
K.Pneumonia	11 (14.3)
Pseudomonas arginase	5 (6.5)
Staph spices	5 (6.5)
Yeast	5 (6.5)
E.coli	4 (5.2)
*Others	12 (15.6)
CSF culture organism isolated (n= 18)	
K.Pneumonia	1 (5.5)
K.rhinoscleromatis	1 (5.5)
No growth	16 (89)
Is the patient started on antibiotics	
No	13 (8.6)
Yes	139 (91.4)
Type of antibiotics (n=139)	
Ampicillin + gentamycin	76 (54.8)
Ampicillin + cefotaxime	24 (17.4)
Ampicillin + gentamycin + metronidazole	23 (16.5)
**Others	16 (11.5)

*others= bacillus, citrobacter, enterococcus, klebsellarhiosclera,
**others= meropenem, vancomycin, amikacin, ceftriaxone, ceftazidime

Antimicrobial susceptibility pattern

In general, most isolated gram-negative bacteria have demonstrated resistance to most antibacterial agents. Antimicrobial susceptibility pattern of the gram-negative organisms in our study shows 43.75% of them are MDR and 12 (37.5%) of them are carbapenem resistance. Specifically, *E. coli* has shown 100% resistance to gentamycin and meropenem. Similarly, *Acinetobacter* and *K. pneumoniae* have exhibited 90% resistance to ceftriaxone. On the other hand, *pseudomonas aeruginosa* has displayed 100% sensitivity to meropenem, and *K. pneumoniae* has shown 81.1% sensitivity to amikacin. In general the study showed resistance pattern of *Acinetobacter*, *K.pneumoniae*, *E.coli* and *pseudomonas aeruginosa* to ceftriaxone, ceftazidime, cefepime, gentamycin was higher except for amikacin.

As for gram-positive bacteria, *coagulase-negative staphylococci (CONS)* and *staphylococcal aureus* have resistance rates of 41.7% and 60.0%, respectively, to methicillin (table 4).

Table 4: Antimicrobial susceptibility pattern

Isolates gram negative bacteria	**Pattern**	**Cefta No. (%)**	**Ceftaz No.(%)**	**CefepNo. (%)**	**Augm No.(%)**	**Cipro No.(%)**	**SXT No.(%)**	**GentaNo .(%)**	**Ami No.(**
Antimicrobial agents tested									
Acinetobacter (n=12)	Sensitive	2 (16.7)	3 (25)	3 (25)	NA	8 (66.7)	NA	2 (16.7)	10 (8
	Intermediate	1 (8.3)	1 (8.3)	2 (16.7)	NA	0 (0.0)	NA	2 (16.7)	2 (1(
	Resistance	9 (75.0)	8 (66.7)	7 (58.3)	NA	4 (33.3)	NA	8 (66.7)	0 (0.
K.Pneumoniae (n= 11)	Sensitive	1 (9.1)	9 (81.8)	1 (9.1)	NA	2 (18.2)	0 (0.0)	1 (9.1)	9 (8
	Intermediate	0 (0.0)	1 (9.1)	0 (0.0)	NA	6 (54.5)	2 (18.2)	3 (27.3)	0 (0.
	Resistance	10 (90.9)	1 (9.1)	10 (83.4)	NA	3 (27.3)	9 (81.8)	7 (63.6)	2 (18
Pseudomonas aeruginosa (n= 5)	Sensitive	NA	2 (40.0)	2 (40.0)	NA	2 (40.0)	NA	3 (60.0)	3 (6(
	Intermediate	NA	3 (60.0)	1 (20.0)	NA	2 (40.0)	NA	1(20.0)	0 (0.
	Resistance	NA	0 (0.0)	2 (40.0)	NA	1 (20.0)	NA	1 (20.0)	2 (4(
E.coli (n= 4)	Sensitive	1 (25.0)	2 (50.0)	1 (25.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	3 (75

	Intermediate	1 (25.0)	2 (50.0)	1 (25.0)	1 (25.0)	1 (25.0)	2 (50.0)	0 (0.0)	0 (0.
	Resistance	2 (50.0)	0 (0.0)	2 (50.0)	3 (75.0)	2 (50.0)	2 (50.0)	4 (100.0)	1 (25
Isolates gram positive bacteria	**Pattern**	**Oxaci No. (%)**	**Penci No.(%)**	**Genta No.(%)**	**Clind No.(%)**	**Eryth No.(%)**	**SXT No.(%)**		
CONS (n= 24)	Sensitive	4 (16.7)	6 (25)	5 (20.8)	7 (29.2)	0 (0.0)	0 (0.0)		
	Intermediate	10 (41.7)	10 (41.7)	10 (41.7)	6 (25.0)	11 (45.8)	8 (33.3)		
	Resistance	10 (41.7)	8 (33.3)	9 (37.5)	11 (45.8)	13 (51.2)	16 (66.7)		
Staph aureus (n= 5)	Sensitive	2 (40.0)	1 (20.0)	2 (40.0)	2 (40.0)	1 (20.0)	1 (20.0)		
	Intermediate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
	Resistance	3 (60.0)	4 (80.0)	3 (60.0)	3 (60.0)	4 (80.0)	4 (80.0)		

Outcome of the patient with HAI

Among all neonates admitted to the TASH Neonatal Intensive Care Unit with a diagnosis of Hospital-Acquired Infection (HAI), a total of 34 (22%) died (Figure 1). Additionally, the average duration of hospital stay was 18.46 ± 11.8 days, with a range of 1-59 days. It is worth noting that more than one-third of these neonates 56 (36.8%) remained hospitalized for at least 18 days following admission (table 5).

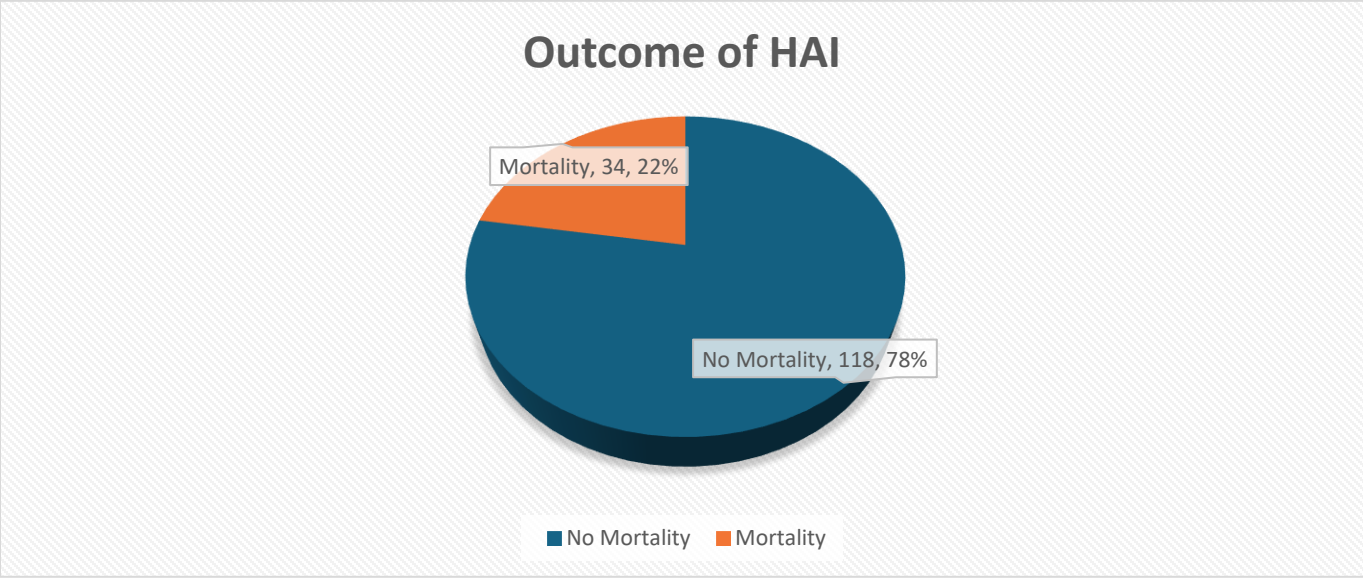

Figure 1: Outcome of neonates with HAI

Table 5: Outcome of neonates with HAI

Variables	Frequency (%)
Any cause of mortality after HAI diagnosis	
No	118 (77.6)
Yes	34 (22.4)
Length of hospital stay	
<18 days	96 (63.2)
>18 days	56 (36.8)

Predictors of mortality among HAI neonates

A binary regression analysis was conducted to determine the factors associated with mortality among neonates who were hospitalized with hospital-acquired infections. Initially, a univariate regression was performed, and variables with a p-value of less than or equal to 0.2 were included in the multivariable logistic regression. The results of the binary regression analysis revealed thatneonates who underwent any surgical procedure had a higher risk of death than those without any procedure (AOR= 5.466, CI= 2.277-12.123, p-value= 0.000). And neonates who required resuscitation after delivery were associated with an increased risk of death (AOR= 2.595, CI= 1.136-7.091, p-value= 0.015) (table 6).

Table 6: Predictors of mortality among HIA neonates

Variables	Treatment outcome		AOR (95%, CI)	P-value
	Survived	death		
Gender				
Female	56	12	1.00	
Male	62	22	0.674 (0.196-2.315)	0.531
Age at admission				
<72 hours	76	16		
>72 hours	39	18	2.505 (0.643-9.756)	0.186
Place of delivery				
TASH	46	6	1.00	
Other hospitals	45	23	0.699 (0.101-4.824)	0.716

Health center	7	1	0.370 (0.009-15.205)	0.600
MCH clinic	15	0	0.851 (0.048-2.310)	0.675
Home	2	4	4.476 (0.185-108.245)	0.357
Gestational age				
<37 weeks	44	11	1.00	
37-42 weeks	74	23	0.407 (0.097-1.704)	0.218
Prolonged rupture of membranes (≥12 hr)				
Yes	94	31	1.00	
No	17	3	0.399 (0.047-3.355)	0.397
Any known maternal illness				
Yes	17	3	1.00	
No	94	31	3.181 (0.322-31.399)	0.322
Bilateral pitting edema				
No	101	18	1.00	
Yes	17	16	0.221 (0.048-1.028)	0.054
Flaring of ala nasi				
No	109	24	1.00	
Yes	9	10	2.001 (0.344-11.643)	0.440
Grunting				
No	104	22	1.00	
Yes	14	12	0.382 (0.087-1.681)	0.203
S/C or I/C retraction				
No	35	5	1.00	
Yes	83	29	0.349 (0.047-2.607)	0.305
Crepitation				
No	65	11	1.00	
Yes	53	23	2.580 (1.527-12.637)	**0.0242***
Decreased activity				
No	63	6	1.00	
Yes	55	28	5.345 (2.061-13.864)	**0.001***
Lethargy				

No	73	9	1.00	
Yes	45	25	1.525 (0.221-10.522)	0. .668
Irritability				
No	105	26	1.00	
Yes	13	8	0.403 (0.075-2.184)	0.292
Surgical procedure				
No	74	8	1.00	
Yes	44	26	5.466 (2.277-12.123)	**0.000***
Resuscitation after Delivery				
No	109	28	1.00	
Yes	9	6	2.595 (1.136-7.091)	**0.015***
Suction machine				
No	95	15	1.00	
Yes	23	19	0.561 (0.073-4.338)	0.580
Gram positive bacteria (n=77)				
No	94	29	1.00	
Yes	24	5	2.24 (0.024-156.34)	0.778
Gram negative bacteria (n=77)				
No	100	22	1.00	
Yes	20	12	12.32 (0.736-108.27)	0.661

***Variables showed a statistically significant association**

Predictors of hospital stay among neonates with HAI

An independent t-test and a one-way ANOVA were used to assess whether there was a significant relationship with the length of hospitalization. The analysis revealed that mothers who did not receive regular antenatal care during their pregnancies and those who delivered their babies at home had higher rates of hospitalization (p-value= 0.013 and 0.047, respectively). Additionally, neonates who survived after being diagnosed with HAI seemed to have a shorter hospital stay (p-value= 0.017) (table 7).

Table 7: Predictors of hospital stay among neonates with HAI

Characteristics	Mean score (S.D)	DF	F	P-value

Gender [a]		150	2.862	0.093
Female	20.46 (12.87)			
Male	16.85 (10.68)			
History of antenatal care [a]		150	6.361	**0.013***
No	19.46 (18.85)			
Yes	18.36 (11.03)			
Place of delivery [b]		4.00	2.470	**0.047***
TASH	18.35 (10.31)			
Other hospitals	18.34 (11.87)			
Health center	14.88 (5.61)			
MCH clinic	15.53 (8.16)			
Home	32.17 (27.18)			
Weight at birth [b]		4.00	0.328	0.721
1000-1499g	18.45 (11.89)			
1500-2500g	17.00 (11.27)			
2500-4000g	18.04 (11.32)			
Grunting [a]		150	0.162	0.668
No	18.95 (11.71)			
Yes	16.08 (12.22)			
Crepitation[a]		150	1.393	0.240
No	16.87 (10.99)			
Yes	20.05 (12.44)			
Lethargy [a]		150	0.891	0.347
No	17.93 (11.75)			
Yes	19.09 (11.93)			
Tremors or seizure [a]		150	0.923	0.338
No	18.06 (11.56)			
Yes	22.13 (13.77)			
Any surgical procedure [a]		150	2.143	0.145
No	18.12 (10.37)			
Yes	18.86 (13.36)			

Resuscitation after Delivery [a]		150	1.506	0.222
No	18.78 (12.14)			
Yes	15.53 (7.86)			
Any cause of mortality after HAI diagnosis [a]		150	5.856	0.017*
No	19.14 (10.54)			
Yes	16.12 (15.39)			

***Variables showed a statistically significant association, [a]independent t-test, [b]one way ANOVA**

Discussion

Herein, we reported a study on the prevalence and outcome of health care associated infection with their bacteriologic profile and antimicrobial susceptibility pattern in neonates admitted to neonatal intensive care unit, Tikur Anbessa specialized hospital.

In this study, we reviewed the medical records of 959 neonates. Of these, 152 developed HAIs during their hospital stay making the incidence rate of HAI 15.8%. A study done in Egypt shows a higher incidence of HAIs in neonates accounts for 28% and the incidence density was 17.5 HAIs per 1,000 patient-days. The higher difference could be due to the study design, the Egyptian study was a prospective cohort over one year period whereas our study is retrospective cross-sectional which makes it difficult to know the exact prevalence (2).

An observational case-control study from New Delhi showed a percentage of HAI in neonates to be 37% which is approximately 2.5 times higher than our study (18).

A study from Italy shows an infection rate of 13.5% which is approximate to our study but difficult to compare with due to a difference in the study design (26)

A retrospective 06-year study from Poland shows a prevalence rate of HAIs in neonates to be 7.32%. Similarly, a study from 31 different hospital in Turkey showed point HAIs prevalence of 7.6% which is a lower rate when compared to our study which could be from the higher standard of care given in developed countries in addition to the assessment only includes culture positive infections (7,15).

Different studies show the distribution of infection as blood stream, pneumonia or VAP, urinary tract infection, meningitis, conjunctivitis and so on. But our study fails to show these patterns since our sampling technique for HAI is almost limited to blood culture and almost all patients didn't have urinalysis, urine culture, CSF analysis and culture, and CXR (2,7,15,18,26).

In our study from a total of 152 patients 77 (55.7%) of them have blood stream infection with positive blood culture making the culture positivity rate of more than 50%. The bacteriologic profile shows the most isolated pathogen being gram negative organisms accounting for 32 (41.6%) followed by gram positive pathogen 29 (37.7%) and yeast isolated from 5 (6.5%) patients.

From the gram-negative pathogen *Acinetobacter* species is the commonest 12 (15.6%), followed by *klebsiella pneumoniae11* (14.3%). And from the gram-positive pathogens *CONS* accounts for 24 (31.2%) of cases and *Staphylococcus aureus* is the second 5 (6.5%).

Like our study the Egyptian, Turkey and Italian studies showed the predominance of gram-negative pathogen followed by gram positive predominantly *CONS*. In all three studies *K.pneumoniae* was the predominant organism unlike our study where *Acinetobacter* species is the predominant one followed by *k.pneumoniae* (2,15,26).

In contrast to our study, studies from India and Poland shows a bacteriologic profile predominantly involving gram positives mainly *CONS* and the Indian study showed gram-negative mainly *Acinetobacter* to be the next predominant pathogen. The difference of the bacteriologic profile could be the absence of central line usage in our set up (7,18).

Antimicrobial susceptibility pattern of the gram-negative organisms in our study shows 43.75% of them are MDR and 12 (37.5%) of them are carbapenem resistance.

In our study resistance pattern of *Acinetobacter, K.pneumoniae, E.coli* and *pseudomonas aeruginosa* to ceftriaxone, ceftazidime, cefepime, gentamycin was higher except for amikacin which is somehow different from the susceptibility pattern from India where amikacin resistance rate for *Acinetobacter* in our setup is zero but in India it reaches 50%. As to the *E.coli* and *Pseudomonasaeruginosa* the resistance rate in our set up is 25% and 40% respectively unlike the Indians study which was 15% and 13% respectively (18)

In our study *Acinetobacte*r, *K. pneumoniae*, and *E. coli* show 3/12 (25%), 5/11 (45.5%), and 4/4 (100%) resistance to carbapenem. But Pseudomonas aeruginosa shows5/5 (100%) sensitivity.

A study from south Africa on the pattern of carbapenem resistance in neonates shows *Klebsiellapneumoniae* 20/32 (62.5%), followed by *Escherichia coli* 8/32 (25%), *Enterobacter cloacae* 3/32 (9.4%) and *Citrobacterfreundii*1/32 (3.1%) (27).

Among the gram-positive pathogens *CONS* and *staphylococcus aureus* shows 10/24 (41.7%) & 3/5 (60%) resistance to methicillin which is different from an Indian study accounting for 80% and 33% respectively (18).

The outcome among all neonates admitted to the TASH Neonatal Intensive Care Unit with a diagnosis of Hospital-Acquired Infection (HAI), a total of 34 (22%) died. Additionally, the average duration of hospital stay was 18.46 ± 11.8 days, with a range of 1-59 days.

Our result shows a little lower rate of mortality compared to the Indian study which accounted for 29% as compared to9% in the control group (18).

In contrast to our study, a study from Italy showed a mortality rate of 6.1% which is significantly lower compared to our study. This difference could be from quality of care after being given after diagnosed with HAI might bequite different in developing and developed world (26).

Similarly, a study done in Egypt showed a mortality rate of 11.75% which is much lower than our study.The median length of stay was 8 days longer which is lower than our setup.

Though our study doesn't show mortality correlation with gram-negative pathogens a study from South Africa showed a higher mortality in patients with carbapenem resistant gram negative pathogens [29].

Conclusion

The prevalence of HAI is still high in our hospital despite other's setup shows a much higher rate. The most common pathogen identified is gram negative like most developing world. Though doesn't show correlation with the identified pathogen having HAI results in higher mortality rate and increases the median length of hospital stay.

Limitation of the study

It’s retrospective in nature and is a single-center site study. In addition, the sample size could not be attained, as some of the cards were incomplete.

Recommendations

This study can be used as a baseline data for future prospective study to assess the incidence and outcome of HAI with prospective cohort study.

In our study we were not able to determine the specific site of HAIs due to inadequate sampling for HAI. Therefore, looking this incompleteness our practice towards evaluating HAI should be improved.

Since the prevalence mortality associated with HAIs in NICU is very high strict IPC practice and routine surveillance should be undertaken.

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ANNEX 1: QUESTIONNAIRE FOR ALL ADMITTED NEONATES

Part 2: Clinical characteristic of patients

Part 1. General Characteristic of the patients

Variables	Phone no----------		Card no----------	Date of admission
Sex	Male	Female		
Age at admission				
Address				

History of antenatal care (≥ 4)	Yes ☐	No ☐			
Place of delivery	TASH	Other Hospital	Health center	MCH Clinic	Home
Gestational Age	Preterm (<37wks)	Term (37-42 wks)	Post term (>42 wks)		
Birth weight (gram)	≥ 2,500	1,500-2,499	1,499- 1000		< 1000
Labor duration in hours	<18hr	≥18hr			
Prolonged rupture of membranes (≥12 hr)	Yes	No			
Any other known Maternal illness	Yes ☐	No ☐	If yes, mention		
Mode of delivery	Vaginal	C/S			
APGAR score	At 1 min.	At 5 min.			
Resuscitation after Delivery	Yes ☐	No ☐			
Invasive procedures (Circle any that applies)	Peripheral vascular line, Central catheter, Urinary catheter, Mechanical ventilation, Thoracic drainage, Surgical procedure (type of surgery)				
Use of suction machine	Yes ☐ Shared Not shared	No ☐			
Is the patient started on antibiotics	Yes ☐ • Ampicillin + Gentamycin for ……...days • Other antibiotics…… for ……. days	No ☐			
Does the patient develop HAI?	Yes ☐ If yes proceed to the next questionnaire	No ☐			

ANEXX 2: QUESTIONIER FOR NEONATES WITH HAI

Part 1: Clinical characteristic of patient with HAI

Weight (KG)--------	Length (cm)-----	Weight for length b/n -2 &-3 SD ------- < -3 SD -------	Bilateral pitting edema ---------
Temperature ºc	----------		
Respiratory symptoms Respiratory rate >60 SaO2 <92% Flaring of ala nasi Grunting S/C or I/C retraction Crepitation	Yes No ☐☐ ☐☐ ☐☐ ☐☐ ☐☐ ☐☐	GI symptoms Poor feeding Vomiting Abdominal distension Diarrhea	Yes No ☐☐ ☐☐ ☐☐ ☐☐
CNS symptoms Decrease activity Lethargy Irritability Tremors or seizure	Yes No ☐☐ ☐☐ ☐☐ ☐☐		

Part 2: Investigations and bacteriologic profile

CBC – WBC ---------- Hct ---------- Plt ----------	Blood culture and gram stain Organism isolated Yes ☐ No ☐ Isolated species----------
U/A - Appearance ---------- WBC---------- Nitrite---------- Leukocyte esterase ----------	Urine culture and gram stain Organism isolated Yes ☐ No ☐ Isolated species----------
CSF analysis- WBC cells/µL ---------- Glucose mg/dL ---------- Protein mg/dL ----------	CSF culture and gram stain Organism isolated Yes ☐ No ☐ Isolated species----------
Pleural fluid analysis –Appearance WBC cells/µL---------- Glucose mg/dl ---------- Protein mg/dl ---------- LDH mg/dl ----------	Pleural fluid culture and gram stain Organism isolated Yes ☐ No ☐ Isolated species----------
Peritoneal fluid analysis–Appearance	Peritoneal fluid culture and gram stain

WBC cells/µL---------- Glucose mg/dl ---------- Protein mg/dl ---------- LDH mg/dl ----------	Organism isolated Yes ☐ No ☐ Isolated species----------
	Wound swab/other site swab culture and gram stain Organism isolated Yes ☐ No ☐ Isolated species----------
CXR	

Part 4; Antimicrobial susceptibility test

Gram negative Identified organism…….	**Gram positive Identified organism……...**	Susceptibility pattern Susceptible/ Resistant
Ceftriaxone	Oxacillin	
Ceftazidime	Penicillin	
Cefepime	Gentamycin	
Augmentin	Clindamycin	
Ciprofloxacin	Erythromycin	
SXT	SXT	
Gentamycin		
Amikacin		
Nitrofurantoin		
Meropenem		

Part 5: Outcome of the patient with HAI

Any cause mortality within 14 days of being diagnosed with HAI?

Yes ☐ Date ---------- No – ☐

Discharged

Yes ☐ Date ---------- No – ☐

Length of Hospital stay after the diagnosis of HAI----------