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DEPARTMENT OF PEDIATRICS CHILD HEALTH NURSING AND MIDWIFERY

HOSPITAL ACQUIRED INFECTIONS AMONG NEONATES IN PUBLIC HOSPITALS OF ADDIS ABABA, ETHIOPIA.

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This thesis by Yordanos Yifat is accepted in its present form by the board of examiners as satisfying thesis requirement for the degree of Masters in Adult Health Nursing.

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ABBREVIATION AND ACRONYMS

CDC	Centers for Disease Control and Prevention
CPAP	Continuous Positive Airway Pressure
GA	Gestational Age
HAI	Hospital-Acquired Infection
HCAI	Healthcare-Associated Infection
IMNCI	Integrated Management of Newborn and Childhood Illness
IP	Infection Prevention
IV	Intravenous
LBW	Low Birth Weight
LOS	Length of Stay
MMR	Maternal Medical Record
MRN	Medical Record Number
NICU	Neonatal Intensive Care Unit
NMR	Neonatal Medical Record
QOC	Quality of Care
SPSS	Statistical Package for the Social Sciences
UVC	Umbilical Venous Catheter
VLBW	Very Low Birth Weight

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ABSTRACT

Background: - Hospital-acquired infections (HAIs) are a leading cause of neonatal morbidity and mortality in neonatal intensive care units (NICUs), Specifically in developing countries. Newborns are highly vulnerable to infection due to their immature immune systems, prolonged hospitalization, invasive procedures, and inadequate infection prevention and control (IPC) practices. Regardless efforts to improve neonatal care in Ethiopia, evidence regarding the prevalence of HAIs and associated factors among neonates in public hospitals is limited.

Objective: - To assess the prevalence of Hospital-acquired infections and associated factors among neonates admitted to NICUs in selected public hospitals of Addis Ababa.

Methods: - A prospective follow up study was conducted on 317 neonates admitted to NICUs in public hospitals. The neonates were followed from the time of admission to the hospital until discharge to identify infections that occurred after admission. Data were collected using structured questionnaires and observation lists. Data entry was performed using Epidata version 4.6 and analyzed using SPSS version 25. Descriptive statistics were used to summarize the study variables. Binary and multivariable logistic regression analyses were performed to identify hospital- acquired infections. Statistical significance was declared at p-value < 0.05 with 95% confidence intervals.

Results: - The prevalence of Hospital-acquired infection among admitted neonates was 43.2%. In multivariable logistic regression analysis, maternal chronic illness (AOR = 0.058, 95% CI: 0.028–0.120), poor IPC practice implementation (AOR = 5.594, 95% CI: 2.230–14.034), prematurity (<37 weeks gestation) (AOR = 4.134, 95% CI: 1.618–10.563), and prolonged NICU stay of more than seven days (AOR = 3.511, 95% CI: 1.712–7.200) were significantly associated with Hospital-acquired infections. The overall model correctly classified 80.4% of cases.

Conclusion: - Hospital-acquired infections remain a major challenge among neonates admitted to NICUs. Strengthening infection prevention and control practices, improving neonatal care, and enhancing surveillance systems are essential to reduce preventable neonatal infections and improve survival outcomes.

Keywords: Hospital-acquired infection, neonate, NICU, infection prevention and control, Ethiopia, neonatal infection, prospective follow-up study.

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

World Health Organization (WHO), define hospital-acquired infections (HAIs), also known as nosocomial infections, are infections that develop after 48 hours of admission and within 48 hours post-discharge, which were not present or incubating at the time of admission in healthcare service delivery organizations (1). These infections still continue one of a major global public health concern and treats, especially for neonates within NICUs. Neonates during hospitalization are particularly susceptible to invasive pathogens because of their poor immune systems and physiologic immaturity (2). Their risk of contracting HAIs is further increased by their different frequent exposure to invasive procedures, long time hospital stays, and broad-spectrum antibiotic therapy (2).

Every year, HAIs impact millions of patients worldwide, resulting in prolonged hospital stays, permanent disability, and high medical expenses. Research shows that compared to high-income countries, the burden of HAIs is disproportionately higher in low- and middle-income countries, ranging from three to twenty times (3). The effects are particularly severe in neonates which is Up to 40% of neonatal deaths in developing nations are caused by infections, with surgical site infections, pneumonia, meningitis, and bloodstream infections accounting for the majority of these cases (4). Overcrowded NICUs, lack of trained staff, poor hand hygiene, limited isolation rooms, and inconsistent IPC measures are all closely linked to the increased burden in resource-limited settings (5).

Neonatal mortality remains a common and serious public health issue in Ethiopia, with infections accounting for the largest share of all child deaths. According to the Ethiopia Mini Demographic and Health Survey (EMDHS 2019) (6), neonatal mortality accounts for nearly half of all child deaths. Despite several initiatives by the Federal Ministry of Health (FMoH), the high rate of neonatal HIA continues to hamper efforts to improve infant outcomes, such as strengthening training in critical care of newborns and expanding NICUs. Studies conducted in tertiary care facilities such as Jimma University Medical Center (7) and Gondar University Hospital NICU have reported neonatal HIA rates of 15-20% (8). However, data from Addis Ababa public hospitals, where many newborns are treated, are still limited.

Neonatal, maternal, and facility-level factors are all part of the multifactorial causes of neonatal HIAs (9). Premature birth, low birth weight, mechanical ventilation, intravenous catheter use, and prolonged hospitalization are among the most common risk factors for neonatal HIA. The risk of infection is also influenced by maternal factors such as delivery method and prematurity (3, 9). The high burden of HAIs is further increased at the facility level by overcrowding, poor water and sanitation infrastructure, poor hand hygiene practices, restricted access to necessary supplies, and a lack of ongoing infection prevention and control surveillance systems (1).

Many public hospitals in Ethiopia do not sufficiently implement comprehensive IPC guidelines at the national and facility levels. The lack of trained IPC staffs, insufficient surveillance systems, and restricted PPE accessibility are problems. Besides, the majority of earlier Ethiopian research was retrospective in nature and depend on medical records that limited the availability of detailed and real time exposure information. In order to generate accurate and situation-specific data about the incidence, risk factors, and preventative measures for HAIs in neonates, it is imperative that wide-ranging prospective studies be carried out.

Consequently, this study was conducted to assess the prevalence of hospital-acquired infections and associated factors among neonates admitted to NICU in public hospitals of Addis Ababa through prospective follow-up of admitted neonates during their hospitalization period. The findings from this study are expected to provide evidence for improving infection prevention strategies, strengthening neonatal care services. The other important issue is for reducing preventable neonatal morbidity and mortality, and supporting national and global health priorities, including Sustainable Development Goal (SDG) 3, which aims to ensure healthy lives and promote well-being across all ages.

1.2. Statement of the Problem

Hospital-acquired infections remain a major causes of preventable morbidity and mortality among hospitalized neonates in NICU particularly in low- and middle-income countries (3). Neonates are particularly vulnerable to the infection due to their immature immune systems and repeated medical procedures such as mechanical ventilation, intravenous catheterization, and nasogastric feeding.

These interventions create potential portal of entry points for causative agents, often leading to bloodstream infections, pneumonia, meningitis, and sepsis conditions that can become quickly fatal if it is untreated (8).

Globally, HAIs significantly impact neonatal mortality in resource-limited settings (10). Neonatal infections excessively impact developing countries with WHO data showing incidence rates 3 to 20 times higher compared to developed nations (11). The reported prevalence of neonatal HAIs ranges from 20% and 40%, advise infection prevention and control (IPC) needs work (12).

Ethiopia's intensive care units still deal with neonatal infections. Previous studies conducted in tertiary hospitals, including Jimma University Medical Center and the University of Gondar Comprehensive Specialized Hospital reports show high burden of neonatal infections. For example, findings from Gondar indicate that approximately 15.8% of acknowledged neonates acquired infections during hospitalization, with prolonged length of stay, use of mechanical ventilation, and urinary catheterization identified as major risk factors (8). However, most data come from top-tier centers, where staff levels, materials, and medical skills lean towards to be stronger compared to general public hospitals.

Even with these findings we still lack prospective data from public hospitals where urban neonates are commonly cared for. This evidence gap delays effective planning and execution of focused infection prevention and control programs. Neonatal infection burden in Addis Ababa public hospitals remains underestimated, despite their high neonatal caseloads. Recognizing real time trends in infections remains tough because past studies leaned deeply on old records. It becomes clearer to start gaps in early morning exposure monitoring when the information is based solely on what has already been written.

Moreover, there is limited prospective evidence assessing neonatal related, maternal related, healthcare worker practice related, and hospital environmental related factors associated with neonatal HAIs in Addis Ababa public hospitals. The absence of such evidence limits the ability of healthcare providers, hospitals administrators, and policymakers to design targeted interventions aimed at reducing infection related neonatal morbidity and mortality.

Therefore, this study aimed to assessing the prevalence of hospital-acquired infections and identify associated factors among neonates admitted to NICU in selected public hospitals of Addis Ababa, Ethiopia.

1.3. Significance of the Study

This study delivers a vital evidence about the prevalence of hospital-acquired infection and associated risk factors among neonates admitted to NICUs in public hospitals of Addis Ababa. The findings of the study have significant implications for healthcare providers, hospital administrators, policymakers, and researchers.

The real-world implications of this research extend to three primary levels of the healthcare system, which is Clinical Outcomes, Operational Management, Public Health Policy.

Furthermore, it supports a comprehensive analysis of the intersection between maternal, neonatal, and facility-related risk factors. Finally, this research brings into line with Ethiopia's national health priorities and Sustainable Development Goal 3.2, providing the empirical foundation required to strengthen neonatal survival strategies across the country.

CHAPTER TWO: LITERATURE REVIEW

2.1. Magnitude of Hospital-Acquired Infections among Neonates

In low- and middle-income countries, hospital-acquired infections (HAIs) are a major concern, as they are often found in settings such as neonatal intensive care units (NICUs), and inadequate resources exacerbate the situation there (9). Due to the nature of newborns and the limitations of health care systems, infections remain a problem in hospitals serving infants worldwide. Evidence from Ethiopia and similar settings suggests that newborns born in hospitals have a high and preventable burden of hospital-acquired infections (3, 8).

Studies of Ethiopian NICUs highlight this overcrowding and data-driven contextual parallels. A retrospective study conducted in Sidama region and four government hospitals reported an incidence of HIA of nearly 40% in 52,514 patient days, equivalent to 39.59 infections per 1,000 patient days (1), highlighting the importance of the problem in resource-limited settings. Similarly, a recent study in a university hospital NICU in Gondar reported an incidence of 18.2 infections per 1,000 neonatal days, for a cumulative incidence of 15.8% (8). Despite differences in study design and duration, both studies highlight prolonged length of stay and use of medical devices as key drivers of infection risk.

The same thing happened elsewhere in Western Cape hospitals in South Africa; of these, 485 developed bloodstream infections out of 23,748 patients, with a median follow-up of 11 days. Another is a four-year Turkish NICU study that demonstrated the power of surveillance (13). It is difficult to compare because the design definitions and time periods are different. HIAs continue to threaten the survival of infants everywhere, including in Ethiopia.

These studies indicate that HIAs are prevalent in Ethiopian healthcare settings and are strongly associated with longer hospital stays, invasive procedures, and poor infection control practices. However, most studies were conducted in tertiary hospitals and do not adequately represent public hospitals in Addis Ababa, where the healthcare system often faces high patient flow, overcrowding, and limited IPC resources and practices. Also, evidence from prospective follow-up studies in Addis Ababa is limited.

Overall, the literature suggests that HIAs are not isolated events but rather reflect broader system-level weaknesses in IPC surveillance and quality of care. Ethiopia urgently needs targeted data to reduce preventable neonatal morbidity and mortality.

2.2. Risk Factors and Underlying Determinants

The risk of hospital-acquired infections (HAIs) among newborns is multifactorial and is caused by the interaction of natural or biological vulnerabilities, clinical care practices, maternal conditions, and institutional factors. In Gondar, hospital stay of more than seven days, CPAP, and urinary catheters were key predictors ($p \leq 0.05$) (8). Similarly, Sidama's retrospective predictors included low birth weight, hospital type, place of delivery, and prior antibiotic use (1). Matches sub Saharan meta-analysis shows very low birth weight, devices, mechanical ventilation, prolonged hospital stays, ICU to higher risk (3). The findings make parallel with broader sub-Saharan African evidence showing that very low birth weight, invasive devices, mechanical ventilation, extended length of stay and intensive care admission substantially increase the likelihood of infection.

2.2.1. Maternal related factors associated with neonatal hospital-acquired infection

Maternal-related factors play important roles in the occurrence of hospital-acquired infections among neonates admitted to NICUs. Maternal chronic illnesses and obstetric complications may increase neonatal susceptibility to infection directly through vertical transmission or indirectly by increasing neonatal complications and prolonged hospitalization (14).

Maternal chronic illnesses such as diabetes mellitus, hypertension, and infectious diseases have been associated with poor neonatal outcomes and increased infection susceptibility (12) and also Neonates born from mothers with chronic illnesses often need intensive monitoring and prolonged NICU admission, increasing exposure to hospital-acquired infection pathogens. Previous studies conducted in Ethiopia have confirmed significant associations between maternal medical conditions and poor neonatal outcomes (1, 8).

Prolonged rupture of membranes (PROM) is one of the most frequently reported maternal predictors of neonatal infection. Prolonged exposure of the fetus to ascending bacterial contamination increases the likelihood of neonatal sepsis and hospital-acquired infections (15).

Studies conducted in low-resource settings have shown that neonates born following PROM were significantly more likely to develop infectious complications compared with those delivered without prolonged membrane rupture (16).

Maternal intrapartum fever and untreated maternal infections have also been associated with increased risk of neonatal infection. Maternal fever during labor may indicate bacterial infection, which may worsen neonatal colonization and subsequent infection in the hospital. (17).

The mode of delivery has also been investigated to influence the incidence of neonatal infections in the hospital. Cesarean section delivery may increase the risk of invasive procedures and prolonged hospitalization in newborns. (18). However, evidence on the relationship between mode of delivery and HAIs is inconsistent across studies. Some studies reported increased infection risk following cesarean delivery, whereas others found no statistically significant association (19).

Maternal antibiotic exposure during pregnancy and delivery has also been investigated in previous studies. Although prophylactic antibiotic use may reduce some maternal and neonatal infectious complications, inappropriate antibiotic use may contribute to antimicrobial resistance and altered neonatal microbial colonization (20).

Despite the recognized importance of maternal-related factors, many Ethiopian studies have focused primarily on clinical aspects of newborns and have paid limited attention to maternal characteristics. Therefore, a comprehensive assessment of maternal-related factors is still necessary to understand the multifaceted nature of hospital-acquired infections in newborns.

2.2.2. Neonatal-related factors associated with hospital-acquired infection

Neonatal-related factors are among the most consistently known predictors of hospital-acquired infections in NICUs. Factors like Prematurity, low birth weight, prolonged hospital stay, low APGAR score, invasive medical procedures, and device utilization considerably increase neonatal susceptibility to infection (3).

Premature birth is a leading cause of neonatal infection because premature neonates have immature immune systems, reduced skin integrity, and limited physiological defense mechanisms (21). A study conducted at the University of Gondar Comprehensive Specialized Hospital found

that premature babies are more than four times more likely to develop hospital-acquired infections compared to babies born at term (AOR = 4.4; 95% CI: 2.4–8.0) (8).

Low birth weight is another important risk factor for HIV in neonates. Very low birth weight neonates often require prolonged hospitalization and invasive supportive interventions, which increases the risk of exposure to pathogens. Studies in sub-Saharan Africa have reported significantly higher rates of infection in low birth weight neonates compared with neonates of normal birth weight (3).

The APGAR score is an important indicator of the health status of neonates and their susceptibility to infection. Neonates with low APGAR scores often require rapid resuscitation, oxygen support, and invasive monitoring, which increases their risk of developing respiratory infections. A study in Ethiopia found that newborns with low APGAR scores were more likely to develop infections than neonates with normal APGAR scores (22).

Previous studies have also reported sex-related differences in the risk of neonatal infection. Male newborns are often considered biologically more susceptible to infectious diseases because of immune and hormonal differences. However, findings on the relationship between sex and infection risk in newborns are inconsistent across studies (23).

NICU length of stay is one of the strongest predictors of hospital-acquired infections. Longer hospital stays involve higher exposure to healthcare environments, contaminated equipment, and invasive procedures. A study in Gondar found that infants admitted for more than seven days were approximately four times more likely to develop HAI than those admitted for shorter stays (AOR = 3.8; 95% CI: 1.9–7.4) (8). Similarly, studies in Sidama region confirmed that longer hospital stays play a significant role in neonatal infections (1).

Invasive medical procedures such as mechanical ventilation, intravenous catheterization, urinary catheterization, and nasogastric tube insertion increase the risk of infection by disrupting natural defense barriers and creating entry points for pathogens (12). Device-associated infections remain among the most common forms of HAIs in NICUs globally.

Overall, characteristics associated with newborns are important determinants of hospital-acquired infections and highlight the importance of strengthening clinical care practices for newborns and reducing unnecessary invasive interventions.

2.2.3. Infection prevention and control practices factors

Effective infection prevention and control (IPC) practices are essential to reduce hospital-acquired infections in NICUs. Evidence shows that adherence to IPC protocols significantly reduces neonatal morbidity and mortality associated with hospital-acquired infections (24).

Hand hygiene is considered the most effective intervention for preventing STIs. The World Health Organization (WHO) recommends strict adherence to hand hygiene before and after patient contact and during invasive procedures (1). However, compliance is still poor in many resource-limited healthcare facilities due to inadequate infrastructure, shortages of essential supplies, and inadequate training of healthcare professionals.

Studies conducted in Ethiopian hospitals have identified significant gaps in IPC implementation. A study conducted in Debre Tabor found that only 59.4% of healthcare professionals demonstrated adequate infection prevention knowledge and practice (25). Inadequate access to alcohol-based hand rubs, inconsistent glove utilization, and poor sterilization practices were major barriers identified in the study.

Proper use of personal protective equipment (PPE) is also essential to prevent the spread of pathogens in NICUs. Inadequate or inconsistent use of PPE exposes healthcare workers and newborns to infectious microorganisms (26). However, shortages of gloves, gowns, masks, and disinfectants remain common challenges in many public hospitals in Ethiopia.

Sterilization and cleaning of reusable medical equipment are equally important components of infection prevention. Failure to adequately clean incubators, suction machines, and medical devices can facilitate the spread of contamination among hospitalized neonates (13).

Training and supportive supervision of healthcare professionals is essential to improve adherence to IPC standards. Evidence shows that regular IPC training, counseling, and supervision significantly improve adherence to infection prevention guidelines and reduce infection rates (24).

Despite national IPC guidelines in Ethiopia, implementation in healthcare facilities is inconsistent due to weak monitoring systems, limited institutional commitment, and a shortage of trained IPC staff.

2.2.4. Hospital environmental and health system factors

Hospital environmental conditions and health system capacity have a significant impact on the incidence of hospital-acquired infections among newborns. Overcrowding, inadequate water and sanitation infrastructure, staffing constraints, and inadequate infection control resources contribute significantly to the spread of infections in NICUs (27).

Crowded NICUs increase close contact between newborns, caregivers, and healthcare workers, thereby facilitating the rapid transmission of pathogens. High patient turnover and limited bed capacity hinder compliance with infection control measures and increase the risk of cross-contamination (2).

Water, sanitation and hygiene (WASH) infrastructure is also crucial for infection prevention. Limited access to clean water, poor waste disposal systems, and inadequate environmental sanitation reduce the effectiveness of IPC interventions (30). Several Ethiopian public hospitals continue to face major challenges related to sanitation infrastructure and environmental hygiene.

Nurse-to-patient ratio is another important determinant of neonatal infection risk. High workload and staff shortages reduce the ability of healthcare workers to adhere to standard infection prevention practices, such as hand hygiene and sterilization of instruments (24). Studies conducted in resource-limited settings have consistently linked understaffed NICUs with increased hospital-acquired infections rates.

Isolation facilities are essential to prevent the spread of infectious pathogens among newborns in hospitals. However, many public hospitals in Ethiopia lack adequate isolation wards and combing systems, which increases the risk of transmission in NICUs (28).

The availability of essential IPC supplies such as gloves, disinfectants, sterilization equipment, alcohol-based hand rubs, and clean water is critical to maintaining a safe environment for newborn care. Frequent stockpiling and limited procurement systems make it difficult to effectively implement infection prevention measures in many public hospitals.

Overall, the literature suggests that hospital-acquired infections in newborns are influenced not only by individual clinical factors but also by broader institutional, environmental, and health system-related determinants. Therefore, improving hospital infrastructure and strengthening health care systems are important strategies to reduce neonatal HAIs**.**

2.3. Summary of the Literature Review

The literature consistently shows that hospital-acquired infections are a major contributor to neonatal morbidity and mortality, particularly in low-resource NICU settings. International and Ethiopian evidence suggests that neonatal HAIs are strongly associated with preterm birth, prolonged hospitalization, invasive procedures, inadequate infection control practices, and poor healthcare infrastructure.

Maternal factors such as chronic illness, prolonged rupture of membranes, and maternal infections contribute significantly to neonatal vulnerability. In addition, institutional challenges including overcrowding, staffing constraints, poor sanitation infrastructure, and inadequate IPC resources further increase the burden of hospital-acquired infections.

Although several studies in Ethiopia have examined neonatal HAIs, most have been conducted in tertiary hospitals and are primarily based on retrospective study designs. Prospective evidence from public hospitals in Addis Ababa is limited.

Therefore, this study was conducted to assess the prevalence and associated factors of hospital-acquired infections in public hospital NICUs in Addis Ababa, Ethiopia.

2.4. Conceptual Framework

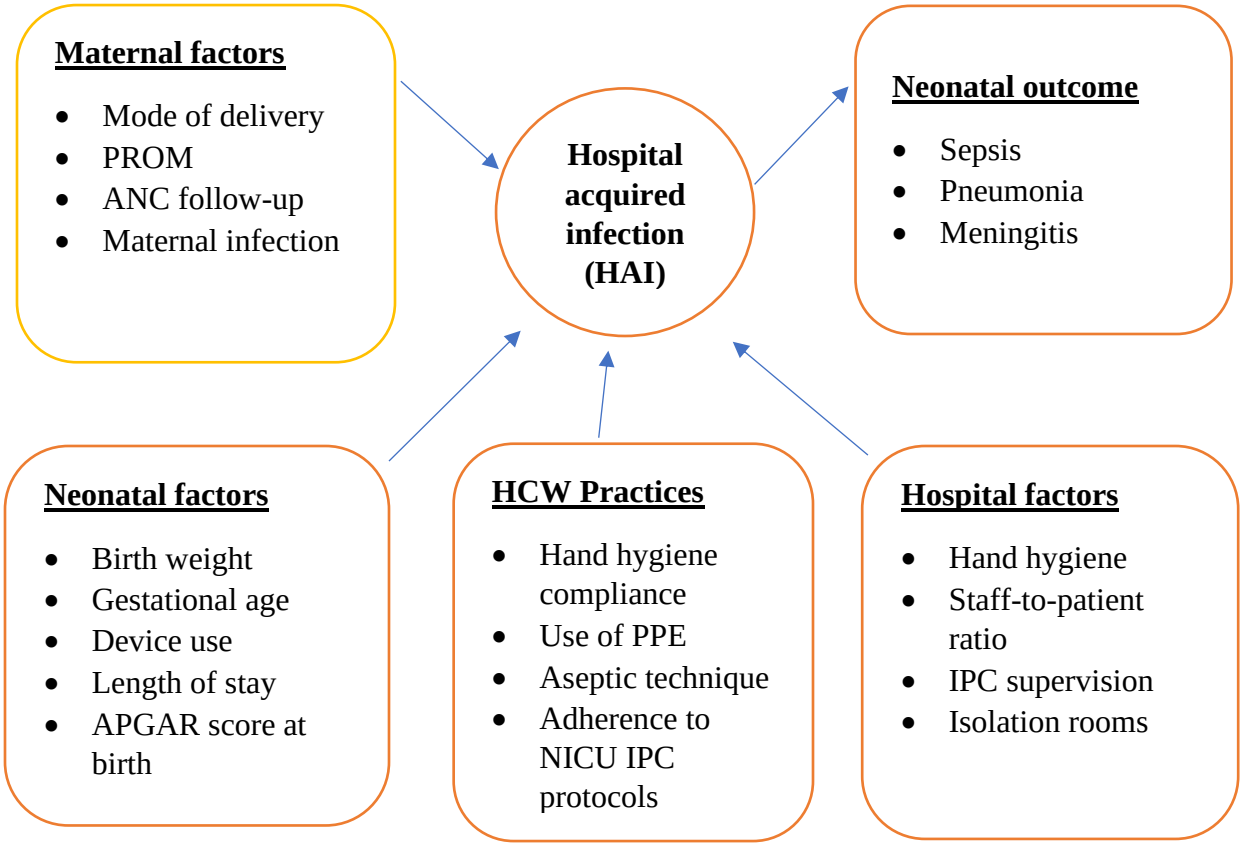


Figure 1 : Conceptual framework of "Hospital-Acquired Infections Among Neonates in Public Hospitals of Addis Ababa, Ethiopia, 2026" (3, 8).

CHAPTER THREE: OBJECTIVES

3.1. General Objective

To assess the prevalence, risk factors, and prevention practices related to hospital-acquired infections among neonates admitted to neonatal intensive care units (NICUs) in public hospitals of Addis Ababa, Ethiopia, in 2026.

3.2. Specific Objectives

- To determine the prevalence of hospital-acquired infections among neonates admitted to NICUs.
- To identify neonatal, maternal, and clinical care factors associated with hospital-acquired infections.
- To assess healthcare workers' adherence to infection prevention and control (IPC) practices in NICUs.
- To assess hospitals environment related factors associated with hospital-acquired infections in NICUs.

CHAPTER FOUR: MATERIALS AND METHODS

4.1. Study Area and Period

The study was conducted in Addis Ababa, Ethiopia, from March to June 2026. All public hospitals in Addis Ababa with functional neonatal intensive care unit (NICU) services constituted the sampling frame. From this sampling frame, four hospitals were selected using a simple random (lottery) method to ensure equal probability of selection and improve representativeness and generalizability, in line with WHO recommendations.

The selected hospitals are Zewditu Memorial Hospital, Tirunesh Beijing General Hospital, Gandhi Memorial Hospital, and Yekatit 12 Hospital Medical College. These hospitals provide comprehensive NICU services and manage a substantial neonatal caseload.

Data collection was carried out from March to April 2026. Data cleaning, analysis, and report writing were conducted from end of April to June 2026**.**

4.2. Study Design

A prospective follow-up study was conducted.

4.3. Population

4.3.1. Source population

All neonates admitted to NICUs of Gandhi Memorial, Tirunesh Beijing, Zewditu Memorial and Yekatit 12 Hospitals during the study period.

4.3.2. Study population

All neonates admitted to the selected NICUs who remain in the unit for ≥48 hours during the data collection period and whose records contain the minimum required information**.**

4.4. Inclusion and Exclusion Criteria

4.4.1. Inclusion criteria

Neonates were included in the study if they meet all of the following criteria:

- Neonates aged 0-28 days admitted to the neonatal intensive care units (NICUs) of the selected public hospitals in Addis Ababa during the study period.
- Neonates who have been hospitalization in the NICU for 48 hours or more.
- Neonates whose mothers or legal guardians provide written informed consent for the participation in study.
- Neonates with complete and accessible medical records containing the minimum required neonatal and maternal clinical information.
- Neonates who are free from signs and symptoms of infection at the time of admission, as documented in the initial clinical assessment.

4.4.2. Exclusion criteria

Neonates were excluded from the study if they meet any of the following criteria:

- Neonates with clinical or laboratory confirmed infection at the time of admission to the NICU.
- Neonates who are discharged, referred, or die within 48 hours of NICU admission.
- Neonates with major congenital anomalies (such as neural tube defects, congenital heart disease, or gastrointestinal malformations) that may independently increase the risk of infection or complicate clinical assessment.
- Neonates whose mothers or legal guardians decline or withdraw written informed consent during the study period.
- Neonates with incomplete, missing, or inaccessible medical records that limit accurate assessment of exposure variables or study outcomes.

4.5. Sampling Technique and Sample Size

4.5.1. Sampling technique

Selection of Hospitals

A simple random sampling (lottery) method was used to select hospitals. All public hospitals in Addis Ababa with functional NICU services were listed and assigned unique identification numbers, from which four hospitals were randomly selected.

Selection of Neonates

A consecutive sample was employed in each selected hospital. All neonates admitted during the data collection period were consecutively enrolled until the assigned sample size was achieved.

4.5.2. Sample size determination

Although the study used a prospective follow-up design, the sample size was calculated using a population-based formula because the primary objective was to estimate the prevalence of hospital-acquired infections among newborns admitted to NICUs. The prevalence estimate was derived from a previous study conducted in Ethiopia under similar circumstances. A prospective follow-up approach was used to confirm the occurrence of hospital-acquired infections in the hospital and to assess associated factors. Therefore, a sample size decision based on relevance was considered appropriate to achieve the primary objective of the study.

The sample size was calculated using the single population proportion formula:

$$n = (Z^2 * P * (1-P)) / d^2$$

Where:

- n = required sample size
- Z = Z-score corresponding to 95% confidence level (1.96)
- P = estimated prevalence of hospital-acquired infections (HAIs) among neonates. Based on prior Ethiopian studies, P = 0.25 (25%) (7, 8)
- d = margin of error, set at 5% (0.05)

Calculation:

$n = (1.96^2 * 0.25 * (1-0.25)) / (0.05^2) = (3.8416 * 0.25 * 0.75) / 0.0025 = 0.7203 / 0.0025 = 288.1$

Considering a 10% non-response or attrition rate:

$n\ final = 288 + (0.1 * 288) = 288 + 28.8 \approx 317$

Final sample size: 317 neonates

4.5.3. Sampling procedure

The total sample size of 317 neonates was proportionally allocated to each of the four selected hospitals based on their average monthly NICU admission case load, which is the recommended approach for health facility–based studies to enhance representativeness and precision.

Based on average monthly admissions, the proportional allocation was as follows:

Table 1: The proportional allocation to each of the four selected hospitals based on their average monthly NICU admission case load.

Hospital	Avg. monthly NICU admissions	Proportion	Allocated sample
Zewditu Memorial Hospital	120	0.122	**39**
Tirunesh Beijing General Hospital	100	0.102	**32**
Gandhi Memorial Hospital	575	0.584	**185**
Yekatit 12 Hospital Medical College	190	0.193	**61**
Total	**985**	**1.000**	**317**

Within each hospital, eligible neonates were enrolled consecutively and followed daily during their NICU stay until discharge or diagnosis of a hospital-acquired infection.

4.6. Operational Definitions

Hospital-Acquired Infection (HAI): An infection occurring in a neonate who has been admitted to the neonatal care unit for ≥ 48 hours, which was not present or incubating at the time of admission, and is identified based on clinical signs and/or laboratory evidence of infection after the first 48 hours of hospitalization (1).

Measurement Approach

Hospital-acquired infection was measured using:

- Daily prospective surveillance of admitted neonates during their NICU stay
- Review of neonatal medical records, including progress notes, laboratory results, and physician diagnoses
- Direct observation and documentation of clinical signs of infection recorded after 48 hours of hospitalization

Neonate: A newborn aged ≤28 days.

Infection Prevention Practices:

Infection prevention practice refer to observable and measurable infection prevention and control (IPC) actions performed by healthcare providers in NICU. These practices were assessed through direct observation using a structured IPC observation checklist during routine clinical care.

The checklist was evaluated adherence to the following IPC components:

- Hand hygiene compliance (performed / not performed at WHO 5 moments) (29, 30).
- Use of personal protective equipment (PPE) (correct / incorrect use) (29, 30).
- Aseptic technique during procedures (adherent / non-adherent) (29, 30).
- Equipment cleaning and disinfection (done/not done per protocol) (29, 30).
- Environmental hygiene (clean bedside surfaces, incubators, and procedure areas) (29, 30).

Each item was scored as "1 = compliant" or "0 = non-compliant," and a composite score was categorized practice as:

- Good practice: ≥80% compliance (30).
- Poor practice: <80% compliance (30).

4.7. Definition of Variables

Dependent Variable: Hospital-acquired infection (HAI)

- **Yes (1):** Neonates develop a hospital acquired infection ≥48 hours after NICU admission.
- **No (0):** Neonates dose not develop a hospital acquired infection during hospital stay.

Independent Variables:

- Neonatal factors: gestational age, birth weight, device use (IV lines, ventilators, catheters), length of NICU stay.
- Maternal factors: mode of delivery, prolonged rupture of membranes (PROM), antenatal care follow-up, maternal infections.
- Hospital factors: hand hygiene facilities, staff-to-patient ratio, availability of isolation rooms, IPC supervision and training.

4.8. Data Collection Method

The following data collection tools was used:

1. **Neonatal and Maternal Medical Record Review Checklist**

   This tool was used to extract information from neonatal and maternal medical records, including socio-demographic characteristics, pregnancy and delivery history, neonatal clinical conditions, use of invasive devices, length of NICU stay. Admission notes and daily progress records was reviewed to confirm the absence of infection at admission and to identify the onset of any hospital-acquired infection.

2. **Health Facility Assessment Questionnaire**

   This tool was used to collect data on NICU infrastructure and facility-level factors, including availability of hand hygiene facilities, PPE and antiseptics, nurse-to-patient ratio, isolation rooms, IPC guidelines, and frequency of IPC supervision.

3. **Direct Observation Checklist for Infection Prevention and Control (IPC) Practices**

   A structured observation checklist was used to assess healthcare workers' adherence to infection prevention and control practices in the NICU. Observations were focus on hand hygiene compliance, use of personal protective equipment (PPE), aseptic technique during procedures, equipment disinfection, and environmental cleanliness.

4.9. Data Quality Control

Several steps were taken to ensure the completeness, validity, accuracy, and consistency of the data. The data collection instruments were reviewed by the principal investigator and academic advisors for clarity, relevance, and alignment with the study objectives and conceptual framework.

Prior to actual data collection, the instruments were pre-tested at Menelik II Comprehensive Specialized Hospital for two consecutive days. The medical record review and HAI monitoring instruments were pre-tested using 16 neonatal records, which is equivalent to approximately 5% (317) of the final sample size. The facility review and healthcare worker IPC observation instruments were pre-tested to assess their clarity, applicability, and feasibility. Necessary changes were made based on the findings of the pre-test prior to actual data collection.

Data collectors and supervisors received standard training on the study objectives, HAI definitions, data collection procedures, medical record retrieval, and IPC observation. Supervisors reviewed completed instruments daily for completeness and consistency, and regular team meetings were held to address data collection challenges. Collected data were entered into EpiData version 4.6, checked for completeness and consistency, cleared for missing values and errors, and exported to SPSS version 25 for analysis. A sample of the entered records was cross-checked with the original data collection forms to minimize data entry errors.

4.10. Data Analysis

The collected data were checked for completeness and consistency before being entered into EpiData version 4.6 and then exported to SPSS version 25 for analysis. Descriptive statistics such as frequencies and percentages were used to summarize socio-demographic characteristics, maternal factors, neonatal characteristics, infection prevention and control (IPC) practice characteristics, hospital environmental characteristics and the prevalence of hospital-acquired infections (HAIs).

The prevalence of hospital-acquired infection was determined by calculating the proportion of newborns with infection after 48 hours of follow-up. The results were presented using tables, figures and narrative descriptions.

Binary logistic regression analysis was used to assess the association between independent variables and hospital-acquired infections. Initially, binary logistic regression analysis was performed to identify candidate variables associated with HAIs. Variables with a p-value less than 0.25 in the bivariate analysis were entered into a multivariable logistic regression model, to control for potential confounding effects.

Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated to determine the strength and direction of the association between independent variables and HAIs. Statistical significance was declared at a p-value less than 0.05.

Model fit was assessed using the Hosmer-Lemshaw goodness-of-fit test. Multicollinearity among independent variables was checked before inclusion in the final model. The final multivariable logistic regression model included maternal chronic illness, IPC practice assessment status, maternal age, infant sex, 5-minute APGAR score, gestational age, and length of NICU stay.

Since newborns were followed from hospital admission to discharge and then 48 hours later to determine the occurrence of infection, the analysis focused on estimating the prevalence of infection and identifying factors associated with the occurrence of hospital-acquired infections among hospitalized newborns.

4.11 Ethical Considerations

Ethical clearance for the study was obtained from department of pediatrics child health nursing and midwifery, school of nursing and midwifery. Additional approval was secured from the Addis Ababa Health Bureau and the administrations of all participating hospitals. Informed written consent was obtained from mothers or legal guardians of all enrolled neonates before data collection begins.

Confidentiality was maintained throughout the study by assigning anonymized identification codes and securely storing all collected data. Participation in the study voluntary participated.

CHAPTER FIVE: RESULTS

5.1. Socio-Demographic and Clinical Characteristics of Neonates and Mothers

A total of 317 mothers of newborns in the NICU were included in the study. More than half (53.6%) of the mothers were between 26-40 years of age. Most (94.6%) lived in urban areas, and 270 (85.2%) were married. Regarding educational level, 135 (42.6%) had a high school education, and 121 (38.2%) had college or higher. In terms of occupation, 135 (42.6%) were housewives. The majority of the participants, 198 (62.5%), had 1-3 family members.

Table 2: Socio-demographic characteristics of mothers of neonates admitted to NICU hospitals in Addis Ababa, Ethiopia, 2026 (n = 317)

Variable	Category	Frequency (n)	Percent (%)
Hospital	Zewditu	39	12.3
	Tirunesh	32	10.1
	Gandhi	185	58.4
	Yekatit 12	61	19.2
Residence	Urban	300	94.6
	Rural	17	5.4
Marital status	Single	47	14.8
	Married	270	85.2

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Table 2 (Continued from previous page)

Variable	Category	Frequency (n)	Percent (%)
Educational status	No formal education	21	6.6
	Primary	40	12.6
	Secondary	135	42.6
	College and above	121	38.2
Occupation	Housewife	135	42.6
	Government employee	55	17.4
	Private employee	92	29.0
	Student	35	11.0
Family size	1–3	198	62.5
	4–6	67	21.1
	6–10	52	16.4
Maternal age	18–25 years	147	46.4
	26–40 years	170	53.6

5.2. Maternal Related Factors Characteristics

Regarding maternal related factors characteristics, 160 (50.5%) mothers delivered via vaginal delivery and 60 (18.9%) delivered via cesarean section. Most mothers (282) (89.0%) received prenatal care. Among the mothers who received ACNC care, 150 (53.2%) had 1-3 ACNC visits. Maternal infection during pregnancy was reported in 38 (12.0%) mothers. Similarly, rupture of membranes during labor and prolonged maternal fever were reported in 36 (11.4%) and 38 (12.0%) mothers, respectively. Most mothers (261) (82.3%) had no chronic medical conditions.

Table 3: Maternal-related characteristics among mothers of neonates admitted to NICU hospitals in Addis Ababa, Ethiopia, 2026 (n = 317)

Variable	Category	Frequency (n)	Percent (%)
Mode of delivery	Spontaneous vaginal delivery	160	50.5
	Assisted vaginal delivery	97	30.6
	Cesarean section	60	18.9
ANC follow-up	Yes	282	89.0
	No	35	11.0
Number of ANC visits (n=282)	1–3 visits	150	53.2
	4–8 visits	132	46.8

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Table 3 (Continued from the previous page)

Variable	Category	Frequency (n)	Percent (%)
Maternal infection during pregnancy	Yes	38	12.0
	No	279	88.0
Prolonged rupture of membranes	Yes	36	11.4
	No	281	88.6
Maternal chronic illness	None	261	82.3
	HIV	21	6.6
	Psychiatric illness	35	11.0
Maternal fever during labor	Yes	38	12.0
	No	279	88.0

5.3. Neonatal Related Factors Characteristics

Of the neonates, 201 (63.4%) were male. The majority, 231 (72.9%) had a birth weight greater than 2500 grams, and 66 (20.8%) were premature. Regarding the five-minute APGAR score, 110 (34.7%) had a score between 7 and 10. The majority, 311 (98.1%), were singletons. Resuscitation was necessary for 47 (14.8%) of the newborns at birth. The majority, 248 (78.2%) stayed in the NICU for 1-7 days, and 270 (85.2%) recovered and were discharged home.

Table 4: Neonatal-related characteristics among neonates admitted to NICU hospitals in Addis Ababa, Ethiopia, 2026 (n = 317)

Variable	Category	Frequency (n)	Percent (%)
Sex of neonate	Male	201	63.4
	Female	116	36.6
Birth weight	>2500 grams	231	72.9
	1500–2499 grams	45	14.2
	<1500 grams	41	12.9
Gestational age	<37 weeks	66	20.8
	37–42 weeks	251	79.2
APGAR score at 1 minute	0–3	35	11.0
	4–6	67	21.1
	7–10	215	67.8

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Table 4 (Continued from the previous page)

Variable	Category	Frequency (n)	Percent (%)
APGAR score at 5 minutes	4–6	207	65.3
	7–10	110	34.7
Multiple birth	Singleton	311	98.1
	Twin	6	1.9
Resuscitation required at birth	Yes	47	14.8
	No	270	85.2
Length of NICU stay	>7 days	69	21.8
	1–7 days	248	78.2
Outcome at discharge	Recovered and discharged	270	85.2
	Referred	47	14.8

5.4. IPC Practice Characteristics

Regarding IPC practices, hand hygiene before touching newborns was practiced in 94 (29.7%) of the observations, and hand hygiene after exposure to body fluids was practiced in 215 (67.8%) of the observations. Gloves were used during invasive procedures in 248 (78.2%) of the observations. The majority of healthcare providers, 290 (91.5%), used masks when indicated, and 292 (92.1%) cleansed the skin with antiseptic before IV insertion or invasive procedures.

Table 5: Infection prevention and control (IPC) practice characteristics in NICU hospitals, Addis Ababa, Ethiopia, 2026 (n = 317)

IPC Practice	Yes n (%)	No n (%)
Hand hygiene before touching neonate	94 (29.7)	223 (70.3)
Hand hygiene before aseptic procedure	194 (61.2)	123 (38.8)
Hand hygiene after body fluid exposure	215 (67.8)	102 (32.2)
Hand hygiene after touching neonate	136 (42.9)	181 (57.1)
Hand hygiene after touching surroundings	109 (34.4)	208 (65.6)
Gloves used during procedures	248 (78.2)	69 (21.8)
Gloves changed between patients	189 (59.6)	128 (40.4)
Mask used when indicated	290 (91.5)	27 (8.5)
PPE discarded properly after use	146 (46.1)	171 (53.9)
Skin disinfected before IV insertion	292 (92.1)	25 (7.9)
Gown/apron used during invasive procedures	148 (46.7)	169 (53.3)

5.5. Hospital Environmental Related Factors Characteristics

Of the four hospitals assessed, all had functional handwashing stations and isolation rooms for exposed newborns. Half of the hospitals had more than 10 NICU beds and hand sanitizers in the care area. They did not report adequate PPE provision or IPC training for staff in the past 12 months. Regular IPC monitoring was conducted in all hospitals.

Table 6: Hospital environmental and institutional characteristics of NICU settings in Addis Ababa, Ethiopia, 2026 (n = 4 hospitals)

Variable	Category	Frequency (n)
Number of NICU beds	6–10	2
	>10	2
Nurse-to-patient ratio	1:2	2
	1:>3	2
Functional handwashing station	Yes	4
Hand rub available	Yes	2
	No	2
Adequate PPE supply	Yes	0
	No	4
Isolation room available	Yes	4

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Table 6 (Continued from the previous page)

Variable	Category	Frequency (n)
IPC guideline available	Yes	2
	No	2
Routine IPC supervision	Yes	4
Frequency of supervision	Monthly	2
	Irregular	2
IPC training in last 12 months	Yes	0
	No	4

5.6. Magnitude of Hospital-Acquired Infections

The prevalence of hospital-acquired infections among hospitalized newborns was 43.2% (137/317). The majority of infected newborns, 125 (91.2%), had neonatal sepsis, and 12 (8.8%) had meningitis.

Table 7: Magnitude of hospital-acquired infections among neonates admitted to NICU hospitals in Addis Ababa, Ethiopia, 2026 (n = 317)

Variable	Category	Frequency (n)	Percent (%)
Developed HAI after 48 hours	Yes	137	43.2
	No	180	56.8
Type of HAI (n=137)	Sepsis	125	91.2
	Meningitis	12	8.8

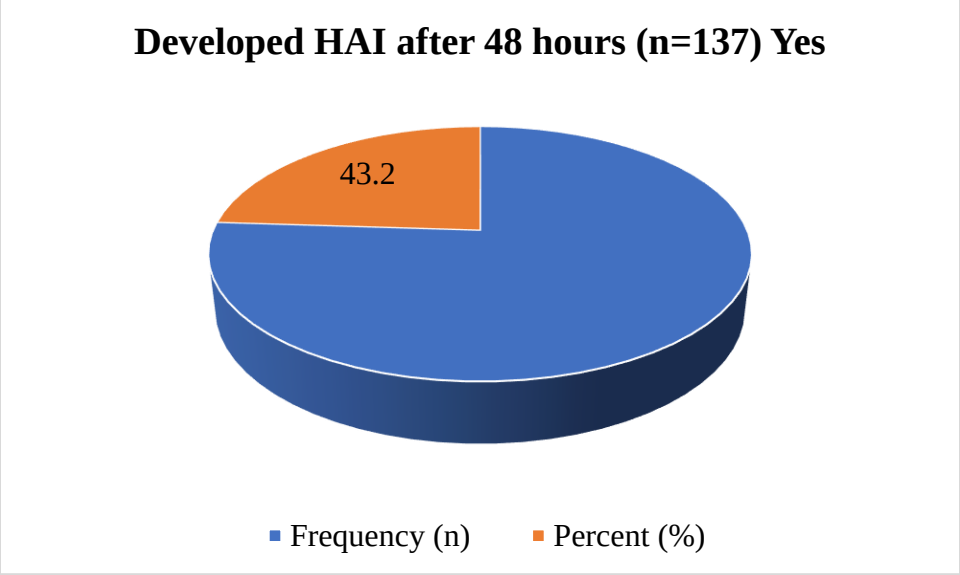


Figure 2: Prevalence of hospital-acquired infections among neonates admitted to NICU hospitals in Addis Ababa, Ethiopia, 2026 (n = 317)

5.7. Factor Associated with Hospital-Acquired Infections

In multivariable logistic regression analysis, maternal chronic illness, IPC practice assessment, gestational age, and NICU length of stay were significantly associated with HAIs.

Neonates born to mothers without chronic illness were 94.2% less likely to develop hospital-acquired infections compared with neonates born to mothers with chronic illness (AOR = 0.058, 95% CI: 0.028–0.120).

Neonates with poor IPC practice assessment (<80%) in NICUs were 5.6 times more likely to develop hospital-acquired infections compared with neonates with good IPC practice assessment in NICUs (AOR = 5.594, 95% CI: 2.230–14.034).

Neonates born prematurely (less than 37 weeks of gestation) were 4.1 times more likely to develop hospital-acquired infections compared with neonates born at term (AOR = 4.134, 95% CI: 1.618–10.563).

Similarly, neonates who stayed in the NICU for more than 7 days were 3.5 times more likely to develop hospital-acquired infections compared with those who stayed for 1–7 days (AOR = 3.511, 95% CI: 1.712–7.200).

In multivariable logistic regression analysis ($p > 0.05$), maternal age, infant gender, and 5-minute APGAR score were not significantly associated with hospital-acquired infections.

Table 8: Bivariate and multivariate logistic regression analysis of association between hospital-acquired infections among neonates admitted to the NICU (N = 317)

Variable	Category	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal chronic illness	No	0.056 (0.031–0.101)	<0.001	0.058 (0.028–0.120)	<0.001*
	Yes	1		1	

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Table 8 (Continued from previous page)

Variable	Category	COR (95% CI)	P-value	AOR (95% CI)	P-value
IPC practice evaluation	Poor (<80%)	4.741 (2.227–10.091)	<0.001	5.594 (2.230–14.034)	<0.001*
	Good (>80%)	1		1	
Maternal age	18–25 years	1.398 (0.894–2.184)	0.142	1.321 (0.711–2.455)	0.379
	26–40 years	1		1	
Sex of neonate	Male	0.723 (0.456–1.146)	0.168	0.619 (0.301–1.271)	0.191
	Female	1		1	
APGAR score at 5 min	4–6	1.737 (1.077–2.802)	0.024	1.003 (0.535–1.881)	0.993
	7–10	1		1	
Gestational age	<37 weeks	4.425 (2.448–7.999)	<0.001	4.134 (1.618–10.563)	0.003*
	37–42 weeks	1		1	
Length of NICU stay	>7 days	1.473 (0.863–2.517)	0.156	3.511 (1.712–7.200)	0.001*
	1–7 days	1		1	

*Significant at $p < 0.05$

Although device-related variables (such as intravenous line use, ventilator support, and catheterization) were included in the data collection instrument, they were not included in the final regression analysis because the incidence was too low and insufficient for meaningful statistical analysis. As a result, stable estimates could not be generated, and these variables were excluded from the multivariate model.

CHAPTER SIX: DISCUSSION

This study assessed the prevalence of hospital-acquired infections (HAIs) and associated factors among neonates admitted to the neonatal intensive care unit (NICU). The findings indicated that hospital-acquired infections continue to be a major public health concern among hospitalized neonates. The study identified several factors related to maternal, neonatal, and infection prevention and control (IPC) practices that were significantly associated with the occurrence of HAIs.

The prevalence of hospital-acquired infections identified in this study was high, indicating that a significant number of newborns developed infections within 48 hours of hospital admission. This finding is consistent with studies in Ethiopia and other low- and middle-income countries, where neonatal health care facilities with weak infection control systems, overcrowding, and limited health care resources contribute significantly to neonatal morbidity and mortality (1, 3, 8). The finding is comparable with the study conducted at the University of Gondar Comprehensive Specialized Hospital, which reported a cumulative incidence of 15.8% among admitted neonates (8). Similarly, retrospective studies from the Sidama region and other Ethiopian settings also documented high infection burdens in NICUs (1). The similarity can be explained by the same health care infrastructure limitations, lack of trained IPC professionals, and inadequate infection control systems in public hospitals in Ethiopia.

Maternal chronic illness has been found to be significantly associated with hospital-acquired infections among neonates. neonates born to mothers without chronic illness were less likely to develop chronic illness compared with neonates born to mothers with chronic illness. The strong protective effect of maternal chronic illness (AOR = 0.058) observed should be interpreted with caution due to the limited data available in some cells and potential confounding. Although the association remained statistically significant in the adjusted model, further studies are needed to confirm this finding. Maternal chronic illness may increase the risk of neonatal infection through poor maternal health, increased complications during delivery, and prolonged neonatal hospitalization. This finding is supported by previous literature showing that maternal medical conditions contribute to neonatal vulnerability and adverse neonatal outcomes (7, 13, 16).

The IPC practice assessment showed a strong association with hospital-acquired infections. Neonates admitted to settings with poor IPC practice scores (<80%) were at higher risk of infection compared to those in settings with better IPC performance. This finding highlights the critical importance of adhering to infection control protocols in NICUs. Similar findings have been reported in healthcare settings in Ethiopia; inadequate hand hygiene, lack of personal protective equipment, and inconsistent cleaning practices have been reported to contribute significantly to hospital-acquired infections (5, 24). The results emphasize the need to strengthen IPC implementation, monitoring, and ongoing surveillance in neonatal care units.

Gestational age was another significant predictor of hospital-acquired infections. Neonates born prematurely (less than 37 weeks of gestation) were more likely to develop the disease than neonates born full-term. This finding is biologically plausible, as premature infants have immature immune systems, immature skin barriers, and often require invasive procedures and prolonged hospitalization. Similar findings have been reported in studies in Gondar and sub-Saharan Africa, where prematurity significantly increased the risk of infection among NICU admissions (8, 19).

Length of NICU stay was significantly associated with hospital-acquired infections. neonates who stayed in the NICU for more than seven days were at higher risk of infection compared with those who stayed for a shorter period. The association between NICU stay and outcome was not significant in the bivariate analysis but became significant after adjustment, possibly due to confounding factors such as gestational age, APGAR score, and severity of illness. After controlling for these variables, longer NICU stay showed an independent association, which may reflect an increased risk of prolonged hospitalization, including infections and other complications. Prolonged hospitalization increases the risk of invasive procedures, contaminated hospital environments, and multidrug-resistant pathogens. This finding is consistent with studies in Ethiopia and other developing countries that have identified high risk factors for HAIs in newborns (1, 8).

Although maternal age, neonatal sex, and five-minute APGAR score were associated in bivariate analyses, they were not statistically significant in the final multivariate model. This may indicate that their effects were confounded by strong clinical and institutional factors such as preterm birth,

IPC practices, and maternal chronic illness. Similar findings have been reported in previous studies where these variables lost their significance after adjustment for other predictors (22).

The study has important implications for neonatal health care services. The high prevalence of hospital-acquired infections described in this study suggests gaps in infection control systems and the quality of neonatal care in NICUs. Strengthening IPC practices, improving surveillance systems, improving staff training, and ensuring adequate supplies and infrastructure are essential to reduce preventable neonatal infections and improve survival outcomes.

Despite its strengths, the study has some limitations. Since the study was conducted in selected public hospitals, the findings may not be generalizable to private hospitals or all healthcare facilities in Ethiopia. In addition, some important clinical and microbiological variables could not be fully assessed due to resource limitations. However, the prospective follow-up nature of the study reduced the reliability of infection identification and recall bias compared with retrospective record reviews.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATION

7.1. Conclusion

This study confirmed the high prevalence of hospital-acquired neonatal infections, indicating that HAI is a major challenge in neonatal healthcare services. Infection transmission is strongly associated with maternal chronic illness, poor implementation of IPC practices, prematurity, and prolonged NICU stay.

The findings suggest that clinical and healthcare facility-related factors contribute significantly to the spread of neonatal hospital-acquired infections. Non-compliance with infection prevention and control measures in NICUs increases the risk of infection transmission among vulnerable newborns. Prolonged hospitalization and premature infants are particularly vulnerable.

Overall, the study highlights the urgent need for strengthened infection prevention strategies, improved neonatal care practices, and healthcare facility preparedness to reduce preventable neonatal infections in public hospitals and improve neonatal survival outcomes.

7.2. **Recommendations**

For Hospital Administrators and Health Facilities

- Infection prevention and control (IPC) programs in NICUs should be strengthened through regular monitoring and surveillance.
- Maintain continuous access to essential IPC supplies, including hand sanitizers, disinfectants, gloves, masks, and personal protective equipment.
- Improve NICU infrastructure, including adequate space, ventilation, and isolation capacity.
- Establish routine surveillance systems to monitor hospital-acquired infections in NICUs.

For Health Care Professionals

- Adhere to strict infection prevention and control guidelines, especially hand hygiene.
- Minimize unnecessary invasive procedures and use aseptic techniques during neonatal care.

- Monitor premature and newborn infants closely during their hospital stay, to identify and manage infections early.
- Provide mothers with ongoing counseling and education on neonatal infection prevention and control.

For the Ministry of Health and Policymakers

- Strengthen national neonatal infection prevention policies and implementation strategies.
- Provide regular IPC training and capacity building programs for NICU healthcare workers.
- Allocate adequate resources to improve neonatal healthcare services and infection prevention infrastructure in public hospitals.
- Strengthen supportive monitoring and surveillance systems in healthcare facilities.

For Researchers

- Conduct multicenter prospective studies with large sample sizes to improve generalizability.
- Evaluate the effectiveness of IPC intervention packages and neonatal care improvement strategies in reducing HAIs.

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APPENDIX

APPENDIX A

QUESTIONNAIRE FOR MOTHERS/CAREGIVERS

Section 1: Socio-Demographic Information

1. Mother's age (years): _____
2. Marital status: ☐ Single ☐ Married ☐ Divorced ☐ Widowed
3. Education level: ☐ No formal ☐ Primary ☐ Secondary ☐ Higher
4. Occupation: ☐ Housewife ☐ Employed ☐ Self-employed ☐ Other _____
5. Residence: ☐ Urban ☐ Rural
6. Household income: ☐ Low ☐ Medium ☐ High

Section 2: Maternal Health and Pregnancy History

7. Gravidity: _____
8. Parity: _____
9. ANC visits: ☐ None ☐ 1–3 ☐ ≥4
10. Maternal chronic illnesses: ☐ Diabetes ☐ Hypertension ☐ HIV ☐ Other _____
11. Infections during pregnancy: ☐ UTI ☐ Malaria ☐ Fever ☐ Other _____
12. Use of antibiotics during pregnancy: ☐ Yes ☐ No
13. Complications during labor: ☐ Yes ☐ No

- If yes, specify _____

14. Mode of delivery: ☐ Spontaneous Vaginal ☐ Assisted Vaginal ☐ Cesarean Section
15. Duration of rupture of membranes: ☐ <12 hrs ☐ 12–18 hrs ☐ >18 hrs
16. Multiple births: ☐ Yes ☐ No

Section 3: Neonatal Birth Information

17. Neonate sex: ☐ Male ☐ Female
18. Birth weight (grams): _____
19. Gestational age (weeks): _____

20. APGAR score at 1 min: _____

21. APGAR score at 5 min: _____

22. Presence of congenital anomalies: ☐ Yes ☐ No

23. Resuscitation required at birth: ☐ Yes ☐ No

24. Immediate postnatal complications: ☐ Yes ☐ No

- If yes, specify _____

Section 4: Postnatal Care Practices

25. Breastfeeding initiated within 1 hour: ☐ Yes ☐ No

26. Skin-to-skin contact within 1 hour: ☐ Yes ☐ No

27. Use of antiseptic for umbilical cord care: ☐ Yes ☐ No

APPENDIX B

HEALTHCARE PROVIDER / FACILITY QUESTIONNAIRE

Section 1: NICU Infrastructure and Staffing

1. Number of NICU beds: _____
2. Average daily admissions: _____
3. Number of nurses per shift: _____
4. Nurse-to-patient ratio: _____
5. Availability of isolation rooms: ☐ Yes ☐ No
6. Availability of hand hygiene stations: ☐ Adequate ☐ Inadequate ☐ None
7. Availability of PPE (gloves, gowns, masks): ☐ Always ☐ Sometimes ☐ Rarely
8. Availability of antiseptics for equipment and surfaces: ☐ Adequate ☐ Inadequate ☐ None
9. Presence of written IPC guidelines: ☐ Yes ☐ No
10. Frequency of IPC supervision: ☐ Daily ☐ Weekly ☐ Monthly ☐ None

Section 2: Staff Training and Practices

11. Formal IPC training received: ☐ Yes ☐ No
12. Frequency of refresher training: ☐ None ☐ Annual ☐ Biannual ☐ Quarterly
13. Use of device-care bundles (IV lines, catheters, ventilators): ☐ Yes ☐ No
14. Monitoring of hand hygiene compliance: ☐ Always ☐ Sometimes ☐ Rarely ☐ Never
15. Reporting system for HAIs in place: ☐ Yes ☐ No
16. Routine surveillance of HAI trends: ☐ Yes ☐ No

APPENDIX C

OBSERVATION CHECKLIST FOR NEONATES

Section 1: Neonatal Clinical Information

1. Admission date: _____
2. Gestational age: ☐ <37 weeks ☐ 37–41 weeks ☐ >41 weeks
3. Birth weight: ☐ <1500 g ☐ 1500–2499 g ☐ ≥2500 g
4. APGAR score: 1 min _____ 5 min _____
5. Sex: ☐ Male ☐ Female
6. Length of NICU stay (days): _____

Section 2: Device and Procedure Monitoring

1. Mechanical ventilation: ☐ Yes ☐ No
    - Duration: _____
2. CPAP/oxygen therapy: ☐ Yes ☐ No
    - Duration: _____
3. IV line: ☐ Yes ☐ No
    - Duration: _____
4. Urinary catheter: ☐ Yes ☐ No
    - Duration: _____
5. Other invasive procedures (e.g., lumbar puncture, intubation): ☐ Yes ☐ No
    - Specify and record duration: _____

Section 3: Infection Prevention Practices (Observed)

1. Hand hygiene before handling neonate: ☐ Yes ☐ No
2. Hand hygiene after handling neonate: ☐ Yes ☐ No

3. Use of gloves: ☐ Yes ☐ No
4. Use of gowns: ☐ Yes ☐ No
5. Use of masks: ☐ Yes ☐ No
6. Equipment sterilized between patients: ☐ Yes ☐ No
7. Isolation precautions applied when necessary: ☐ Yes ☐ No
8. Environmental cleaning practices (bed, incubator, surfaces): ☐ Adequate ☐ Inadequate ☐ Not observed

Section 4: Signs and Diagnosis of HAI

- Clinical signs observed:
  ☐ Fever (>38°C) ☐ Hypothermia (<36°C) ☐ Lethargy ☐ Poor feeding ☐ Respiratory distress ☐ Apnea ☐ Jaundice ☐ Skin lesions ☐ Abdominal distension ☐ Others _____
- Date of first observed symptom: _____
- Clinical diagnosis confirmed by physician: ☐ Yes ☐ No
- Type of HAI (suspected/confirmed):
  ☐ Sepsis ☐ Pneumonia ☐ Meningitis ☐ Urinary tract infection ☐ Surgical site infection ☐ Others _____