Original Article
DOI: https://doi.org/10.70749/ijbr.v3i4.2232

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

# Pattern of Nosocomial Infections in Neonatal Intensive Care Unit

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## ARTICLE INFO

**Keywords:** Nosocomial infections, Neonates, Klebsiella and Pseudomonas species.

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**Declaration**
**Authors' Contribution:** All authors equally contributed to the study and approved the final manuscript.

**Conflict of Interest:** No conflict of interest.

**Funding:** No funding received by the authors.

**Article History**
Received: 26-01-2025 Revised: 19-04-2025
Accepted: 22-04-2025 Published: 30-04-2025

## ABSTRACT

**Background and Aim:** Hospital-acquired infections continue to be a major contributor to morbidity and mortality in neonates, especially in neonatal intensive care units (NICUs). Timely recognition of causative organisms ensures appropriate treatment as well as infection control. Therefore, the objective of this study was to evaluate the pattern of nosocomial infections in the neonatal intensive care unit (NICU) of Combined Military Hospital (CMH) Peshawar. **Patients and Methods:** A cross-sectional study conducted on 177 neonates (aged 3 to 28 days) in the Department of Pediatric Medicine, CMH Peshawar from April 2024 to November 2024. All the neonates admitted for >48 hours and fulfilling operational criteria for nosocomial infection, were enrolled. Data collection included demographic and clinical details, physical examination, and laboratory investigations (CBC, CRP, blood/urine cultures, chest X-ray). Organisms identified through standard culture methods. Data analysis was performed using SPSS v23, with qualitative and quantitative variables summarized using frequencies, percentages, means, or medians as appropriate. Chi-square test applied for stratified data with a significance level of $p \leq 0.05$. **Results:** Out of 177 neonates, there were 103 (58.2%) male and 74 (41.8%) female. Hyaline membrane disease was the leading cause found in 90 (50.8%) neonates followed by transient tachypnea of the newborn 14 (7.9%), meconium aspiration syndrome 11 (6.2%), and birth asphyxia 7 (4%). Approximately, 24 (13.6%) neonates had congenital anomalies. The overall mean of hospitalization was 13.8 ±16.5 days. Regarding mode of delivery, the frequency of unassisted vaginal delivery, cesarean section, and instrumental delivery was 89 (50.3%), 84 (47.5%), and 4 (2.3%), respectively. Among 177 neonates, nosocomial infections (NIs) developed in 36 (20.3%) and incidence rate of approximately 14.5 infections per 1000 patient-days. Based on infection's sites, the lungs (pneumonia) were affected in 88 (49.7%) neonates followed by bloodstream infections 74 (41.8%), skin and soft tissue infections 11 (6.2%), and urinary tract infections 4 (2.3%). Staphylococcus species (23.5%), Klebsiella species (22%), and Enterobacter cloacae (20.6%) were the most commonly isolated pathogens from clinical specimens. **Conclusion:** Organisms such as Staphylococcus species and Klebsiella species mostly cause the nosocomial infections among neonates. To reduce the hospital-acquired infections in NICU, the early diagnosis, continuous surveillance, and targeted antimicrobial therapy are essential.

## INTRODUCTION

Healthcare-associated infections (HAIs), also known as nosocomial infections, occur within medical settings when infectious agents such as bacteria, viruses, fungi, or parasites affects susceptible hosts, leading to disease after 48hours of hospital stay. Patients, contaminated hospital surfaces, improper handling of medical equipment and clothing, healthcare workers, inadequate sanitation, visitors, and lapses in standard infection control practices are various reservoirs that originates these pathogens [1]. HAIs represents the most severe and preventable complication in neonatal intensive care units (NICUs). Premature infants are particularly at risk due to their underdeveloped immune systems and the necessity for prolonged use of invasive devices such as catheters. The incidence of HAIs in this population inversely related to both birth weight and gestational age, and it tends to rise with the duration of hospitalization [2].

Neonatal sepsis continues to be one of the most common cause for admission and mortality within Neonatal Intensive Care Units (NICUs), often considered as healthcare-associated infections when linked to the care received by pregnant women or neonates. The condition divided into two broad categories: Early Onset Sepsis

(EOS) and Late Onset Sepsis (LOS). EOS usually occurs in the first 48–72 hours post-delivery due to maternal factors and perinatal care. On the other hand, LOS occurs from day 4 up until 90 days of life and commonly linked with exogenous infection through medical intervention. Contributing factors to LOS include prematurity, low birth weight, prolonged use of intravenous catheters, mechanical ventilation, total parenteral nutrition (TPN), and broad-spectrum antibiotics [3]. Some risk factors that increases the chances of sepsis in neonates include low gestational age, lower birth weight, greater severity of illness, longer length of stay in hospital; along with a number of invasive interventions [4]. Of all nosocomial infections acquired in NICUs, bloodstream infections (BSIs) are most common with an incidence rate of about 24–30% among neonates [5].

Earlier study found that the predominant organisms isolated were Klebsiella sp (35%) followed by Coagulase Negative Staphylococci (17%), Pseudomonas (16.5%), Streptococcus pneumonia (11%), Staphylococcus aureus (8%) [6]. Hospitals in developing countries face a heightened risk of infection transmission, where the progress in neonatal health outcomes is often undermined by hospital-acquired infections and their related morbidity, mortality, and financial burden [6–9]. These infections largely attributed to gaps in knowledge and training regarding fundamental infection control practices, as well as deficiencies in infrastructure, healthcare systems, and available resources. The situation becomes particularly critical when medical devices such as intravenous catheters and ventilators used without adequate precautions, significantly increasing the risk of infection [10–12]. To determine causative agents for the nosocomial infection in our population. Since it is associated with an increase in mortality, morbidity, and prolonged length of hospital stay, both the human and financial costs of these infections are high. Previously no data is available for our local population. Therefore, this study carried out to benefits patients by selecting targeted antibiotic therapy according to identified organism and hospital administration to update drug formulary according to organism isolated.

## METHODOLOGY

A cross-sectional study conducted on 177 neonates (aged 3 to 28 days) in the Department of Pediatric Medicine, CMH Peshawar from April 2024 to November 2024. All the neonates admitted for >48 hours and fulfilling operational criteria for nosocomial infection, were enrolled. The sample size calculated using WHO software, with a confidence level of 95%, absolute precision of 4%, and an anticipated prevalence of *Staphylococcus aureus* as 8%, the least frequent organism in similar study [13]. Exclusion criteria comprised neonates with early-onset sepsis, maternal history of prolonged rupture of membranes or perinatal infection (as determined through history or medical record), neonates who stayed less than 48 hours in the neonatal unit, and those with a known or suspected immunodeficiency. Nosocomial infection operationally defined as the presence of any of the following clinical and laboratory findings in a neonate after 48 hours of hospital admission:

- Clinical signs such as lethargy, reluctance to feed, or temperature instability (<35°C or >38.5°C)
- Laboratory markers including leukocytosis (>30,000/mm$^3$), leukopenia (<4,000/mm$^3$), or C-reactive protein (CRP) >10 mg/L
- Positive findings on blood or urine culture, or radiographic evidence of pneumonia (bilateral infiltrates or consolidation on chest X-ray)

Detailed demographic data, including age, gender, birth weight, gestational age (prematurity), socioeconomic status, maternal education, and mode of delivery, were recorded on a structured proforma. Each neonate underwent a thorough clinical examination. Laboratory investigations including complete blood count (CBC), CRP, blood cultures, urine cultures, and chest X-rays conducted for all neonates suspected of nosocomial infection. Organisms causing infection were identified through standard microbiological culture techniques using appropriate media (e.g., blood agar, MacConkey agar), and identified based on colony morphology, staining characteristics, and biochemical reactions.

SPSS v23 used for data analysis. Categorical parameters such as gender, prematurity, mode of delivery, and type of organism presented as frequencies and percentages. Numerical variables including age, weight, and duration of hospital stay expressed as means ± standard deviations (SD). Data stratified based on relevant variables such as age, gender, birth weight, and duration of hospital stay. Post-stratification, Chi-square test applied to assess associations, and a p-value of ≤0.05 considered statistically significant.

## RESULTS

Out of 177 neonates, there were 103 (58.2%) male and 74 (41.8%) female. Hyaline membrane disease was the leading cause found in 90 (50.8%) neonates followed by transient tachypnea of the newborn 14 (7.9%), meconium aspiration syndrome 11 (6.2%), and birth asphyxia 7 (4%). Approximately, 24 (13.6%) neonates had congenital anomalies. The overall mean of hospitalization was 13.8 ±16.5 days. Regarding mode of delivery, the frequency of unassisted vaginal delivery, cesarean section, and instrumental delivery was 89 (50.3%), 84 (47.5%), and 4 (2.3%), respectively. Among 177 neonates, nosocomial infections (NIs) developed in 36 (20.3%) and incidence rate of approximately 14.5 infections per 1000 patient-days. Based on infection's sites, the lungs (pneumonia) were affected in 88 (49.7%) neonates followed by bloodstream infections 74 (41.8%), skin and soft tissue infections 11 (6.2%), and urinary tract infections 4 (2.3%). Staphylococcus species (23.5%), Klebsiella species (22%), and Enterobacter cloacae (20.6%) were the most commonly isolated pathogens from clinical specimens.

**Table 1**

Demographic details (N=177)

| Variables | | Value [ N (%)] |
|---|---|---|
| Gender | Male | 103 (58.2%) |
| | Female | 74 (41.8%) |
| Mean Duration of Hospitalization days | | 13.8 ± 16.5 |
| Nosocomial Infections (NIs) | | 36 (20.3%) |
| Mode of Delivery | Unassisted Vaginal Delivery | 89 (50.3%) |
| | Cesarean section | 84 (47.5%) |
| | Instrumental Delivery | 4 (2.3%) |

**Figure 1**
*Primary Diagnoses*

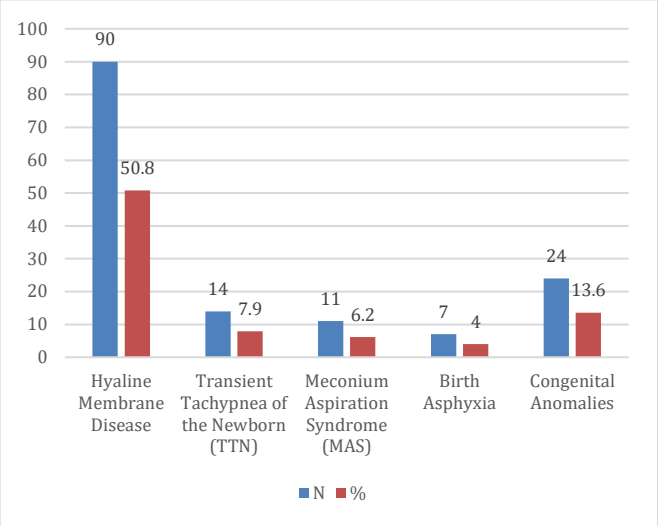


**Figure 2**
*Sites of Infections (%)*

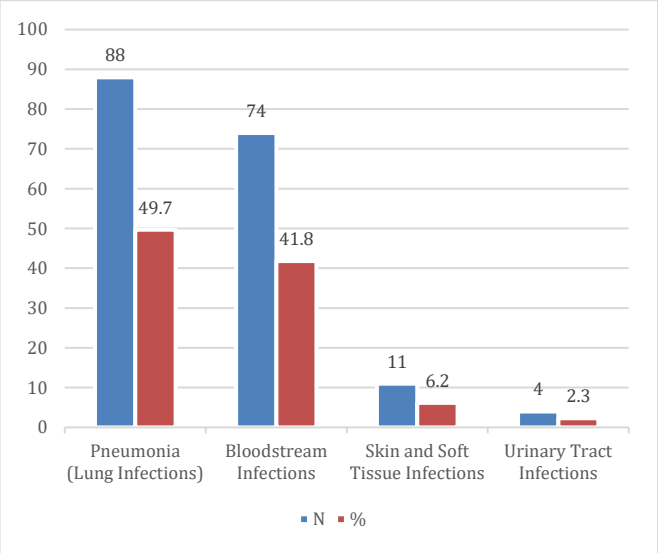


**Figure 3**
*Most Common Isolated Pathogens*

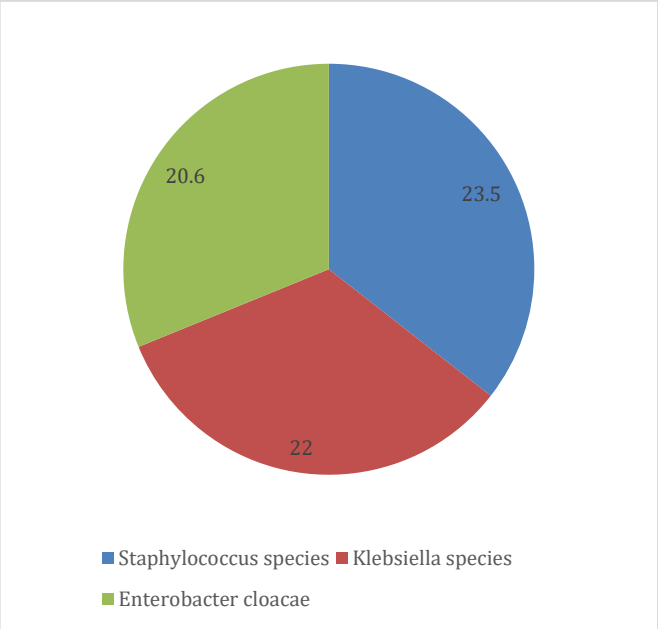


**Table 2**
*Stratification of Neonatal Characteristics and Outcomes (n=177)*

| Variable | Category | Frequency (n) | %age |
|---|---|---|---|
| Gender | Male | 103 | 58.2% |
| | Female | 74 | 41.8% |
| Cause of Admission | Hyaline Membrane Disease (HMD) | 90 | 50.8% |
| | Transient Tachypnea of the Newborn (TTN) | 14 | 7.9% |
| | Meconium Aspiration Syndrome (MAS) | 11 | 6.2% |
| | Birth Asphyxia | 7 | 4.0% |
| Congenital Anomalies | Present | 24 | 13.6% |
| | Absent | 153 | 86.4% |
| Mode of Delivery | Unassisted Vaginal Delivery | 89 | 50.3% |
| | Cesarean Section | 84 | 47.5% |
| | Instrumental Delivery | 4 | 2.3% |
| Nosocomial Infections (NIs) | Developed NIs | 36 | 20.3% |
| | Did Not Develop NIs | 141 | 79.7% |
| Infection Site | Pneumonia (Lungs) | 88 | 49.7% |
| | Bloodstream Infections (BSI) | 74 | 41.8% |
| | Skin & Soft Tissue Infections (SSTI) | 11 | 6.2% |
| | Urinary Tract Infections (UTI) | 4 | 2.3% |
| Common Pathogens Isolated | Staphylococcus species | 42 | 23.5% |
| | Klebsiella species | 39 | 22.0% |
| | Enterobacter cloacae | 36 | 20.6% |
| Hospital Stay (days) | Mean ± SD | — | 13.8±16.5 days |
| Infection Rate | Infections per 1000 patient-days | — | 14.5 |

## DISCUSSION

The present study provides valuable insights into the epidemiological and clinical profiles of neonates admitted to the neonatal intensive care unit (NICU), with a particular focus on nosocomial infections (NIs) and associated risk factors. Of the 177 neonates included, there was a male predominance (58.2%), which is consistent with previous findings indicating a higher incidence of neonatal complications among male infants, potentially due to differences in lung maturity and immune responses [14, 15].

Hyaline Membrane Disease (HMD) affected 50.8% of neonates emerged as the prime cause for NICU admission. This high frequency underscores the vulnerability of premature infants to surfactant deficiency and subsequent respiratory distress syndrome, which remains a major contributor to neonatal morbidity despite advances in surfactant therapy and prenatal corticosteroids. Transient tachypnea of the newborn (7.9%) and meconium aspiration syndrome (6.2%) are the next frequent respiratory conditions. Additionally, pre-and post-term neonates also reflects the delayed fluid clearance and perinatal asphyxia. Birth asphyxia is the major critical issue causing the long-term neurodevelopmental impairment among neonates, only reported in 4% cases [16].

Early diagnosis and antenatal screening are the important parameters to be performed highlighted by 13.6% cases having congenital anomalies, potentially reducing the complications associated with postnatal through timely intervention. The mean duration of hospitalization, 13.8 ± 16.5 days, is notably high and reflects both the severity of neonatal conditions and the occurrence of secondary complications, including NIs. Similar findings reported in

earlier studies [17, 18].

Mode of delivery appeared to have no significant differences between unassisted vaginal delivery (50.3%) and cesarean section (47.5%) whereas small fraction underwent instrumental delivery (2.3%). Obstetric complications might be influenced by cesarean section or birth-related trauma reduction strategy, which in turn also associated with increased risk of nosocomial infections and neonatal respiratory issues [19].

Nosocomial infections affected 20.3% newborns, with the incidence of 14.5 infections per 1000 patients, indicated a significant burden on NICU resources and patient results. The lungs were the most affected site (49.7%), especially by pneumonia, followed by infection of bloodstream (41.8%). These findings correspond to other NICU-based studies, where aggressive processes such as mechanical ventilation and catheterization are common and increase the infection risk [20, 21]. Skin and soft tissue infections (6.2%) and urinary tract infections (2.3%) were less prevalent but were still notable.

Microbiological analysis showed that Staphylococcus species (23.5%), Klebsiella species (22%), and Enterobacter cloacae (20.6%) were the predominant pathogens. These organisms are well-documented causes of hospital-acquired infections and often demonstrate resistance to many antibiotics, complicating treatment regimens. The high prevalence of Klebsiella and Enterobacter suggests a possible breach in infection control measures, including sterilization practices and hand hygiene compliance, warranting urgent review and reinforcement of NICU protocols [22].

Overall, the study highlights on the need for strategies to reduce neonatal morbidity through better monitoring mechanisms for better delivery care, increased infection control practices, and nosocomial infections.

## CONCLUSION

Organisms such as Staphylococcus species and Klebsiella species mostly cause the nosocomial infections among neonates. To reduce the hospital-acquired infections in NICU, the early diagnosis, continuous surveillance, and targeted antimicrobial therapy are essential. Further research suggested for effective management and control of nosocomial infections among neonates in NICU.

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