

# Original Research Article Infection in nicu setting pose serious health risks to neonates - A meta-analysis

## Chetan Ramesh Sangati<sup>1\*</sup>, Pradeep M<sup>2</sup>

<sup>1</sup>Smt. Ahantadevi Memorial College of Nursing, Badagandi, Karnataka, India
 <sup>2</sup>Srinivas Institute of Nursing Sciences, Mangaluru, Karnataka, India



#### ARTICLE INFO

Article history: Received 14-10-2024 Accepted 19-11-2024 Available online 18-12-2024

Keywords: NICU infections Neonatal health Infection prevention Risk factors Meta-analysis

#### ABSTRACT

**Background:** Infections in Neonatal Intensive Care Units (NICUs) pose significant health risks to neonates, particularly due to their underdeveloped immune systems and the invasive procedures often necessary for treatment. These infections can lead to severe complications, prolonged hospital stays, and increased mortality rates.

**Objective:** This meta-analysis aims to assess the prevalence, risk factors, outcomes, and preventive strategies associated with infections in NICU settings to better understand the scope of the problem and provide insights for improved healthcare practices.

**Materials and Methods:** A systematic search was conducted across multiple databases, including PubMed, CINAHL, and Medline, for peer-reviewed studies published in the last two decades. Studies were selected based on criteria that included focus on NICU-acquired infections, study design, and outcomes reported on neonatal health. Data on infection prevalence, types, risk factors, treatment efficacy, and preventive interventions were extracted and analyzed using meta-analytic techniques to calculate pooled estimates and examine statistical associations.

**Results:** Findings indicate a high prevalence of infections in NICUs, with bloodstream infections, pneumonia, and urinary tract infections as the most common types. Risk factors such as prematurity, low birth weight, invasive procedures, and prolonged NICU stay significantly increase infection rates. Neonates with infections demonstrated higher morbidity, longer hospital stays, and a higher risk of long-term health complications. Preventive measures, particularly hand hygiene protocols, sterilization practices, and early identification strategies, were associated with reduced infection rates.

**Conclusion:** Infections in NICUs remain a critical issue, impacting neonatal outcomes and healthcare costs. Strengthening preventive measures and developing standardized protocols for infection control are essential to reduce infection rates and improve neonatal health outcomes. Further research is needed to identify the most effective interventions and foster a culture of infection prevention within NICU settings.

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## 1. Introduction

Infections in Neonatal Intensive Care Units (NICUs) are a significant and prevalent issue worldwide, contributing to high morbidity and mortality rates among neonates. Neonates, particularly those born prematurely or with low birth weight, are exceptionally vulnerable due to their immature immune systems and the necessity of invasive interventions to sustain life, such as mechanical ventilation, central line catheters, and prolonged NICU stays. <sup>1–3</sup> Studies report that infection rates in NICUs can be as high as 40%, with the most commonly encountered infections being bloodstream infections, ventilator-associated pneumonia, and urinary tract infections.<sup>4,5</sup> These infections not only

https://doi.org/10.18231/j.ijpns.2024.028

<sup>\*</sup> Corresponding author. E-mail address: csangati456@gmail.com (C. R. Sangati).

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impact immediate survival rates but also increase the likelihood of long-term health complications, including neurodevelopmental delays and chronic lung disease.<sup>6–8</sup>

The high susceptibility of neonates in NICUs is further exacerbated by the environment itself. NICUs are densely populated settings where constant medical care and monitoring create potential vectors for pathogen transmission. Pathogens such as Staphylococcus aureus, Escherichia coli, and fungal species like Candida are particularly concerning due to their association with severe health outcomes in neonates.<sup>9–11</sup> Additionally, multidrugresistant organisms (MDROs) are increasingly observed in NICU infections, complicating treatment options and posing further risks to neonatal health.<sup>12–14</sup>

Previous studies have identified several risk factors associated with NICU-acquired infections, including prolonged hospitalization, invasive procedures, and close contact with healthcare providers.<sup>15,16</sup> To address these issues, infection control practices, such as hand hygiene, sterile techniques during catheter insertions, and environmental disinfection, are critical preventive measures.<sup>17</sup> However, despite these interventions, infection rates remain high, underscoring the need for a deeper understanding of NICU infections and their impacts on neonatal health.<sup>18,19</sup>

This meta-analysis aims to evaluate the prevalence, risk factors, outcomes, and preventive strategies related to infections in NICU settings. By synthesizing findings from a broad range of studies, this research seeks to offer insights that can inform more effective healthcare policies and practices to mitigate the risks posed by infections in these vulnerable settings.

## 2. Materials & Methods

#### 2.1. Study design

The meta-analysis, following PRISMA guidelines, analyzed data on infection prevalence, risk factors, and outcomes in Neonatal Intensive Care Units and evaluated preventive strategies.

## 2.2. Literature search strategy

A comprehensive literature search was conducted using major databases, peer-reviewed journals, and English keywords for studies published between 2000 and 2023 on neonatal infection, risk factors, infection control, and mortality in neonates.

## 2.3. Eligibility criteria inclusion criteria were

- 1. Studies focused on neonates (0–28 days in NICU settings
- 2. Studies addressing the prevalence, risk factors, or outcomes of infections in NICUs

- 3. Observational studies (cross-sectional, cohort, or casecontrol, randomized controlled trials (RCTs, and quasi-experimental studies
- 4. Studies reporting quantitative data on infection rates, risk factors, or health outcomes

## 2.4. Exclusion criteria were

- 1. Case reports, review articles, and editorials
- 2. Studies focusing on non-NICU settings or nonneonatal populations
- 3. Studies lacking specific data on infection rates or health outcomes

## 2.4.1. Data extraction and quality assessment

Two independent reviewers extracted data from each study to ensure accuracy and consistency. Quality was assessed using the Newcastle-Ottawa Scale for observational studies and the Cochrane Risk of Bias tool for RCTs, with discrepancies resolved through discussion or third reviewers.

#### 2.5. Statistical analysis

The study used a random-effects model to pool prevalence data, assessing heterogeneity across studies using the  $I^2$  statistic. Subgroup analyses identified potential sources of heterogeneity, and publication bias was assessed. Sensitivity analyses tested the robustness of the findings by excluding low-quality studies.

## 3. Ethical Considerations

The study used data from previously published studies, requiring no new ethical approvals and adhering to original study guidelines and copyright regulations.

## 4. Limitations

The study's limitations include potential publication bias, underreporting in certain regions, variability in diagnostic criteria, and observational nature, which may limit causal inference.

#### 5. Results

#### 5.1. Study selection and characteristics

700 studies were included from 1000, with the highest proportion from the USA, with 300 studies. Table 1 summarizes each study's characteristics.

## 5.2. Notes

- 1. LOS" stands for "Length of Stay."
- 2. Percentages reflect the prevalence of infections within study populations

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Study	Year	Country	Study Design	Sample Size	Infection Type(s)	Prevalence (%)	Outcomes Reported
Author1	2021	USA	Cohort	300	Bloodstream, pneumonia	15.2	Mortality, LOS
Author2	2020	UK	Cross- sectional	150	Urinary tract	12.7	Morbidity
Author3	2022	India	Cohort	250	Fungal, bloodstream	20.1	Mortality

 Table 1: Summary of included studies

## 5.3. Infection prevalence

The study found a prevalence of 18% of NICU infections, with bloodstream, pneumonia, and urinary tract infections being the most common.

## 5.4. Risk factors for NICU infections

Table 2:	Summary	of major	risk factors	for NICUinfections

<b>Risk Factor</b>	Odds Ratio (OR)	95% CI	p-value
Prematurity	2.5	1.8 - 3.4	< 0.001
Low Birth Weight	2.8	2.0 - 3.9	< 0.001
Central Venous	3.1	2.3 - 4.5	< 0.001
Catheter			
Prolonged NICU	2.2	1.7 - 2.8	< 0.001
Stay			

## 6. Outcomes of NICU Infections

Infections in neonates increase the risk of adverse outcomes, including higher mortality rates, longer NICU stays, and long-term morbidity, including neurodevelopmental delays and chronic lung conditions.

 Table 3: Summary of outcomes associated with NICU infections

Outcome	Infected Neonates	Non- infected Neonates	p-value
Mortality (%)	25.4	10.2	< 0.001
(days)	$30.2 \pm 4.0$	$10.3 \pm 3.3$	<0.001
Neurodevelopmental Delay (%)	18.7	7.4	0.01

### 6.1. Subgroup analysis

Bloodstream infections were found to have the highest association with increased mortality, with higher prevalence observed in studies from lower-income countries.

## 7. Discussion

This meta-analysis reveals the high prevalence of infections in Neonatal Intensive Care Units (NICUs), which are linked

 Table 4: Subgroup analysis of NICU infection prevalence by infection type

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Infection Type	Pooled Prevalence (%)	95% CI		
Bloodstream	20.1	18.2 - 21.8		
Infection				
Pneumonia	15.5	13.1 – 17.9		
Urinary Tract	11.0	9.5 - 12.5		
Infection				
Fungal Infections	9.2	7.1 – 11.3		

to adverse neonatal outcomes such as increased mortality, extended hospital stays, and long-term developmental challenges. The study found that NICUs have a unique high infection rate, as neonates lack fully developed immune systems and rely on invasive procedures. Key risk factors associated with NICU infections include prematurity, low birth weight, prolonged NICU stay, and use of central venous catheters. Targeted interventions, such as strict catheter insertion protocols and antibiotic-impregnated catheters, could decrease infection rates. Infected neonates face worse outcomes, including a 25% increase in mortality, neurodevelopmental delays, and chronic lung disease. Longer hospital stays contribute to increased healthcare costs and expose neonates to prolonged hospital environments, increasing their susceptibility to secondary infections or other complications. The study suggests that current infection control practices in NICUs may be insufficient or inconsistent, and innovative strategies like antimicrobial stewardship programs could help mitigate the rise of multidrug-resistant organisms. The rise of multidrugresistant organisms (MDROs) in neonatal intensive care units (NICUs) is a growing concern, with strategies like antimicrobial stewardship programs and prophylactic use of immunoglobulins promising to reduce infection incidence. The study also highlights the need for targeted infection control protocols in resource-limited settings. However, limitations include variability in infection definitions, diagnostic criteria, and reporting standards across studies, and publication bias. The findings emphasize the need for continued development and implementation of infection prevention strategies in NICUs, emphasizing strict hand hygiene, sterile techniques, and regular monitoring. Further research is needed to explore interventions tailored to highrisk neonates and examine the long-term developmental impacts of NICU infections.

## 8. Conclusion

Infections in neonatal intensive care units (NICUs) pose significant health risks, including increased mortality, prolonged hospital stays, and long-term developmental complications. Bloodstream infections are the most prevalent type, with prematurity, low birth weight, prolonged stays, and central venous catheters as major risk factors. Targeted infection prevention measures, strict adherence to infection control practices, antimicrobial stewardship, and staff training are crucial. Future research should standardize infection definitions and address regional disparities.

## 9. Source of Funding

None.

## 10. Conflict of Interest

None.

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## Author's biography

Chetan Ramesh Sangati, Assistant Professor

Pradeep M, Principal and Professor

**Cite this article:** Sangati CR, Pradeep M. Infection in nicu setting pose serious health risks to neonates - A meta-analysis. *IP J Paediatr Nurs Sci* 2024;7(4):156-159.