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Clinical and Microbiological Profile of Neonates Admitted in Nicu and its Short-Term Outcome

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Abstract: ***Late-onset neonatal sepsis continues to place a heavy burden on neonatal intensive care units, especially among preterm and low birth weight infants. This prospective observational study assessed the clinical features, bacterial profile, antibiotic susceptibility, and short-term outcomes of culture-confirmed late-onset sepsis in a tertiary care hospital in South Gujarat, India, between October 2023 and October 2024. A total of 101 neonates with positive blood cultures were included. Respiratory distress, feeding intolerance, lethargy, apnea, and temperature instability were the most frequent clinical features. C-reactive protein showed better diagnostic value than routine blood cell parameters. Gram-negative bacteria were the leading pathogens, with Klebsiella pneumoniae isolated most often, followed by Acinetobacter baumannii and Pseudomonas aeruginosa. Many isolates showed resistance to commonly used empirical antibiotics, although selected organisms remained susceptible to cefepime, cotrimoxazole, and carbapenems. More than half of the affected neonates were discharged, while mortality remained high, particularly among preterm infants. The findings highlight the need for regular monitoring of local bacterial patterns, timely review of empirical antibiotic policies, effective antimicrobial stewardship, and strict infection control measures to reduce the burden of late-onset neonatal sepsis and improve outcomes in neonatal intensive care units.***

Keywords: Late-onset neonatal sepsis, Neonatal intensive care unit, Klebsiella pneumoniae, antimicrobial resistance, Blood culture

1. Introduction

Neonatal sepsis remains one of the leading causes of neonatal morbidity and mortality worldwide, particularly in low- and middle-income countries. Despite considerable advances in neonatal intensive care, healthcare-associated infections continue to contribute substantially to prolonged hospitalisation, increased healthcare costs, neurodevelopmental impairment, and mortality. (1–4)

Late-onset sepsis (LOS), defined as sepsis occurring after 72 hours of life, is predominantly acquired from the hospital environment or community and differs from early-onset sepsis with respect to its epidemiology, risk factors, microbiological spectrum, and clinical presentation. Prematurity, low birth weight, prolonged hospitalisation, invasive procedures, mechanical ventilation, central vascular catheters, and parenteral nutrition significantly increase the risk of LOS. (2, 4–6)

The clinical manifestations of LOS are often subtle and nonspecific, making early diagnosis difficult. Blood culture remains the diagnostic gold standard; however, its sensitivity is limited and results are delayed. Consequently, clinicians frequently initiate empirical antibiotic therapy based on local epidemiological data and antimicrobial susceptibility patterns. (2, 7–9)

The microbiological profile of neonatal LOS varies considerably among institutions and changes over time due to evolving antimicrobial resistance. Periodic evaluation of causative organisms and their susceptibility profile is therefore essential to formulate appropriate empirical antibiotic policies and strengthen antimicrobial stewardship programmes. (5, 10–15)

Limited contemporary data are available from western India, particularly Gujarat, regarding the clinical profile, bacterial spectrum, antimicrobial resistance patterns, and outcomes of neonatal LOS. The present prospective observational study was undertaken at a tertiary care neonatal intensive care unit in South Gujarat to evaluate the clinical characteristics, microbiological profile, antimicrobial susceptibility patterns, and short-term outcomes of neonates developing late-onset sepsis. The findings are expected to provide valuable evidence for improving empirical treatment protocols and infection control practices.

2. Methodology

1) Study design and setting

A prospective observational study was conducted in the Neonatal Intensive Care Unit (NICU) of Government Medical College and New Civil Hospital, Surat, Gujarat, India, over a one-year period from October 2023 to October 2024. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from parents or legal guardians before enrolment.

2) Study population

All inborn neonates admitted to the NICU who developed late-onset sepsis (LOS), defined as clinical features of sepsis occurring after 72 hours of life, were screened. (2,13) During the study period, 8,790 deliveries occurred at the tertiary care centre, 4,806 neonates were admitted to the NICU, 768 developed neonatal sepsis, of whom 256 had late-onset sepsis. Among these, 101 neonates with culture-positive LOS constituted the final study population.

3) Inclusion criteria

- Neonates admitted to the NICU who developed clinical features suggestive of sepsis after 72 hours of life.
- Blood culture positive for a pathogenic microorganism.

4) Exclusion criteria

- Early-onset sepsis (<72 hours of life). (2,13)
- Culture-negative late-onset sepsis.
- Neonates with incomplete clinical or microbiological data.

5) Data Collection

Demographic characteristics, maternal and perinatal risk factors, clinical presentation, laboratory investigations, microbiological profile, antimicrobial susceptibility pattern, treatment details, duration of hospital stay, feeding practices, and short-term outcomes were recorded using a structured case record form.

6) Laboratory Investigations

Complete blood count, absolute neutrophil count, and C-reactive protein were performed at admission and repeated after 72 hours when clinically indicated. Blood cultures were obtained before initiation of antibiotics using aseptic precautions. Approximately 1 mL of blood was inoculated into pediatric blood culture bottles and processed using automated culture systems. Positive cultures were identified by standard microbiological methods, and antibiotic susceptibility testing was performed according to institutional laboratory protocols. (16)

7) Statistical Analysis

Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), whereas categorical variables were presented as frequencies and percentages. A p-value <0.05 was considered statistically significant.

3. Observation

During the study period, 8,790 deliveries were conducted, of which 4,806 neonates required admission to the neonatal intensive care unit (NICU). A total of 768 neonates were diagnosed with neonatal sepsis, including 256 cases of late-onset sepsis (LOS). Among these, 101 neonates had culture-confirmed LOS and were included in the final analysis.

Low birth weight (63.4%) and prematurity (41.6%) were common among neonates with culture-positive LOS, indicating that these groups remain at increased risk of healthcare-associated infections. Respiratory distress was the most common indication for NICU admission, followed by perinatal asphyxia and congenital heart disease.

Clinical manifestations of LOS were nonspecific, with respiratory distress, feeding intolerance, lethargy, apnea, and temperature instability being the predominant presenting features. Elevated C-reactive protein (CRP) was observed in 82.2% of cases and demonstrated greater diagnostic utility than total leukocyte count and absolute neutrophil count.

Gram-negative organisms were the predominant pathogens isolated from blood cultures. Klebsiella pneumoniae was the most frequently isolated organism, followed by Acinetobacter baumannii and Pseudomonas aeruginosa. The majority of isolates exhibited high resistance to commonly used empirical antibiotics, while comparatively better susceptibility was observed to cefepime, cotrimoxazole, and carbapenems among selected organisms.

The overall short-term outcome showed that 55.4% of neonates were discharged, 11.9% left against medical advice, and 32.7% died. Mortality was higher among preterm neonates than term neonates, although this difference did not reach statistical significance (p = 0.155).

Overall, the study highlights that late-onset neonatal sepsis continues to be an important cause of morbidity and mortality in the NICU. The predominance of multidrug-resistant Gram-negative organisms underscores the need for continuous microbiological surveillance, periodic revision of empirical antibiotic policies, implementation of antimicrobial stewardship programmes, and strict infection prevention and control practices to improve neonatal outcomes.

4. Discussion

Late-onset sepsis (LOS) remains a major cause of neonatal morbidity and mortality in neonatal intensive care units (NICUs), particularly in resource-limited settings. The present prospective observational study evaluated the clinical profile, microbiological spectrum, antimicrobial susceptibility pattern, and short-term outcomes of culture-positive LOS in a tertiary care NICU in South Gujarat. (1–6)

Among the neonates with culture-positive LOS, low birth weight and prematurity constituted a substantial proportion of affected infants, reaffirming their role as major risk factors for nosocomial infections. Immaturity of the immune system, prolonged hospitalization, frequent invasive procedures, and the need for respiratory support increase susceptibility to healthcare-associated infections. Similar findings have been reported in previous Indian and international studies. (5, 6, 17–20)

Respiratory distress was the most common indication for NICU admission among neonates who subsequently developed LOS. Other common indications included perinatal asphyxia and congenital heart disease. These conditions often necessitate prolonged intensive care, invasive monitoring, vascular access, and mechanical ventilation, thereby increasing the risk of hospital-acquired bloodstream infections. (18–20)

The clinical manifestations of LOS in this study were nonspecific, consistent with previous reports. Respiratory distress, lethargy, feeding intolerance, apnea, temperature instability, and poor perfusion were frequently observed. Such nonspecific presentations emphasize the importance of maintaining a high index of suspicion in hospitalized neonates, as delayed diagnosis may adversely affect outcomes. (2, 4, 18)

Among laboratory parameters, C-reactive protein (CRP) demonstrated a higher positivity rate than total leukocyte count and absolute neutrophil count. Although blood culture remains the gold standard for diagnosis, inflammatory markers such as CRP remain valuable adjuncts for early diagnosis and monitoring of treatment response. However, laboratory parameters should always be interpreted in conjunction with the clinical picture. (7– 9, 21)

Gram-negative organisms predominated among culture-positive isolates in the present study, with Klebsiella pneumoniae being the most common pathogen, followed by Acinetobacter baumannii and Pseudomonas aeruginosa. This

microbiological profile is comparable to reports from several tertiary care NICUs in India, where multidrug-resistant Gram-negative bacilli have increasingly replaced Gram-positive organisms as the leading cause of LOS. The predominance of these pathogens reflects selective antibiotic pressure, prolonged hospitalization, and transmission within the hospital environment. (5, 15, 18, 19, 22)

Antimicrobial susceptibility testing revealed considerable resistance to commonly used empirical antibiotics. Although carbapenems retained activity against a proportion of isolates, resistance was also observed, indicating the emergence of multidrug-resistant organisms. These findings underscore the urgent need for continuous microbiological surveillance, strict antimicrobial stewardship, and periodic revision of institutional empirical antibiotic policies based on local susceptibility patterns. (5, 15, 22–24)

The mortality rate observed among culture-positive LOS cases highlights the significant clinical burden of neonatal sepsis. Mortality was higher among preterm infants than term infants, although the difference was not statistically significant. The increased mortality in preterm neonates may be attributed to immature immune function, multiple comorbidities, prolonged intensive care, and greater exposure to invasive interventions. Early recognition, prompt initiation of appropriate antibiotics, meticulous supportive care, and rigorous infection prevention practices remain essential to improving neonatal survival. (6, 18, 20, 22)

The strengths of the present study include its prospective design, microbiological confirmation of all included cases, and comprehensive evaluation of clinical, laboratory, and outcome parameters. However, the study also has certain limitations. It was conducted at a single tertiary care centre, limiting the generalizability of the findings. Only short-term outcomes were assessed, and long-term neurodevelopmental follow-up was not available. Molecular characterization of antimicrobial resistance mechanisms was also beyond the scope of the study.

Overall, the present study provides contemporary epidemiological data on late-onset neonatal sepsis in a tertiary care NICU in South Gujarat. The findings contribute valuable local evidence that can assist clinicians in selecting appropriate empirical antibiotic therapy and strengthening infection prevention and antimicrobial stewardship programmes. (13,15,22)

5. Conclusion

Late-onset neonatal sepsis remains a significant cause of morbidity and mortality among NICU-admitted neonates, particularly in preterm and low birth weight infants. Gram-negative bacteria, especially Klebsiella pneumoniae, were the predominant causative organisms. A high prevalence of antimicrobial resistance among commonly used antibiotics emphasizes the importance of continuous surveillance of local microbiological trends and antibiotic susceptibility patterns.

Early diagnosis based on careful clinical assessment, supported by laboratory markers and timely blood culture, together with prompt institution of appropriate antimicrobial therapy, is essential for improving neonatal outcomes. Regular updating of empirical antibiotic policies, strict adherence to infection prevention and control measures, implementation of antimicrobial stewardship programmes, and minimization of unnecessary invasive procedures are crucial strategies for reducing the burden of late-onset sepsis in NICUs.

Further multicentre studies with larger sample sizes and long-term follow-up are recommended to better understand changing pathogen profiles, antimicrobial resistance patterns, and long-term outcomes among survivors of neonatal late-onset sepsis. (15,22,24)

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