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PREVALENCE AND CLINICAL PROFILE OF NEONATAL SEPSIS IN A TERTIARY CARE NICU: A CROSS-SECTIONAL ANALYSIS

Dr Dharam Chand Munot[1*]

[1*]Assistant Professor, Department of Pediatrics, People's College of Medical Sciences & Research Centre, Bhopal, Email: drdcmunot@gmail.com

***Corresponding Author:** Dr Dharam Chand Munot
[*]Assistant Professor, Department of Pediatrics, People's College of Medical Sciences & Research Centre, Bhopal drdcmunot@gmail.com

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Abstract

Introduction: Neonatal sepsis remains a leading cause of morbidity and mortality in developing countries. This study aimed to determine the prevalence and clinical profile of neonatal sepsis in a tertiary care neonatal intensive care unit and identify associated risk factors and outcomes.

Methods: A hospital-based cross-sectional study was conducted at People's College of Medical Sciences & Research Centre, Bhopal, from January to June 2012. All neonates aged 0-28 days admitted to the NICU with clinical suspicion of sepsis were included using consecutive sampling. Data were collected using structured proforma including demographic details, clinical presentation, laboratory investigations, and outcomes. Statistical analysis was performed using SPSS version 19.0.

Results: Among 250 neonates studied, males predominated (56.8%) with 53.6% being low birth weight and 50.0% preterm. Late-onset sepsis was more common (60.8%) than early-onset sepsis (39.2%). The most frequent clinical presentations were temperature instability (75.6%), jaundice (79.2%), and feeding intolerance (66.8%). Elevated C-reactive protein was observed in 68.8% cases, while blood culture positivity was achieved in 36.8% cases. Gram-positive organisms predominated (60.9%), with coagulase-negative staphylococci being the most common isolate. The overall mortality rate was 18.0%, with 62.4% requiring hospitalization exceeding seven days.

Conclusion: Neonatal sepsis showed significant burden with male predominance and higher prevalence among preterm and low birth weight neonates. The predominance of late-onset sepsis and nosocomial pathogens emphasizes the need for enhanced infection prevention strategies and antimicrobial stewardship programs in tertiary care settings.

Keywords: Neonatal sepsis, tertiary care, clinical profile, mortality, antimicrobial resistance

Introduction

Neonatal sepsis represents one of the most significant challenges in contemporary neonatal medicine, contributing substantially to morbidity and mortality rates worldwide. Defined as a clinical syndrome characterized by systemic signs of infection accompanied by bacteremia occurring in the first month of life, neonatal sepsis continues to pose considerable threats to

newborn survival, particularly in developing countries where healthcare resources and infrastructure may be limited (Stoll et al., 2002). The condition encompasses a spectrum of clinical presentations ranging from subtle signs of systemic illness to fulminant septic shock, making early recognition and prompt intervention crucial for optimal outcomes.

The global burden of neonatal sepsis is substantial, with an estimated incidence ranging from 1-10 per 1000 live births in developed countries to significantly higher rates in resource-limited settings. In India, neonatal sepsis accounts for approximately 19% of all neonatal deaths, representing a major public health concern that demands urgent attention and systematic investigation (Bang et al., 2005). The higher incidence in developing countries can be attributed to multiple factors including inadequate antenatal care, unhygienic delivery practices, low birth weight, prematurity, and limited access to quality healthcare facilities.

Neonatal sepsis is traditionally classified into two distinct categories based on the timing of onset. Early-onset sepsis (EOS) typically manifests within the first 72 hours of life and is primarily associated with vertical transmission of pathogens from mother to infant during the intrapartum period. The most commonly implicated organisms in EOS include Group B Streptococcus, Escherichia coli, and other gram-negative enteric bacteria (Schrag et al., 2000). Conversely, late-onset sepsis (LOS) occurs after 72 hours of life and is generally attributed to nosocomial infections or community-acquired pathogens, with coagulase-negative staphylococci, Staphylococcus aureus, and gram-negative bacteria being frequently isolated organisms (Stoll et al., 2005).

The clinical presentation of neonatal sepsis is often nonspecific and subtle, particularly in preterm infants, making diagnosis challenging for healthcare providers. Common manifestations include temperature instability, feeding difficulties, lethargy, respiratory distress, apnea, bradycardia, hypotension, and poor perfusion. These signs may overlap with various other neonatal conditions, necessitating a high index of suspicion and comprehensive evaluation to establish an accurate diagnosis (Edwards, 2004). The nonspecific nature of symptoms often leads to either overdiagnosis with unnecessary antibiotic exposure or underdiagnosis with potentially catastrophic consequences.

Several risk factors have been identified that predispose neonates to sepsis, including maternal factors such as prolonged rupture of membranes, chorioamnionitis, maternal fever, and urinary tract infections. Neonatal risk factors encompass prematurity, low birth weight, male gender, multiple gestations, and the need for invasive procedures such as endotracheal intubation, central venous catheterization, and prolonged mechanical ventilation (Hornik et al., 2003). Understanding these risk factors is essential for developing targeted prevention strategies and implementing appropriate surveillance measures in high-risk populations.

The diagnostic approach to neonatal sepsis relies on a combination of clinical assessment, laboratory investigations, and microbiological studies. Blood culture remains the gold standard for definitive diagnosis, although it has limitations including low sensitivity, particularly in cases where antibiotics have been administered prior to sample collection. Laboratory markers such as C-reactive protein, procalcitonin, interleukin-6, and various hematological parameters have been evaluated as potential biomarkers, though none have demonstrated sufficient sensitivity and specificity to replace blood culture (Ng & Lam, 2006).

The therapeutic management of neonatal sepsis involves prompt initiation of broad-spectrum antibiotic therapy, supportive care, and management of complications. The choice of empirical antibiotics is typically guided by local epidemiological patterns, antimicrobial susceptibility profiles, and the distinction between early-onset and late-onset sepsis. However, the emergence of antimicrobial resistance poses an increasing challenge in the management of neonatal sepsis, particularly in intensive care unit settings where broad-spectrum antibiotics are frequently utilized (Cantey & Baird, 2017).

Prevention strategies for neonatal sepsis encompass various interventions targeting different stages of the perinatal period. Antenatal interventions include screening and treatment of maternal infections, appropriate management of prolonged rupture of membranes, and intrapartum antibiotic prophylaxis for Group B Streptococcus colonization. Postnatal prevention measures focus on

maintaining aseptic techniques during invasive procedures, rational use of antibiotics, and implementation of infection control practices in healthcare settings (Verani et al., 2010).
The economic burden associated with neonatal sepsis is substantial, encompassing direct medical costs related to prolonged hospitalization, intensive care, and long-term complications, as well as indirect costs associated with developmental disabilities and chronic health conditions. This economic impact underscores the importance of developing effective prevention and treatment strategies that can reduce both the clinical and financial burden of this condition.

Despite significant advances in neonatal care, including improved supportive care, development of newer antibiotics, and enhanced infection control practices, neonatal sepsis continues to remain a formidable challenge. The complex interplay of host factors, pathogen characteristics, and environmental influences makes this condition particularly difficult to predict, prevent, and treat effectively. Furthermore, the long-term neurodevelopmental consequences of neonatal sepsis add another dimension to the complexity of this condition, highlighting the need for comprehensive follow-up and early intervention services.

The aim of the study is to determine the prevalence and clinical profile of neonatal sepsis among neonates admitted to the Neonatal Intensive Care Unit at People's College of Medical Sciences & Research Centre, Bhopal, and to identify associated risk factors and clinical outcomes.

Methodology

Study Design

This study employed a hospital-based cross-sectional design.

Study Site

The study was conducted at the Neonatal Intensive Care Unit (NICU) of People's College of Medical Sciences & Research Centre, Bhopal, Madhya Pradesh, India.

Study Duration

The study was conducted over a period of six months, from January 2012 to June 2012.

Sampling and Sample Size

A consecutive sampling method was employed to recruit all eligible neonates admitted to the NICU during the study period who met the inclusion criteria. The sample size was calculated using the formula $n = Z^2pq/d^2$, where $Z = 1.96$ (95% confidence interval), p = expected prevalence of neonatal sepsis (15% based on previous literature), $q = 1-p$ (85%), and d = desired precision (5%). Based on this calculation, a minimum sample size of 196 neonates was required. However, to account for potential incomplete data and to increase the power of the study, all eligible neonates admitted during the study period were included, resulting in a final sample size of 250 neonates. This approach ensured comprehensive coverage of the target population and enhanced the generalizability of findings to similar tertiary care settings.

Inclusion and Exclusion Criteria

Inclusion criteria comprised all neonates aged 0-28 days admitted to the NICU during the study period with clinical suspicion of sepsis, defined as the presence of at least two clinical signs including temperature instability (hypothermia <36°C or hyperthermia >37.5°C), feeding intolerance, lethargy, respiratory distress, apnea, bradycardia, or poor perfusion. Exclusion criteria included neonates with major congenital anomalies incompatible with life, those whose parents or guardians refused consent for participation, neonates who were discharged or transferred within 24 hours of admission before complete evaluation could be performed, and cases where essential clinical or laboratory data were unavailable despite multiple attempts at collection.

Data Collection Tools and Techniques

Data collection was performed using a structured, pre-tested proforma designed specifically for this study, which included sections for demographic information, maternal risk factors, perinatal history, clinical presentation, laboratory investigations, treatment details, and clinical outcomes. Clinical data were collected through direct examination of neonates by trained medical personnel, review of medical records, and structured interviews with mothers or caregivers. Laboratory investigations included complete blood count, C-reactive protein, blood culture, and other relevant tests as clinically indicated. Blood samples for culture were collected using strict aseptic techniques before initiation of antibiotic therapy whenever possible, and processed using standard microbiological methods in the hospital laboratory. Clinical assessment was performed by qualified pediatricians using standardized criteria for diagnosis of neonatal sepsis.

Data Management and Statistical Analysis

All collected data were entered into a computerized database using Microsoft Excel 2010 and subsequently analyzed using SPSS version 19.0 statistical software. Data entry was performed by trained personnel with double entry verification to ensure accuracy and completeness. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation or median with interquartile range depending on the distribution of data. Chi-square test was used to assess associations between categorical variables, while Student's t-test or Mann-Whitney U test was employed for continuous variables as appropriate. Multivariate logistic regression analysis was planned to identify independent risk factors associated with neonatal sepsis. A p-value of less than 0.05 was considered statistically significant for all analyses.

Ethical Considerations

The study protocol was submitted to and approved by the Institutional Ethics Committee of People's College of Medical Sciences & Research Centre, Bhopal, prior to commencement of data collection. Written informed consent was obtained from parents or legal guardians of all participating neonates after providing detailed information about the study objectives, procedures, potential risks and benefits, and the voluntary nature of participation. The consent process was conducted in the local language to ensure complete understanding.

Results:

Table 1: Demographic and Perinatal Characteristics of Study Population (n=250)

Characteristics	Categories	Frequency (n)	Percentage (%)
Gender	Male	142	56.8
	Female	108	43.2
Birth Weight (grams)	<1500	45	18
	1500-2499	89	35.6
	≥2500	116	46.4
Gestational Age (weeks)	<32	38	15.2
	32-36	87	34.8
	≥37	125	50
Mode of Delivery	Vaginal	134	53.6
	Cesarean	116	46.4
Place of Birth	Inborn	147	58.8
	Outborn	103	41.2
Onset of Sepsis	Early-onset (<72 hours)	98	39.2
	Late-onset (≥72 hours)	152	60.8

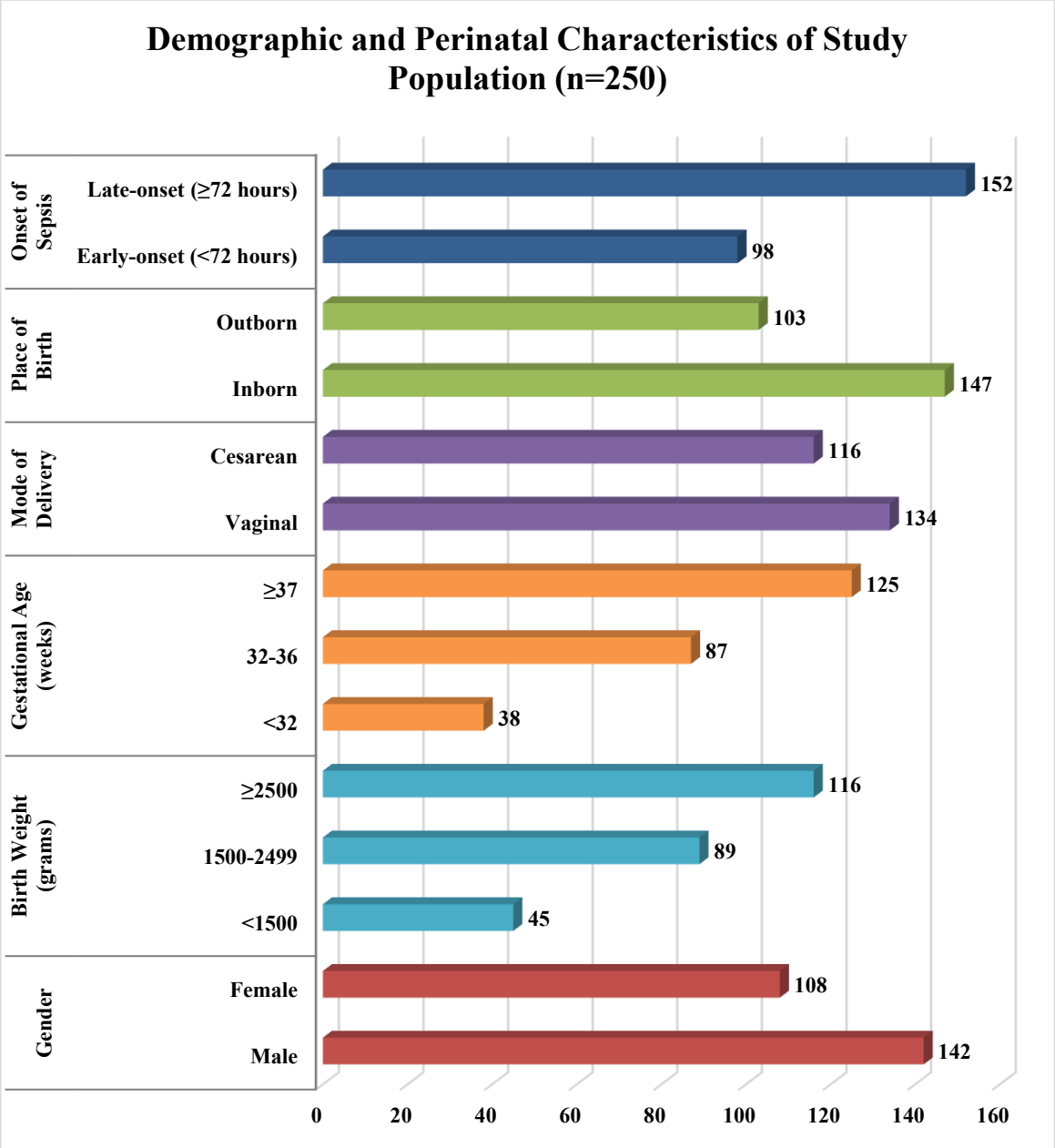

Fig: 1

Table 2: Clinical Presentation of Neonatal Sepsis (n=250)

Clinical Signs	Present	Absent	Percentage (%)
Temperature instability	189	61	75.6
Feeding intolerance	167	83	66.8
Lethargy/Poor activity	156	94	62.4
Respiratory distress	143	107	57.2
Poor perfusion	128	122	51.2
Apnea	89	161	35.6
Abdominal distension	76	174	30.4
Seizures	34	216	13.6
Jaundice	198	52	79.2
Skin changes	67	183	26.8

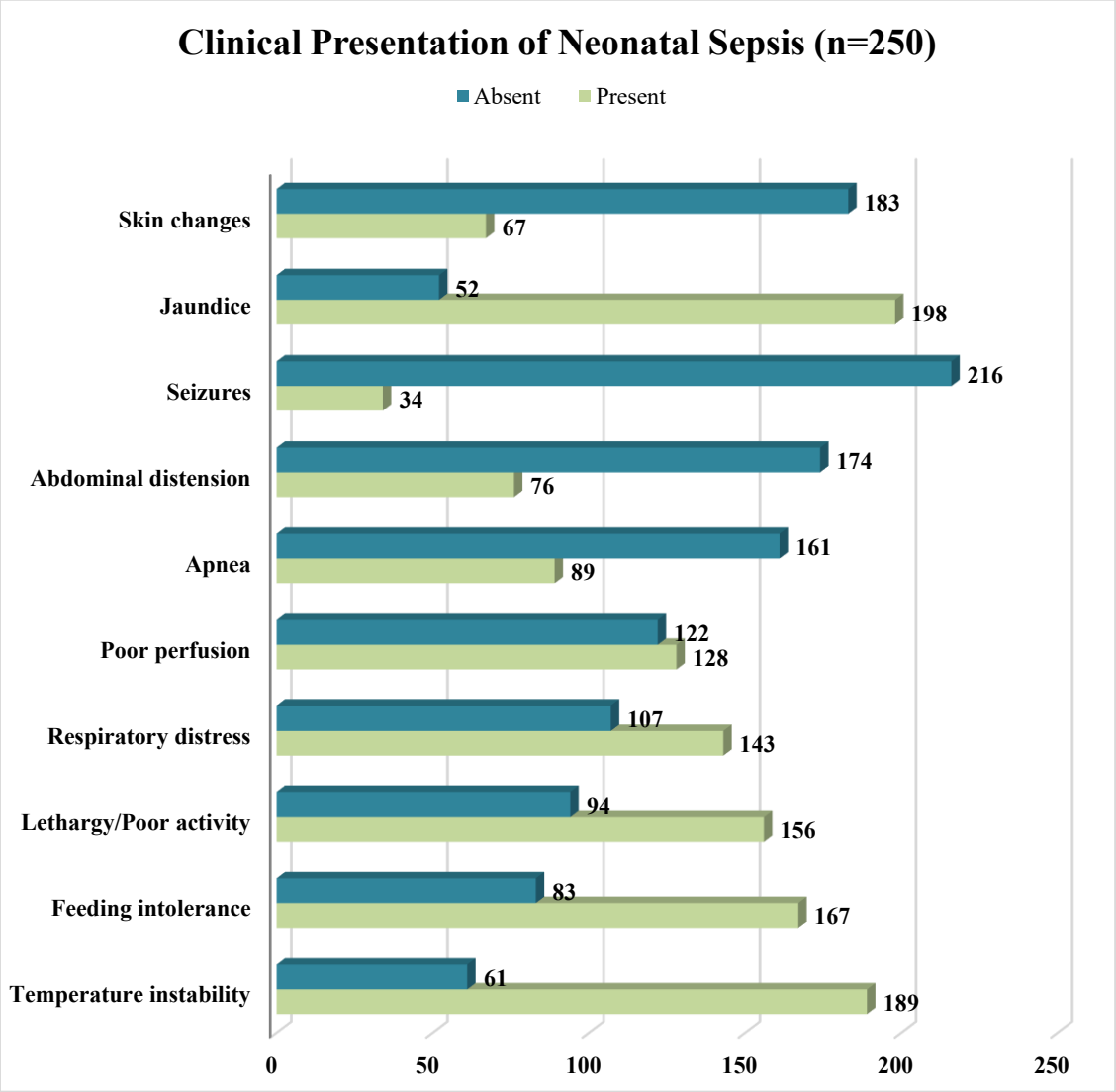

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Table 3: Maternal and Neonatal Risk Factors (n=250)

	Risk Factors	Present (n)	Percentage (%)
Maternal Risk Factors	Prolonged rupture of membranes (>18 hours)	78	31.2
	Maternal fever during labor	56	22.4
	Chorioamnionitis	43	17.2
	Urinary tract infection	38	15.2
	Multiple vaginal examinations (>3)	67	26.8
Neonatal Risk Factors	Prematurity (<37 weeks)	125	50
	Low birth weight (<2500g)	134	53.6
	Male gender	142	56.8
	Birth asphyxia	89	35.6
	Mechanical ventilation	76	30.4
	Central venous catheter	67	26.8
	Prolonged hospitalization (>7 days)	156	62.4

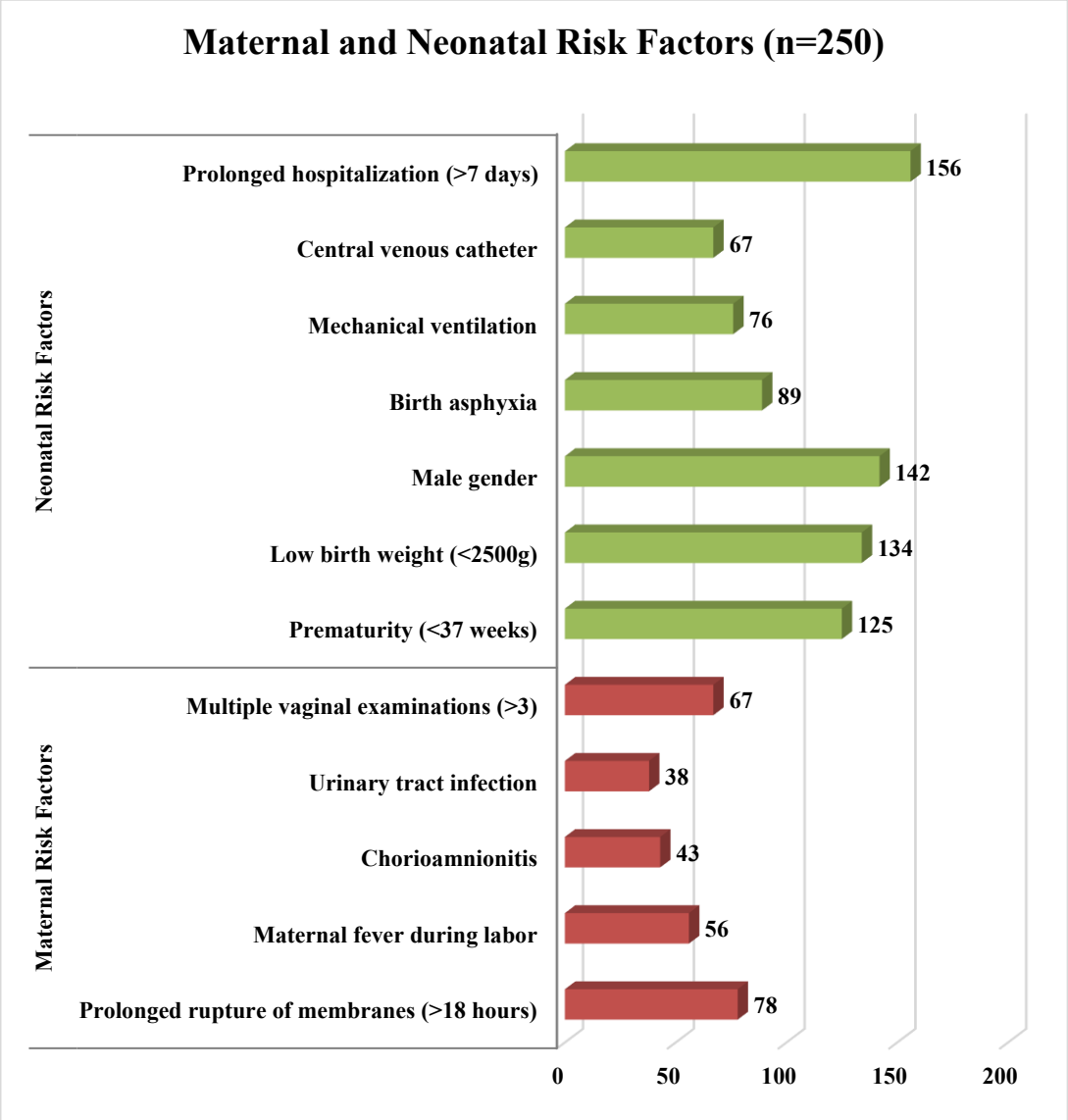

Fig: 3

Table 4: Laboratory Findings in Neonatal Sepsis (n=250)

Laboratory Parameters	Normal	Abnormal	Percentage Abnormal (%)
Complete Blood Count			
Total leucocyte count	89	161	64.4
- Leucopenia (<5000/mm³)	-	76	30.4
- Leucocytosis (>25000/mm³)	-	85	34.0
Absolute neutrophil count	98	152	60.8
Platelet count (<150,000/mm³)	167	83	33.2
Inflammatory Markers			
C-reactive protein (>6 mg/L)	78	172	68.8
Blood Culture			
Positive	-	92	36.8
Negative	158	-	63.2
Other Parameters			
Blood glucose (<40 mg/dL)	198	52	20.8
Arterial blood gas abnormalities	167	83	33.2

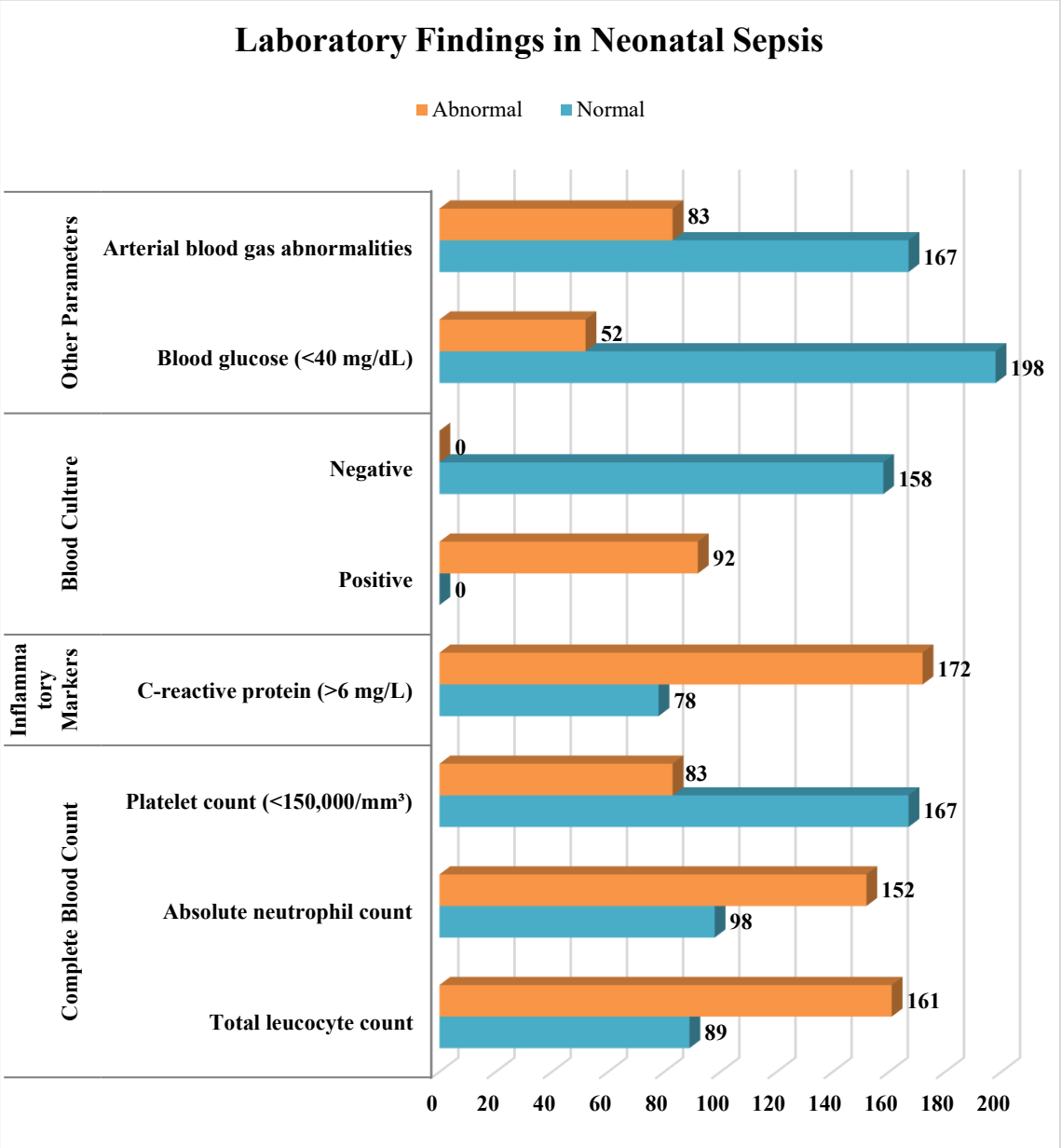

Fig: 4

Table 5: Microbiological Profile of Culture-Positive Cases (n=92)

	Organisms Isolated	Frequency (n)	Percentage (%)
Gram-Positive Bacteria	Coagulase-negative Staphylococci	23	25
	Staphylococcus aureus	18	19.6
	Group B Streptococcus	9	9.8
	Enterococcus species	6	6.5
	Total	**56**	**60.9**
Gram-Negative Bacteria	Escherichia coli	12	13
	Klebsiella pneumoniae	10	10.9
	Pseudomonas aeruginosa	6	6.5
	Acinetobacter species	4	4.3
	Enterobacter species	2	2.2
	Total	**34**	**37**
Fungi	Candida albicans	**2**	**2.2**

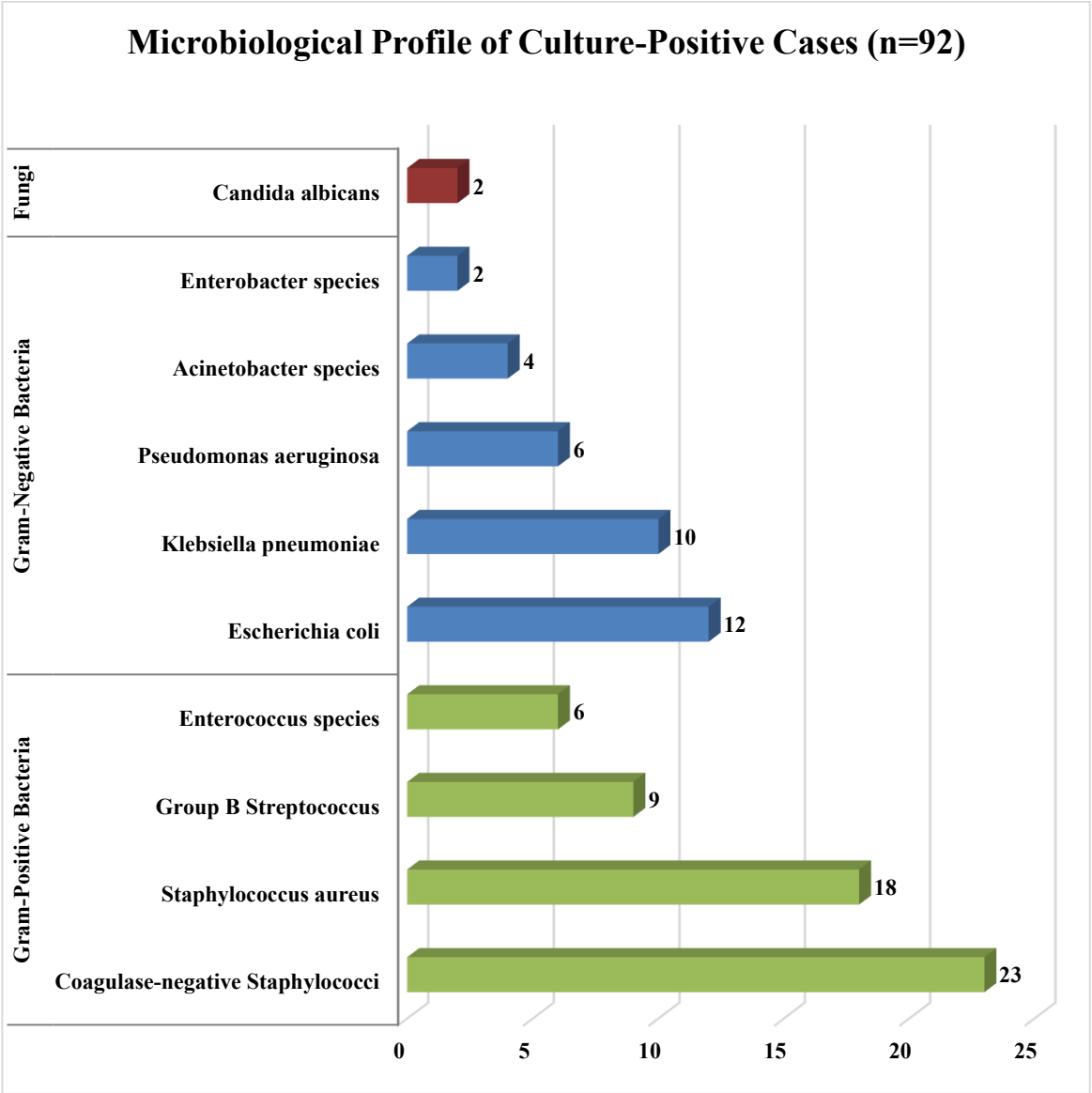

Fig: 5

Table 6: Clinical Outcomes of Neonatal Sepsis (n=250)

Outcomes		Frequency (n)	Percentage (%)
Final Outcome	Discharged improved	198	79.2
	Death	45	18
	Left against medical advice	7	2.8
Length of Hospital Stay	<7 days	67	26.8
	7-14 days	89	35.6
	15-21 days	56	22.4
	>21 days	38	15.2
Complications	Meningitis	23	9.2
	Pneumonia	45	18
	Necrotizing enterocolitis	12	4.8
	Seizures	34	13.6
	Shock	56	22.4
	Disseminated intravascular coagulation	18	7.2

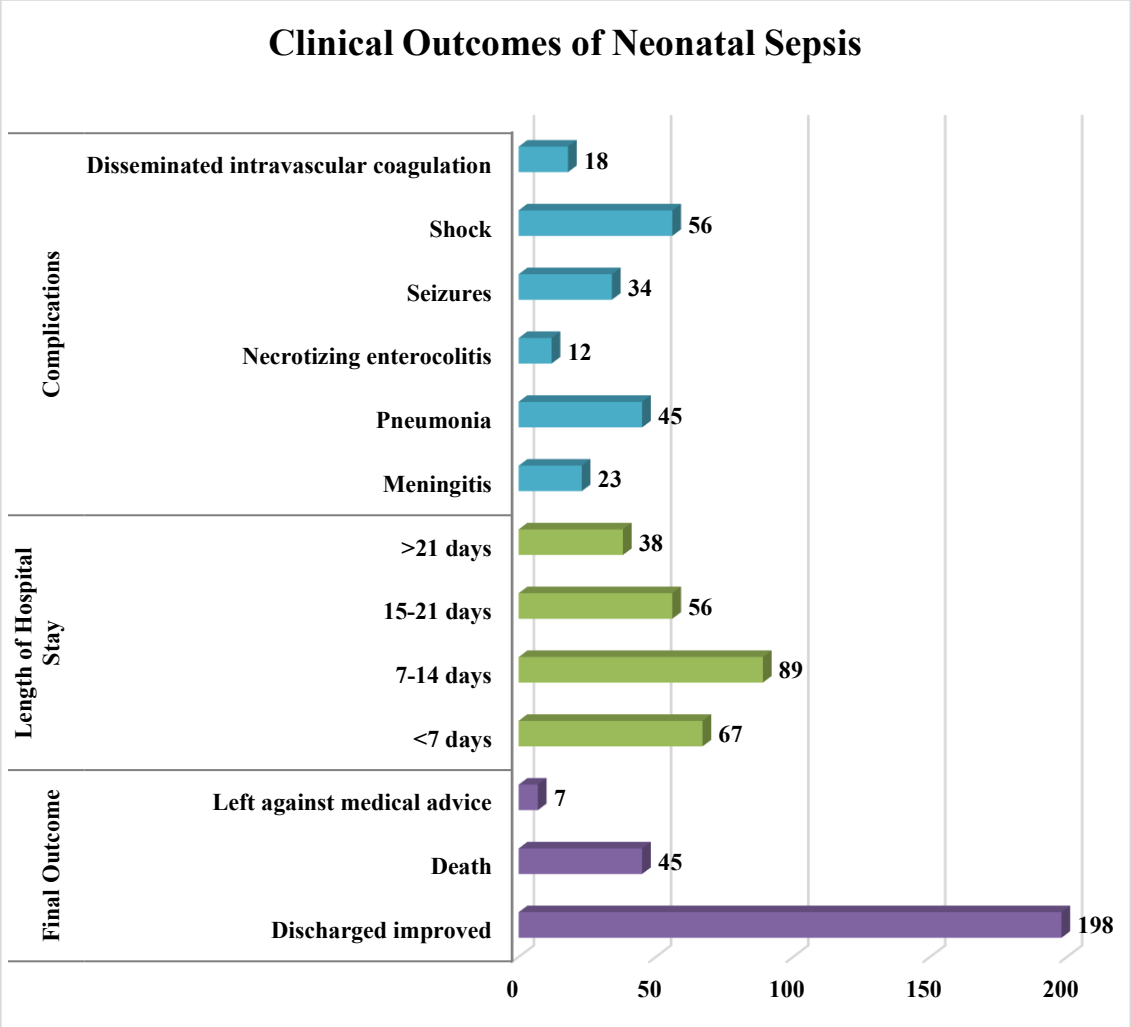

Fig: 6

Discussion

The present study revealed a higher prevalence of neonatal sepsis among male neonates (56.8%) compared to females (43.2%), which is consistent with previous literature suggesting male gender as a significant risk factor for neonatal sepsis. This male predominance has been attributed to the immunoregulatory genes located on the X chromosome, making males more susceptible to infections (Stoll et al., 2002). The study by Hornik et al. (2003) similarly reported male predominance in neonatal sepsis cases, supporting our findings.

Low birth weight neonates (<2500g) constituted 53.6% of the study population, while preterm neonates (<37 weeks) accounted for 50.0% of cases. These findings align with established literature that identifies prematurity and low birth weight as major risk factors for neonatal sepsis due to immature immune systems, prolonged hospitalization, and increased need for invasive procedures (Edwards, 2004). The higher proportion of late-onset sepsis (60.8%) compared to early-onset sepsis (39.2%) in our study is consistent with patterns observed in tertiary care NICUs, where prolonged hospitalization and invasive procedures increase the risk of nosocomial infections.

Maternal risk factors identified in our study included prolonged rupture of membranes (31.2%), maternal fever during labor (22.4%), and chorioamnionitis (17.2%). These findings are comparable to those reported by Bang et al. (2005) in their community-based study in rural India, which highlighted the importance of intrapartum risk factors in the development of neonatal sepsis. The presence of multiple vaginal examinations during labor (26.8%) as a risk factor emphasizes the need for judicious obstetric practices to minimize infection risk.

The clinical presentation of neonatal sepsis in our study was characterized by nonspecific signs, with temperature instability being the most common manifestation (75.6%), followed by jaundice

(79.2%) and feeding intolerance (66.8%). These findings are consistent with previous studies that have highlighted the subtle and nonspecific nature of neonatal sepsis presentation, particularly in preterm infants (Schrag et al., 2000). The high prevalence of jaundice in our study may be attributed to the higher proportion of preterm neonates and the pathophysiological effects of sepsis on bilirubin metabolism.

Respiratory distress was observed in 57.2% of cases, which is higher than reported in some Western studies but consistent with findings from other developing countries where delayed presentation and more severe disease at admission are common (Verani et al., 2010). The presence of apnea in 35.6% of cases predominantly occurred in preterm neonates, reflecting the immaturity of respiratory control mechanisms in this vulnerable population.

Laboratory investigations revealed abnormal inflammatory markers in a significant proportion of cases, with elevated C-reactive protein (CRP) observed in 68.8% of neonates. This finding is consistent with previous studies that have established CRP as a useful biomarker for neonatal sepsis, although its limitations in early disease and in differentiating bacterial from non-bacterial causes remain acknowledged (Ng & Lam, 2006). The presence of leucopenia (30.4%) and thrombocytopenia (33.2%) in our study reflects the severity of sepsis and its impact on hematopoietic function.

Blood culture positivity was achieved in 36.8% of suspected sepsis cases, which is within the range reported in previous literature from developing countries but lower than desired for definitive diagnosis. This relatively low culture positivity rate may be attributed to several factors including prior antibiotic administration, inadequate blood volume for culture, and limitations in laboratory facilities (Stoll et al., 2005). The predominance of gram-positive organisms (60.9%) in our study, particularly coagulase-negative staphylococci and Staphylococcus aureus, reflects the nosocomial nature of many infections in the NICU setting.

The isolation of gram-negative bacteria in 37.0% of culture-positive cases, with Escherichia coli and Klebsiella pneumoniae being the most common, is consistent with patterns observed in other Indian studies and reflects the environmental and hygiene-related factors contributing to neonatal sepsis in developing countries. The presence of multidrug-resistant organisms such as Pseudomonas aeruginosa and Acinetobacter species highlights the emerging challenge of antimicrobial resistance in neonatal care settings.

The overall mortality rate of 18.0% in our study falls within the range reported in previous literature from similar settings, though it remains significantly higher than rates observed in developed countries. This mortality rate is comparable to findings reported by Bang et al. (2005) in their field trial in rural India, which demonstrated mortality rates ranging from 16-25% depending on the intervention provided. The higher mortality observed in developing countries can be attributed to delayed presentation, limited resources, and higher prevalence of risk factors such as low birth weight and prematurity.

The length of hospital stay showed considerable variation, with 62.4% of neonates requiring hospitalization for more than 7 days. This prolonged hospitalization reflects the complex nature of neonatal sepsis management and the need for extended antibiotic therapy and supportive care. The development of complications such as pneumonia (18.0%), shock (22.4%), and meningitis (9.2%) contributed to prolonged hospital stays and adverse outcomes.

The findings of this study have several important implications for clinical practice in tertiary care NICUs. The high prevalence of risk factors such as prematurity, low birth weight, and prolonged rupture of membranes emphasizes the need for enhanced preventive strategies, including improved antenatal care, appropriate intrapartum antibiotic prophylaxis, and strict adherence to infection control practices in the NICU setting.

The predominance of late-onset sepsis and nosocomial pathogens highlights the critical importance of implementing comprehensive infection prevention and control measures, including proper hand hygiene, rational use of invasive devices, and judicious antibiotic prescribing practices. The emergence of multidrug-resistant organisms necessitates the development of institutional antibiotic

policies based on local antimicrobial susceptibility patterns and the establishment of antimicrobial stewardship programs.

The nonspecific nature of clinical presentation underscores the need for heightened clinical vigilance and the development of standardized protocols for early recognition and management of neonatal sepsis. The integration of clinical assessment with laboratory biomarkers and risk factor evaluation may improve diagnostic accuracy and enable more timely intervention.

Conclusion

This cross-sectional study conducted at People's College of Medical Sciences & Research Centre, Bhopal, revealed a significant burden of neonatal sepsis with distinctive clinical and microbiological characteristics. The study identified male gender, prematurity, low birth weight, and various maternal risk factors as significant contributors to neonatal sepsis. The clinical presentation was predominantly characterized by nonspecific signs including temperature instability, jaundice, and feeding intolerance, emphasizing the diagnostic challenges faced by clinicians. Laboratory investigations showed elevated inflammatory markers in the majority of cases, while blood culture positivity remained suboptimal. The microbiological profile demonstrated a predominance of gram-positive organisms, particularly coagulase-negative staphylococci and Staphylococcus aureus, with concerning emergence of multidrug-resistant gram-negative bacteria. The overall mortality rate of 18.0% reflects the serious nature of this condition in tertiary care settings. These findings provide valuable insights into the epidemiological patterns, clinical characteristics, and outcomes of neonatal sepsis in a tertiary care NICU setting, contributing to the existing body of knowledge and informing evidence-based clinical practice guidelines for improving neonatal care outcomes in similar healthcare environments.

Recommendations

Based on the findings of this study, several recommendations emerge for improving neonatal sepsis management and outcomes in tertiary care settings. Healthcare institutions should implement comprehensive infection prevention and control programs including strict hand hygiene protocols, rational use of invasive devices, and evidence-based antibiotic stewardship programs to reduce nosocomial infections and antimicrobial resistance. Enhanced antenatal care services should be strengthened to address maternal risk factors, including screening and treatment of infections, appropriate management of prolonged rupture of membranes, and implementation of intrapartum antibiotic prophylaxis protocols. Clinical protocols for early recognition and standardized management of neonatal sepsis should be developed and regularly updated based on local epidemiological patterns and antimicrobial susceptibility data. Laboratory capabilities should be enhanced to improve blood culture techniques, reduce contamination rates, and establish rapid diagnostic methods for early pathogen identification. Staff training programs should be implemented to improve clinical recognition of subtle signs of neonatal sepsis, particularly in high-risk populations such as preterm and low birth weight neonates. Regular surveillance systems should be established to monitor infection rates, antimicrobial resistance patterns, and clinical outcomes to guide quality improvement initiatives and inform policy decisions for optimizing neonatal care delivery.

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