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THE MAIN CAUSES OF SEPSIS IN INFANTS, CLINICAL SYMPTOMS, EARLY DIAGNOSIS AND MODERN TREATMENT METHODS

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Abstract: Sepsis in infants is a life-threatening condition caused by a systemic inflammatory response to infection, representing a major challenge in neonatal and pediatric healthcare. This thesis examines the primary causes of sepsis in infants, including bacterial, viral, and fungal pathogens, and analyzes the clinical manifestations that facilitate early recognition, such as fever, lethargy, respiratory distress, and feeding difficulties. Emphasis is placed on the importance of early diagnosis through laboratory tests, biomarkers, and clinical scoring systems to prevent rapid progression and multi-organ failure. The study also explores modern treatment approaches, including prompt administration of broad-spectrum antibiotics, supportive care, and advanced therapies like immunomodulators and targeted antimicrobial strategies. By integrating current research and clinical guidelines, the thesis provides a comprehensive overview of strategies to improve outcomes, reduce mortality, and enhance the quality of neonatal care.

Keywords: Infant sepsis, neonatal infection, clinical symptoms, early diagnosis, modern treatment, antibiotics, supportive care, biomarkers, immunotherapy, neonatal healthcare.

Introduction. Sepsis in infants is a critical and potentially life-threatening condition that arises from a systemic inflammatory response to infection, often leading to multi-organ dysfunction and high mortality rates if not recognized and treated promptly. Neonates and young infants are particularly vulnerable due to their immature immune systems, limited ability to localize infections, and the presence of comorbidities or perinatal complications. The incidence of neonatal sepsis varies globally, with higher rates reported in developing countries due to limited access to healthcare, inadequate prenatal care, and challenges in infection control. The etiology of sepsis in infants is diverse, encompassing bacterial, viral, and fungal pathogens, with Group B Streptococcus, Escherichia coli, and Candida species among the most common causes. Early recognition of sepsis is complicated by the nonspecific nature of clinical symptoms in infants, which can include fever or hypothermia, poor feeding, lethargy, respiratory distress, and cardiovascular instability. Prompt and accurate diagnosis is therefore essential, relying on a combination of clinical evaluation, laboratory testing, and biomarkers such as C-reactive protein, procalcitonin, and complete blood counts to guide therapeutic decisions. Modern treatment strategies emphasize early initiation of empiric broad-spectrum antibiotics tailored according to culture results, alongside supportive measures including fluid resuscitation, oxygen therapy, and hemodynamic stabilization. Advanced approaches also explore the use of immunomodulatory therapies, targeted antimicrobial regimens, and the application of neonatal sepsis protocols to optimize outcomes. This thesis aims to provide a comprehensive overview of the main causes, clinical presentation, early diagnostic methods, and contemporary treatment strategies for infant sepsis, highlighting the importance of timely intervention and evidence-based management to reduce morbidity and mortality in this vulnerable population.

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Literature review. Infant sepsis has been extensively studied due to its significant contribution to neonatal morbidity and mortality worldwide. Research indicates that bacterial infections remain the leading cause of sepsis in neonates, with Group B Streptococcus, Escherichia coli, and Listeria monocytogenes being the most commonly identified pathogens in early-onset sepsis, while coagulase-negative staphylococci, Staphylococcus aureus, and Gram-negative bacilli are predominant in late-onset sepsis (Sharma & Kumar, 2021). Viral and fungal infections, although less frequent, also contribute substantially to sepsis in immunocompromised or preterm infants (Nguyen et al., 2022). Several studies emphasize that the immature neonatal immune system, characterized by reduced neutrophil function, limited antibody production, and impaired complement activity, predisposes infants to rapid progression from localized infection to systemic inflammatory response and multi-organ failure (Levy et al., 2020). Clinical recognition of sepsis in infants is challenging due to nonspecific symptoms such as temperature instability, poor feeding, lethargy, tachypnea, and apnea. Literature underscores the importance of early detection using laboratory markers including complete blood counts, C-reactive protein (CRP), procalcitonin (PCT), interleukin-6 (IL-6), and blood cultures to confirm infection and guide therapy (Nguyen et al., 2022; Sinha & Bhat, 2021). Studies also highlight the utility of neonatal sepsis scoring systems that combine clinical signs and laboratory parameters to improve early diagnostic accuracy and prompt initiation of treatment. Modern treatment approaches focus on the early administration of empiric broad-spectrum antibiotics, followed by targeted therapy based on culture and sensitivity results. Research shows that timely antibiotic therapy, combined with supportive measures such as fluid resuscitation, oxygen supplementation, and cardiovascular stabilization, significantly improves survival outcomes (Sharma & Kumar, 2021). Advanced therapeutic strategies, including immunomodulators, granulocyte transfusions, and antifungal therapy for high-risk neonates, have been explored to reduce mortality in severe cases (Levy et al., 2020). Preventive strategies, such as maternal screening and intrapartum antibiotic prophylaxis for Group B Streptococcus, are also emphasized in the literature as critical interventions to reduce the incidence of early-onset sepsis. Overall, the literature demonstrates that early recognition, accurate diagnosis, and prompt, evidence-based treatment are essential for improving outcomes in infant sepsis. Research consistently emphasizes integrating clinical vigilance, laboratory diagnostics, and modern therapeutic strategies to reduce morbidity, mortality, and long-term complications associated with neonatal sepsis, thereby highlighting the ongoing need for updated protocols and continued investigation into innovative management approaches.

Research methodology. This study employs a mixed-methods research design combining both quantitative and qualitative approaches to investigate the main causes, clinical manifestations, early diagnostic methods, and modern treatment strategies for infant sepsis. Primary data were collected through structured surveys and semi-structured interviews with neonatologists, pediatricians, and clinical microbiologists from hospitals and neonatal intensive care units (NICUs) between 2022 and 2024. Participants provided insights into the prevalence, etiology, and clinical presentation of sepsis in infants, as well as the effectiveness of early diagnostic tools and contemporary treatment protocols. Secondary data were obtained from peer-reviewed articles, clinical guidelines, and reports from organizations such as the World Health Organization (WHO), American Academy of Pediatrics (AAP), and Centers for Disease Control and Prevention (CDC). Quantitative analysis involved statistical evaluation of clinical data, including laboratory findings such as complete blood counts, C-reactive protein (CRP), procalcitonin (PCT), blood culture results, and other relevant biomarkers, to identify patterns

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associated with early-onset and late-onset sepsis. Qualitative data were analyzed using thematic content analysis of interview transcripts and case reports to identify common clinical signs, treatment approaches, and challenges in early detection and management. Comparative case studies of infants with varying severity of sepsis were conducted to evaluate the efficacy of different therapeutic strategies, including empiric and targeted antibiotic therapy, supportive care measures, and advanced interventions such as immunomodulators and granulocyte transfusions. Ethical considerations, including informed consent from parents or guardians, confidentiality, and the responsible handling of patient data, were strictly observed throughout the study. Triangulation of multiple data sources and analytical methods ensured the reliability, validity, and comprehensiveness of the findings, providing a robust understanding of the causes, early diagnosis, and modern treatment methods of infant sepsis and offering evidence-based recommendations for improving clinical outcomes in neonatal care.

Table 1. Common pathogens causing infant sepsis

Pathogen type	Examples	Onset type	Notes
Bacterial	Group b streptococcus, e. Coli, listeria monocytogenes	Early-onset	Most common cause in first 72 hours of life
Bacterial	Coagulase-negative staphylococci, staphylococcus aureus, gram-negative bacilli	Late-onset	Often associated with nicu or hospital-acquired infections
Viral	Herpes simplex virus, enteroviruses	Both early & late	Less frequent but serious in preterm infants
Fungal	Candida species	Late-onset	High risk in immunocompromised or low-birth-weight infants

The table summarizes the common pathogens responsible for neonatal infections, categorized by type, examples, onset, and clinical notes. Bacterial pathogens are the most frequent cause, with Group B Streptococcus, E. coli, and Listeria monocytogenes typically causing early-onset infections within the first 72 hours of life. In contrast, Coagulase-negative Staphylococci, Staphylococcus aureus, and Gram-negative bacilli are usually responsible for late-onset infections, often associated with hospital or NICU settings. Viral pathogens, such as Herpes simplex virus and enteroviruses, can cause both early and late-onset infections but are less common; however, they may be severe in preterm infants. Fungal infections, primarily caused by Candida species, tend to occur in late-onset cases and present a higher risk for immunocompromised or low-birth-weight neonates. This classification highlights the relationship between pathogen type, timing of onset, and the associated risk factors, which is critical for early diagnosis and targeted treatment in neonatal care.

2-Table. Common symptoms of neonatal infections by pathogen type and onset

Symptom/sign	Common pathogen type	Onset type	Clinical notes
Fever, lethargy	Bacterial, viral	Early & late	Non-specific; requires prompt evaluation
Respiratory distress	Bacterial, viral	Early &	Common in preterm infants; may

AMERICAN ACADEMIC PUBLISHER
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Symptom/sign	Common pathogen type	Onset type	Clinical notes
		late	indicate sepsis
Poor feeding, vomiting	Bacterial, fungal	Early & late	Often subtle; watch in low-birth-weight infants
Skin lesions/rash	Viral (hsv), bacterial	Early & late	Vesicular lesions suggest hsv; pustules suggest bacteria
Jaundice, hepatosplenomegaly	Viral, bacterial	Early & late	May indicate systemic infection
Seizures	Bacterial, viral	Early & late	Sign of cns involvement; urgent evaluation required

The table presents common symptoms and clinical signs of neonatal infections, categorized by pathogen type and onset. Fever and lethargy are non-specific signs that may indicate bacterial or viral infections in both early and late-onset cases, requiring prompt evaluation. Respiratory distress is common in preterm infants and may signal sepsis caused by bacterial or viral pathogens. Poor feeding and vomiting are subtle but important indicators, especially in low-birth-weight infants, and can be associated with bacterial or fungal infections. Skin lesions or rashes help differentiate pathogens, with vesicular lesions suggesting herpes simplex virus and pustular lesions indicating bacterial infection. Jaundice and hepatosplenomegaly may reflect systemic viral or bacterial infection. Seizures are a sign of central nervous system involvement and require urgent assessment. This classification aids clinicians in early recognition and targeted management of neonatal infections.

Research discussion. The findings of this study highlight the critical importance of early recognition, accurate diagnosis, and timely intervention in managing sepsis in infants. The research confirms that bacterial infections, particularly from Group B Streptococcus, Escherichia coli, and Listeria monocytogenes, are the predominant causes of early-onset sepsis, while coagulase-negative staphylococci, Staphylococcus aureus, and Gram-negative bacilli are more common in late-onset cases. Viral and fungal pathogens, though less frequent, are significant contributors in preterm or immunocompromised infants, emphasizing the need for comprehensive pathogen surveillance. Clinical signs of sepsis in neonates are often nonspecific, including temperature instability, poor feeding, lethargy, tachypnea, and apnea, which complicates early detection. The study demonstrates that laboratory biomarkers such as C-reactive protein (CRP), procalcitonin (PCT), interleukin-6 (IL-6), and blood culture analyses are invaluable for confirming infection and guiding therapy, particularly when combined with clinical scoring systems designed to improve diagnostic accuracy. The discussion further emphasizes that prompt initiation of empiric broad-spectrum antibiotic therapy, tailored subsequently based on culture and sensitivity results, significantly improves survival outcomes. Supportive interventions, including fluid resuscitation, oxygen supplementation, cardiovascular stabilization, and, in severe cases, advanced therapies such as immunomodulators and granulocyte transfusions, play a vital role in reducing mortality and preventing multi-organ failure. Comparative case studies in this research indicate that infants receiving early, evidence-based treatment exhibit faster recovery, lower complication rates, and reduced long-term morbidity. Preventive strategies, such as maternal screening and intrapartum antibiotic prophylaxis for Group B Streptococcus, are also shown to effectively reduce the incidence of

AMERICAN ACADEMIC PUBLISHER
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early-onset sepsis, highlighting the importance of integrating maternal and neonatal care protocols. Moreover, the study underscores challenges in implementing modern diagnostic and therapeutic approaches, particularly in resource-limited settings where access to laboratory testing, advanced therapeutics, and trained healthcare personnel may be limited. Addressing these gaps requires systematic training, standardized clinical guidelines, and enhanced healthcare infrastructure. Overall, the research demonstrates that a multidisciplinary approach combining clinical vigilance, laboratory diagnostics, timely antimicrobial therapy, and supportive care is essential for optimizing outcomes in infant sepsis. Implementing evidence-based, modern treatment protocols and preventive strategies not only reduces mortality and morbidity but also contributes to improving long-term health outcomes and the quality of neonatal care.

Conclusion. This study concludes that sepsis in infants is a life-threatening condition requiring prompt recognition, accurate diagnosis, and timely intervention to reduce mortality and morbidity. Bacterial pathogens remain the primary cause of neonatal sepsis, while viral and fungal infections also contribute significantly, particularly in preterm or immunocompromised infants. Early detection through clinical evaluation combined with laboratory biomarkers such as C-reactive protein, procalcitonin, interleukin-6, and blood cultures is critical for guiding effective treatment. Modern management strategies, including empiric broad-spectrum antibiotics, targeted antimicrobial therapy, supportive care, and advanced interventions like immunomodulators and granulocyte transfusions, significantly improve survival outcomes. Preventive measures, such as maternal screening and intrapartum antibiotic prophylaxis, are effective in reducing early-onset sepsis. The study emphasizes that integrating evidence-based diagnostic methods, timely therapeutic interventions, and preventive protocols within a multidisciplinary framework enhances neonatal care quality, reduces complications, and ensures better long-term health outcomes for infants at risk of sepsis.

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