

PAEDIATRIC SEPSIS STRATEGIES FOR EARLY DETECTION AND COLLABORATIVE CARE

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Abstract: Paediatric sepsis remains a significant cause of mortality and morbidity globally, with a disproportionately high burden in low- and middle-income countries like Pakistan. The high rates of sepsis-related deaths in Pakistan are attributed to delayed diagnosis, inadequate healthcare infrastructure, antimicrobial resistance (AMR), and limited access to appropriate medical care. This review focuses on strategies for early detection and collaborative care approaches in the management of paediatric sepsis, particularly in the context of Pakistan's healthcare system. **Methods:** This review synthesizes findings from recent studies (2014-2024) addressing the pathophysiology, risk factors, early detection strategies, and treatment modalities for paediatric sepsis, with an emphasis on the unique challenges faced in Pakistan. It discusses the role of biomarkers, clinical scoring systems, and multidisciplinary care models in improving outcomes for children with sepsis. The review also examines the impact of antimicrobial resistance on sepsis treatment and highlights technological advancements such as artificial intelligence and telemedicine that can aid in early diagnosis. **Results:** Early detection of paediatric sepsis in Pakistan is hindered by a lack of awareness, inadequate diagnostic tools, and delays in seeking medical care, particularly in rural areas. Biomarkers such as procalcitonin (PCT) and C-reactive protein (CRP) have shown promise in diagnosing sepsis, but their use is limited due to resource constraints. Collaborative care models, incorporating multidisciplinary teams and family-centred care, have improved outcomes in larger urban hospitals but remain underutilized in rural regions. Antimicrobial resistance presents a significant challenge, necessitating more stringent antibiotic stewardship programs. **Conclusion:** To reduce the burden of paediatric sepsis in Pakistan, efforts must focus on enhancing early detection through the implementation of standardized sepsis protocols, increasing access to diagnostic tools, and promoting collaborative care approaches. Addressing antimicrobial resistance through improved antibiotic stewardship is also critical. The integration of technological solutions, such as AI-based diagnostic tools and telemedicine, offers the potential for improving sepsis outcomes in resource-limited settings.

Keywords: Paediatric Sepsis, Sepsis Early Detection, Antimicrobial Resistance, Biomarkers, Procalcitonin

Introduction

Paediatric sepsis is a significant cause of mortality and morbidity in Pakistan, where healthcare resources are often limited, and access to timely care is challenging. Sepsis, a dysregulated host response to infection leading to life-threatening organ dysfunction, disproportionately affects children in low- and middle-income countries (LMICs) like Pakistan, where socio-economic disparities exacerbate health outcomes. (1). The mortality rate for paediatric sepsis in Pakistan is estimated to be higher than in many high-income countries, primarily due to delays in diagnosis and treatment, inadequate healthcare infrastructure, and a lack of standardized sepsis protocols. (2).

This review focuses on strategies for early detection of paediatric sepsis and the role of collaborative care, especially in resource-limited settings such as Pakistan. The emphasis is on improving the recognition and management of sepsis in children through better diagnostic tools, multidisciplinary approaches, and the adaptation of global guidelines to the local healthcare context. (3).

2. Pathophysiology of Paediatric Sepsis in Pakistan

Paediatric sepsis in Pakistan follows a similar pathophysiological process as described globally, characterized by an excessive inflammatory response to infection that leads to organ dysfunction. (4). However, the unique demographic and healthcare challenges in Pakistan contribute to an increased burden. Malnutrition, poor sanitation, and overcrowded living conditions are major contributing factors to the high incidence of infections leading to sepsis in children. (5).

In Pakistan, common infectious agents responsible for sepsis in children include bacterial pathogens such as *Streptococcus pneumoniae*, *Escherichia coli*, and *Staphylococcus aureus*, which are often exacerbated by antimicrobial resistance (AMR) (6). AMR poses a severe threat to effective sepsis management, as many commonly used antibiotics are no longer effective due to inappropriate antibiotic use, a problem particularly prevalent in rural areas where access to healthcare is limited (7).

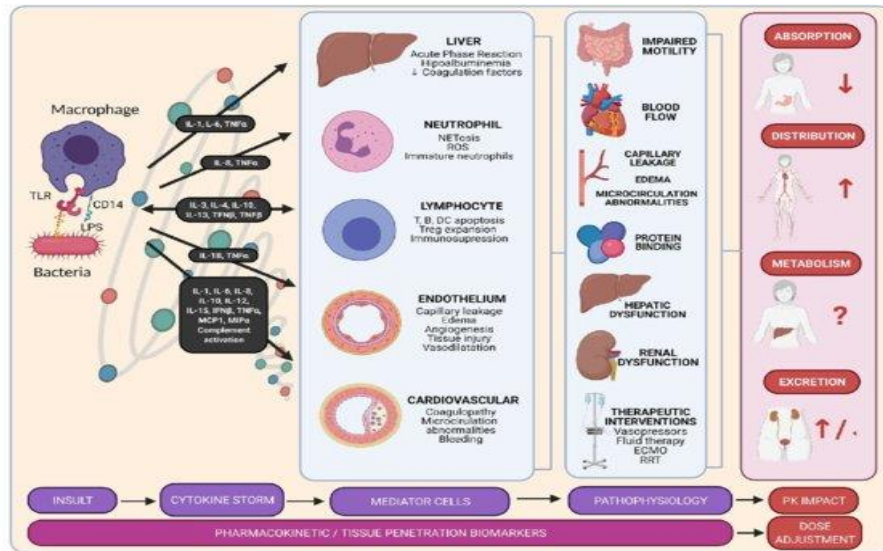


Fig 1 Pathophysiology of Paediatric Sepsis

3. Risk Factors and Predictors of Sepsis in Pakistani Children

In Pakistan, several risk factors predispose children to sepsis, including neonatal complications, preterm birth, and poor vaccination coverage (8). Neonatal sepsis remains a leading cause of death in Pakistani hospitals, with Group B Streptococcus and *E. coli* being the primary causative agents in early-onset neonatal sepsis. (5). Children from low-income families, particularly those living in rural areas,

are at greater risk due to malnutrition and lack of access to clean water and sanitation. Immunization rates in Pakistan remain suboptimal, contributing to higher incidences of infections such as pneumonia and diarrhoea, which can progress to sepsis. (9). In addition, delays in seeking medical care, due to limited healthcare access and financial constraints, lead to late presentations and poorer outcomes. (2).

Social and cultural factors also play a role in the risk of sepsis. Gender disparities in healthcare access mean that female children in Pakistan are less likely to receive timely medical care, leading to increased mortality from preventable diseases such as sepsis. (10)



Fig 2 Risk Factors and Predictors of Sepsis in Pakistani Children

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4. Early Detection Strategies in Paediatric Sepsis in Pakistan

Early detection of sepsis in children is critical but remains a challenge in Pakistan due to the lack of awareness among healthcare providers and the population. (11). In rural health centres, where access to advanced diagnostic tools is limited, clinical symptoms are often the first line of detection. Children presenting with fever, tachycardia, and respiratory distress should be rapidly assessed for sepsis, but delays are common due to overcrowded healthcare facilities and a lack of standardized sepsis protocols. (7).

4.1 Clinical Signs and Symptoms in Pakistani Settings

The clinical presentation of sepsis in children is similar globally, but in Pakistan, children often present late due to socio-economic and logistical challenges (12). Neonates, for example, may present with subtle symptoms such as poor feeding and lethargy, often misdiagnosed as common neonatal illnesses until the infection becomes severe. (6).

4.2 Use of Biomarkers The use of biomarkers like procalcitonin (PCT) and C-reactive protein (CRP) has proven to be effective in the early detection of sepsis (13). However, in Pakistan, these tests are not widely available, particularly in rural settings. (14). Efforts are being made to introduce affordable point-of-care testing (POCT) in government hospitals, but challenges remain due to budget constraints and a lack of trained personnel to interpret results.(7).

4.3 Advances in Technology Advances in technology, such as telemedicine and AI-driven diagnostic tools, have the potential to improve early detection of sepsis in Pakistani children (15). Several pilot programs in major cities like Karachi and Lahore have demonstrated the efficacy of using AI-based tools for early sepsis prediction in neonatal intensive care units (NICUs) (16). However, widespread implementation is still hindered by infrastructural limitations.

5. Collaborative Care Approaches in Pakistani Healthcare

Collaborative care, involving multidisciplinary teams, is essential for the effective management of paediatric sepsis. (17). In Pakistan, the lack of structured teamwork in many healthcare facilities contributes to the high mortality rates associated with sepsis. (2). In major hospitals like Aga Khan University Hospital and Jinnah Postgraduate Medical Centre, collaborative care models are being developed, integrating physicians, nurses, and allied health professionals to improve sepsis outcomes. (7).

5.1 Role of Family-Centered Care Family-centered care is particularly important in Pakistan, where family members are often the primary caregivers for hospitalized children (18). Engaging families in the care process has been shown to improve early recognition of symptoms and adherence to treatment protocols. (8). However, cultural barriers and a lack of healthcare literacy among parents remain challenges in rural areas.

6. Early Treatment Modalities and Management

In Pakistan, timely treatment of paediatric sepsis is often hindered by delayed healthcare access and lack of resources. The administration of antibiotics remains the first-line treatment, but widespread antimicrobial resistance (AMR) complicates the choice of appropriate empiric therapy. (7).

Studies have highlighted the importance of early, appropriate antibiotic use, but over-prescription and misuse have led to resistance, further complicating sepsis management. (5).

6.1 Antimicrobial Resistance in Pakistan AMR is a growing problem in Pakistan, with many common pathogens exhibiting resistance to first-line antibiotics. A national action plan to combat AMR was launched in 2017, but the impact on paediatric sepsis management has been limited due to challenges in implementation (6). Physicians must often rely on broad-spectrum antibiotics, contributing to further resistance.

7. Challenges in Managing Paediatric Sepsis in Pakistan

The challenges of managing paediatric sepsis in Pakistan are numerous. These include inadequate healthcare infrastructure, lack of standardized treatment protocols, limited access to advanced diagnostics, and a high burden of antimicrobial resistance. (7). Additionally, socio-economic factors, such as poverty and illiteracy, exacerbate the difficulties faced by healthcare providers in identifying and treating sepsis early. (5).

8. Recent Advances and Future Directions

Recent efforts to address paediatric sepsis in Pakistan include the implementation of telemedicine programs, the introduction of sepsis bundles in major hospitals, and the development of national sepsis guidelines. (11). However, more efforts are needed to ensure widespread access to these resources, particularly in rural areas. (16). The development of low-cost, point-of-care diagnostic tools is crucial for improving sepsis outcomes in resource-limited settings. (19).

Conclusion

Paediatric sepsis remains a major challenge in Pakistan, where delayed diagnosis, lack of resources, and antimicrobial resistance contribute to high mortality rates. Early detection strategies, including the use of biomarkers and collaborative care approaches, are critical to improving outcomes. However, significant efforts are needed to address the healthcare disparities that affect access to timely care. The adoption of global sepsis guidelines, tailored to the local context, will be essential in reducing the burden of paediatric sepsis in Pakistan.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

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Not applicable

Consent for publication

Approved

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The authors declared the absence of a conflict of interest.

Author Contribution**NAJMUD DIN (Consultant Pediatrics)**

Coordination of collaborative efforts.

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Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.

Conception of Study, Final approval of manuscript.

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Data acquisition, and analysis.

Manuscript drafting.

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