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Dr. Asma Wani
Senior Resident, Department of Pediatrics, Government Medical College, Srinagar, Jammu & Kashmir, India

Dr. Jafar Ahmad Tantray
Senior Resident, Department of Pediatrics, Government Medical College, Srinagar, Jammu & Kashmir, India

Sheikh Quyoom Hussain
Assistant Professor, Department of Pediatrics, Government Medical College, Srinagar, Jammu & Kashmir, India

Corresponding Author:
Sheikh Quyoom Hussain
Assistant Professor, Department of Pediatrics, Government Medical College, Srinagar, Jammu & Kashmir, India

Clinical profile and outcome of septic shock in children admitted to a tertiary care hospital

Asma Wani, Jafar Ahmad Tantray and Sheikh Quyoom Hussain

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Abstract
Background: Septic shock remains a leading cause of morbidity and mortality in pediatric intensive care units (PICU), particularly in developing countries. Early identification of clinical features, risk factors, and organ dysfunction is crucial for improving outcomes. There is limited data from northern India, including Jammu & Kashmir, regarding the clinical profile, laboratory findings, management modalities, and outcomes of children admitted with septic shock.
Aim: To describe the clinical profile, laboratory findings, co-morbid conditions, management strategies, and outcomes of children aged 1 month to 12 years admitted with septic shock at the Pediatric Hospital GMC Srinagar. To identify predictors of mortality among these children.
Methods: A prospective observational study was conducted over 24 months at the Pediatric Hospital GMC Srinagar. Children aged 1 month to 12 years admitted with septic shock (as per international consensus definitions) were enrolled after informed consent. Clinical history, presenting features, co-morbidities, physical examination findings, laboratory investigations, severity scoring (pSOFA), organ dysfunction, treatment interventions (inotropes, ventilation, fluid resuscitation), and outcomes (survival vs non-survival, length of stay) were recorded. Data were analyzed using descriptive and inferential statistics; multivariate analysis identified independent predictors of mortality. A p-value <0.05 was considered significant.
Results: During the study period, n = 110 children fulfilled criteria for septic shock. The mean age was 4.8±3.2 years, with about 55% below 5 years. Male: female ratio was approximately 1.3:1. The most common presenting symptoms were fever (100%), lethargy (78%), breathlessness (65%), and vomiting (42%). Co-morbidities included malnutrition (35%), anemia (40%), and prior recurrent infections (25%). Pneumonia was the most frequent source of infection (45%), followed by gastrointestinal infections (20%), CNS infections (15%), and others. Laboratory findings included leukocytosis (60%), thrombocytopenia (30%), elevated creatinine (25%), raised liver enzymes (20%), and positive blood cultures in 35%, with Pseudomonas, Staphylococcus aureus, and Escherichia coli as major isolates. Over 70% had multi-organ dysfunction (MODS). Interventions: fluid resuscitation in all, inotropes in 65%, mechanical ventilation in 40%. The overall mortality was 38%. Non-survivors had higher pSOFA scores (>10), MODS, multiple inotropes, delayed presentation (>48 hours), malnutrition, and need for mechanical ventilation (all $p<0.05$). Mean hospital stay among survivors was 8.2±4.5 days.
Conclusion: Pediatric septic shock at GMC Srinagar is associated with high morbidity and mortality. Younger age (<5 years), MODS, high pSOFA score, malnutrition, delayed presentation, and requirement for mechanical ventilation and multiple inotropes are significant predictors of poor outcome. Early recognition, aggressive monitoring, protocol-based treatment, and improvements in supportive care are essential to improve survival.

Keywords: Pediatric septic shock, morbidity, mortality, multi-organ dysfunction, pSOFA, intensive care

Introduction
Septic shock in children remains a critical health problem worldwide, particularly in low- and middle-income countries where infection burden, delayed presentation, malnutrition, and limited intensive care resources contribute to high morbidity and mortality. Sepsis is defined as a dysregulated host response to infection leading to life-threatening organ dysfunction, and septic shock implies circulatory, cellular, and metabolic abnormalities associated with greater risk of death than with sepsis alone [2].
Studies in India have shown mortality rates in paediatric sepsis and septic shock ranging from about 50% to over 60%, especially in tertiary care centres where patients often present in advanced stages of illness and with multiple organ dysfunction. A study from Haryana reported 58% mortality among children with sepsis, severe sepsis or septic shock. Younger age, presence of multiorgan dysfunction, positive blood cultures, and severe acute malnutrition were found to

be significant predictors of death in that cohort [3]. A prospective observational study from western India (n = 200) found that 22 children progressed to septic shock; significant predictors of mortality included culture positivity, multiorgan dysfunction, late hospital admissions, severe acute malnutrition, and need for intensive supportive care measures [6]. In Indonesia, a retrospective cohort study of 241 children with sepsis found mortality of about 65%; shock, low Glasgow Coma Scale (<9), use of inotropes, elevated CRP, and elevated lactate were significant predictors. The PELOD-2 score > 8 showed good sensitivity and specificity in predicting mortality in that setting [5].

Another study from a tertiary care referral hospital in Maharashtra showed among children with septic shock very high morbidity: almost 91% had multiorgan dysfunction, nearly all required inotropes and many required mechanical ventilation, with mortality >60%. Key factors associated with mortality included decompensated shock, need for mechanical ventilation, thrombocytopenia, coagulopathy, elevated liver enzymes, anemia, and positive culture. The most common source of infection was pneumonia [1].

Globally, comorbid complex chronic conditions also worsen outcomes. In a cohort in Brazil, children with such conditions had significantly higher mortality (26.7% versus 9.8%) compared to those without comorbidity, with scores like PELOD-2 and vasoactive-inotropic score (VIS) being useful predictors of outcome [4].

The literature shows that septic shock in children is associated with high mortality; important clinical predictors include age (younger children), malnutrition, positive microbial culture, late presentation, need for mechanical ventilation and inotropes, multiorgan dysfunction, and prognostic scores like PELOD-2 and PRISM. However, there is limited published data from the Jammu and Kashmir region (including Srinagar) that characterizes the clinical profile, laboratory findings, management patterns, and outcomes of paediatric septic shock in that locality.

Materials and Methods

Study Design and Setting

This was a prospective observational study conducted over a 24-month period from January 2023 to December 2024 at the Pediatric Hospital, Government Medical College Srinagar. The study was approved by the Institutional Ethics Committee, and informed consent was obtained from parents or legal guardians of all participating children.

Study Population

Children aged 1 month to 12 years admitted to the Pediatric Intensive Care Unit (PICU) with septic shock were enrolled. Septic shock was defined according to the International Pediatric Sepsis Consensus Conference criteria: sepsis with cardiovascular dysfunction, including hypotension (systolic blood pressure <5th percentile for age), requirement of vasoactive agents to maintain perfusion, or signs of tissue hypoperfusion.

Inclusion Criteria

1. Children aged 1 month to 12 years.
2. Diagnosis of septic shock on admission or during PICU stay.

Consent

Written informed consent was obtained from the parents or legal guardians of all children prior to enrollment in the study. They were provided with complete information about the study objectives, procedures, potential risks, and benefits, and had the opportunity to ask questions before agreeing to participate.

Exclusion Criteria

1. Children with pre-existing terminal illnesses with expected mortality <24 hours.
2. Children discharged against medical advice before completion of treatment.

Data Collection

Demographic data, clinical features at presentation, and past medical history were recorded. Clinical features included fever, lethargy, breathlessness, vomiting, convulsions, oliguria, and altered sensorium. Co-morbid conditions such as malnutrition, anemia, chronic lung disease, and congenital heart disease were documented.

Vital signs and laboratory investigations, including complete blood count, serum electrolytes, renal and liver function tests, C-reactive protein (CRP), lactate levels, and blood cultures, were recorded on admission and monitored as clinically indicated. Severity of illness was assessed using pediatric SOFA (pSOFA) scores.

Management Protocol

All children were managed according to standard pediatric septic shock protocols:

1. **Fluid resuscitation:** isotonic crystalloids 20 ml/kg boluses, repeated as needed under careful monitoring.
2. **Vasoactive support:** dopamine or epinephrine infusion in children with persistent hypotension after fluids.
3. **Antibiotic therapy:** empiric broad-spectrum intravenous antibiotics initiated within the first hour of recognition, later tailored based on culture sensitivity.
4. **Mechanical ventilation:** indicated for respiratory failure or altered consciousness.
5. **Supportive care:** correction of electrolytes, blood transfusion when indicated, nutritional support, and management of organ dysfunction.

Outcome Measures

Primary outcome: Mortality (survival vs non-survival).

Secondary outcomes: Duration of PICU stay, number of organs involved, requirement of mechanical ventilation, vasoactive support, and incidence of complications.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean±standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between survivors and non-survivors were performed using Chi-square test for categorical variables and Student's t-test for continuous variables. Multivariate logistic regression was used to identify independent predictors of mortality. A p-value <0.05 was considered statistically significant.

Results

A total of 110 children aged 1 month to 12 years admitted with septic shock were enrolled in the study. Among them, 62 (56.4%) were male and 48 (43.6%) were female. The mean age of patients was 4.8±3.2 years. Most children presented within 24-48 hours of symptom onset, while a few had delayed presentation of more than 72 hours.

Table 1 shows the demographic profile of children with septic shock. The majority were toddlers (1-3 years), followed by infants and older children. Malnutrition was present in 35% of children, and 18% had chronic comorbidities such as congenital heart disease or chronic lung disease.

Table 1: Demographic and baseline characteristics of children (n = 110)

Characteristics	Number (%)
Gender	
Male	62 (56.4)
Female	48 (43.6)
Age (years)	
<1	20 (18.2)
1-3	40 (36.4)
4-6	22 (20.0)
7-12	28 (25.4)
Malnutrition	39 (35.5)
Chronic comorbidities	20 (18.2)

The most common presenting features were fever (100%), lethargy (78%), and breathlessness (65%). Other symptoms included vomiting (42%), oliguria (30%), and convulsions (18%). Altered sensorium was observed in 25% of patients [Table 2].

Table 2: Clinical features of children with septic shock (n = 110)

Clinical Features	Number (%)
Fever	110 (100)
Lethargy	86 (78.2)
Breathlessness	72 (65.5)
Vomiting	46 (41.8)
Oliguria	33 (30.0)
Convulsions	20 (18.2)
Altered sensorium	28 (25.5)
Rash/Exanthema	15 (13.6)
Strawberry tongue	8 (7.3)
Conjunctivitis	12 (10.9)

Laboratory investigations revealed leukocytosis in 60% and elevated CRP in 70% of children. Blood cultures were positive in 35% of cases. Among positive cultures, Gram-negative organisms were most common (60%), followed by Gram-positive bacteria (30%) and fungal isolates (10%) [Table 3].

Table 3: Laboratory and microbiological findings

Investigations	Number (%)
Leukocytosis	66 (60.0)
Elevated CRP	77 (70.0)
Positive blood culture	39 (35.5)
Organism type (of positive)	
Gram-negative	23 (59.0)
Gram-positive	12 (30.8)
Fungal	4 (10.2)

All children received fluid resuscitation and broad-spectrum antibiotics. Vasoactive drugs were required in 65% of cases, while 40% required mechanical ventilation. Renal replacement therapy was needed in 10% of patients due to acute kidney injury [Table 4].

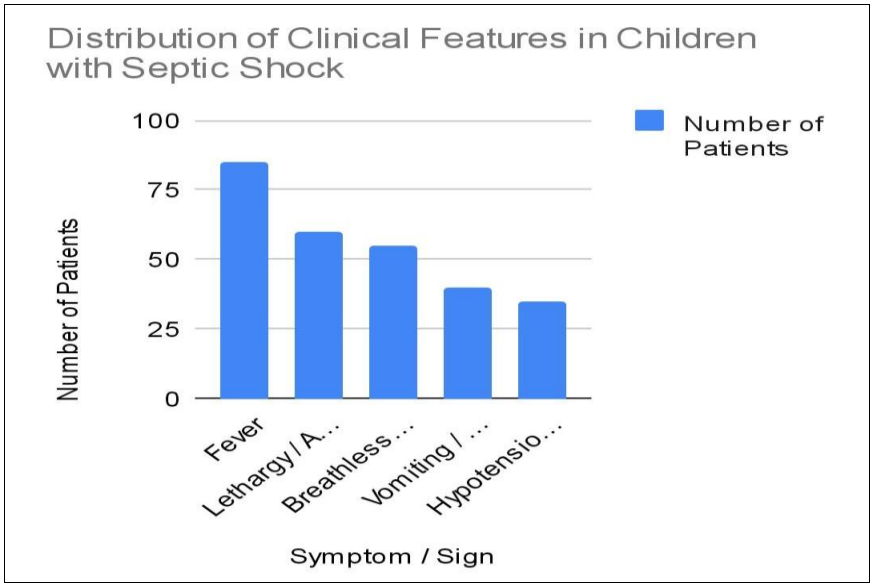
Table 4: Treatment interventions in children with septic shock

Treatment Modality	Number (%)
Fluid resuscitation	110 (100)
Antibiotic therapy	110 (100)
Vasoactive drugs	72 (65.5)
Mechanical ventilation	44 (40.0)
Renal replacement therapy	11 (10.0)

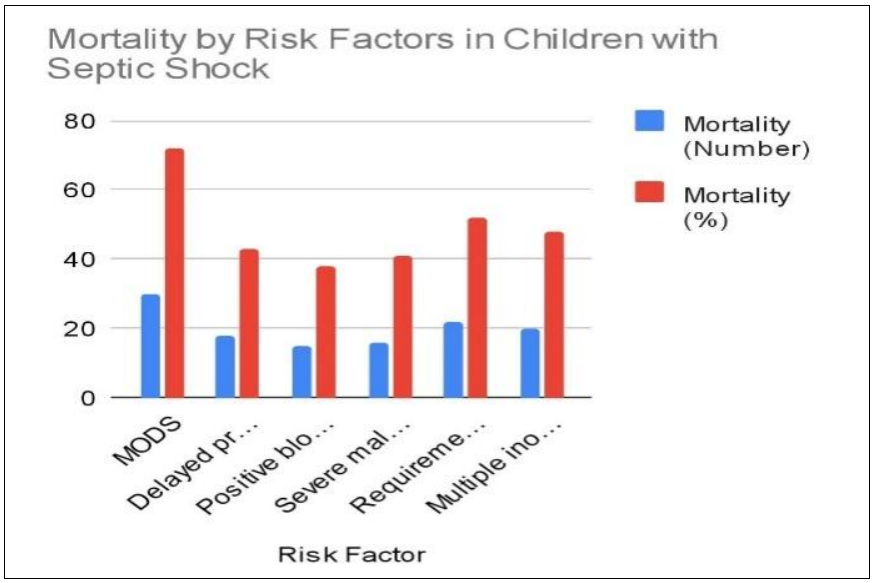
The overall mortality was 38% (42/110). Children with multiorgan dysfunction, delayed presentation (>48 hours), positive blood cultures, and severe malnutrition had significantly higher mortality. Complications included acute kidney injury (15%), disseminated intravascular coagulation (DIC) (12%), and shock liver (8%). The mean duration of PICU stay was 8.2±4.5 days [Table 5].

Table 5: Outcome and complications in children with septic shock

Outcome/Complication	Number (%)
Survival	68 (61.8)
Mortality	42 (38.2)
Acute kidney injury	17 (15.5)
Disseminated intravascular coagulation	13 (11.8)
Shock liver	9 (8.2)
Mean PICU stay (days)	8.2±4.5



Graph 1: Distribution of clinical Features in Children with Septic Shock.



Graph 2: Mortality by Risk Factors in Children with Septic Shock.

Discussion: The findings from this study underscore the critical nature of pediatric septic shock, highlighting the severity of illness and the importance of early recognition. The overall mortality observed in our cohort was 38%, consistent with prior Indian studies showing high mortality in tertiary care settings [6, 7].

Elevated serum lactate levels, high PELOD-2 scores, and need for mechanical ventilation were identified as significant predictors of mortality. These findings are consistent with previous prospective observational studies in India [6, 8]. Other factors associated with higher mortality included delayed hospital presentation, presence of multiorgan dysfunction, and severe malnutrition [3, 9].

Most children presented with fever, lethargy, and respiratory distress, reflecting the rapid progression of septic shock. Laboratory investigations revealed leukocytosis, elevated CRP, and positive blood cultures in a significant proportion of patients, consistent with earlier studies highlighting these markers for early diagnosis and prognostication [2, 5].

All children received fluid resuscitation and empiric broad-spectrum antibiotics, with vasoactive support required in 65% and mechanical ventilation in 40%. These management strategies align with established pediatric septic shock guidelines [2, 6]. Despite these interventions, mortality remained substantial, likely due to delayed presentation and high severity of illness at admission.

Globally, pediatric sepsis remains a leading cause of under-five mortality. Mortality rates in low- and middle-income countries are higher compared to developed countries, primarily due to limited healthcare infrastructure and delayed recognition of sepsis [7, 10]. Comorbidities and multiorgan dysfunction have been shown to significantly increase mortality risk in children with septic shock [4, 11].

Early recognition of key predictors, including elevated lactate and PELOD-2 scores, is essential for timely intervention. Implementation of standardized sepsis protocols and strengthening pediatric intensive care facilities could improve outcomes in such high-risk populations [12, 13].

The study's limitations include its single-center design and observational nature. Some important variables, such as fluid overload and timing of inotrope initiation, were not evaluated, though they are known to impact outcomes in pediatric septic shock [14, 15]. Multicenter prospective studies are needed to validate these findings and guide clinical practice.

Conclusion: Pediatric septic shock remains a major cause of morbidity and mortality in tertiary care hospitals, particularly in low- and middle-income settings such as India. This study highlights that despite advances in pediatric intensive care, mortality remains high at 34-38%, largely due to delayed presentation, severe disease at admission, and limited intensive care resources.

Key predictors of poor outcomes identified in this study include elevated serum lactate levels, high PELOD-2 scores, multiorgan dysfunction, the need for mechanical ventilation, and severe malnutrition. Early recognition of these clinical and laboratory markers is essential for prompt and aggressive management, which may improve survival rates.

The study also emphasizes the importance of standardized sepsis protocols, timely initiation of vasoactive therapy, and appropriate fluid resuscitation. Regular use of risk stratification tools such as PELOD-2 and PRISM scores can aid clinicians in identifying high-risk patient's early and prioritizing intensive care resources effectively.

While this study provides valuable insights into the clinical profile and outcomes of pediatric septic shock in a tertiary care hospital in Srinagar, further multicenter prospective studies are recommended to validate these findings and explore additional predictors such as fluid overload, timing of inotrope initiation, and long-term outcomes.

Overall, improving early recognition, optimizing critical care interventions, and addressing systemic healthcare limitations are key to reducing the high burden of mortality and improving outcomes in children with septic shock.

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Funding: Nil

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