

Original Research Article

Predicting mortality from septic shock among pediatric population in emergency room

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ABSTRACT

Background: Sepsis is defined as systemic inflammatory response syndrome in the presence of a suspected or known invasive infection and septic shock is defined as sepsis and cardiovascular organ dysfunction which persists even after initial fluid resuscitation. It is important to identify the risk of progression of sepsis to septic shock and death in the pediatric age group in order to prevent mortality.

Methods: This cohort study was carried out among 142 children aged between one month and 18 years who were diagnosed with sepsis in the emergency room (ER). All the hemodynamic and laboratory parameters were evaluated. The participants were followed up for a period till recovery/death. Particulars related to the management of the cases in terms of fluid resuscitation, inotropes and antibiotics were also documented.

Results: Majority of the participants were aged between 1-10 years and were males. There was a statistically significant difference in the temperature, total leukocyte count and other biochemical parameters between survivors and non survivors ($p < 0.05$). Initiation of antibiotics within one hour was significantly higher among the survivors compared to the non survivors ($p < 0.05$).

Conclusion: There is a need for immediate and early detection of abnormalities in the clinical and laboratory parameters in order to prevent mortality due to septic shock in the pediatric emergency room.

Keywords: Hemodynamic parameters, Inotropes, Resuscitation, Sepsis, Septic shock

INTRODUCTION

Sepsis and septic shock are one of the important causes of morbidity and mortality among the pediatric cases identified in the ER. Septic shock is often the sequelae of a systemic response to any infection. The American college of chest physicians and society of critical care medicine consensus established definitions for sepsis and septic shock, namely pediatric systemic inflammatory response syndrome (SIRS) in 2005. Accordingly, SIRS was defined as the presence of at least two abnormalities in temperature, heart rate, respiratory rate, or leukocyte count, of which one abnormality must be either abnormal temperature or leukocyte count.¹ Similarly, sepsis was defined as SIRS in the presence of a suspected or known invasive infection and septic shock was defined as sepsis and cardiovascular organ dysfunction which persists even

after initial fluid resuscitation of 40 ml/kg within one hour.² The work up for septic shock is based on identifying the presence of various factors, namely, unexplained metabolic acidosis, increased arterial lactate, oliguria, prolonged capillary refill and wide gap between core and peripheral temperature. Among these criteria, at least two must be present to confirm the diagnosis of septic shock.³

According to world health organization data, 80% of the deaths in children <4 years of age have been attributed to septic shock.⁴ There has been an increase in the incidence of septic shock by over 43% between 2000 and 2005 in the Western countries.⁵ According to various studies published in developing countries like India, the overall mortality rate of septic shock in the pediatric population was greater than 50%, indicating an alarming situation.⁶

Moreover, studies have also documented that maximum deaths occur in the initial one to two hours of resuscitation, which focuses on the aggressiveness of care and support required for managing this condition.

Although septic shock is majorly encountered after prolonged hospitalization, it is sometimes encountered as an emergency, with patients presenting for the first time in the ER. In such situations, it is important to sensitize the care providers to identify the presence of septic shock as early as possible and also monitor the child for symptoms of recovery/progression. It is an established fact that early recognition and early resuscitation are the key factors to improved outcomes. However, there are no clear end points to determine the progress of the condition in an ER setting. Therefore, it may be recognized that a study needs to be carried out focusing on the challenges unique to the ER setting, in order to prevent/predict the worsening of the septic shock for aggressive management in the ER.

Objectives were to evaluate the clinical and laboratory parameters for predicting the mortality of septic shock in the pediatric population presenting in the ER.

METHODS

This cohort study was carried out in the department of emergency medicine of the tertiary care hospital among pediatric patients diagnosed with septic shock. The study was carried out for a period of four years between January 2010 and 2014.

All the pediatric patients between one month and 18 years, who were diagnosed with septic shock were selected for the study. A total of 142 patients were evaluated for this study.

Approval was obtained from institutional ethics committee prior to commencement of study. All parents and guardian were explained in detail about study and informed consent was obtained prior to data collection.

For data collection a structured proforma was used to obtain details regarding the study participants. The participants were followed up till recovery/death. They were further classified as non survivors of the septic shock episode and survivors for comparison and analysis. Particulars related to demographic characteristics, vitals, Glasgow coma scale, and treatment provided were recorded. Laboratory parameters including haemoglobin, haematocrits, total leukocyte count, platelet count, prothrombin time, activated partial thromboplastin time, capillary blood glucose, serum bicarbonate, serum creatinine, C-reactive protein and blood culture and sensitivity were documented.

Data was entered and analyzed using SPSS ver.20 software. The prevalence of various parameters for cases and controls were expressed as mean values. The

differences in mean parameters between cases and controls were analyzed using independent sample t test. A p value <0.05 was considered statistically significant.

RESULTS

This cohort study was carried out among a total of 142 participants who were diagnosed with septic shock in the emergency room. Majority of the participants were aged between 1-10 years and were males. Overall mortality rate of septic shock in study was 57.7%. Among the survivors, co-morbidities were present in 40% while among the non survivors, co-morbidities were present in 40.2%. Among the survivors and non survivors, the infection predominantly originated from the lung (33.3 and 40% respectively) followed by abdomen (15 and 20% respectively). The third most common cause of infection among the survivors and non survivors was dengue (13.3 and 12% respectively) (Table 1).

On evaluating Glasgow coma scale, it was observed that majority of participants had a score between 10 and 14, of which majority were non-survivors compared to survivors (47.6%). In addition, increased number of non survivors had a score <10 (26.8%) compared to survivors (20%) (Figure 1).

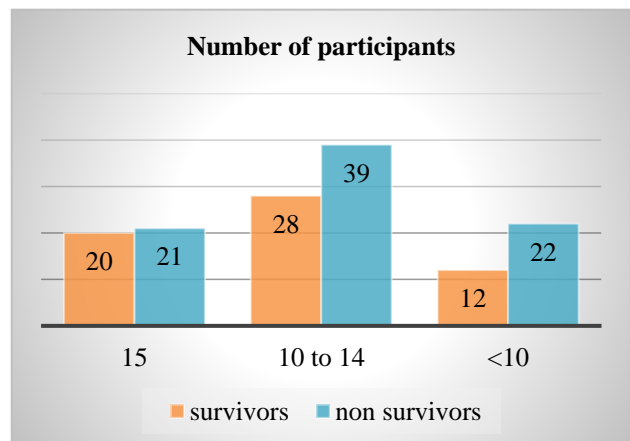


Figure 1: Glass coma scale findings.

There was a statistically significant difference between the survivors and non survivors with regards to various hemodynamic parameters. On comparing the heart rate among the participants beyond one year of age, we observed a significantly higher heart rate among non survivors (72.2 and 57.9% respectively) in the age group of 1-10 years and >10 years. This difference was statistically significant ($p < 0.001$). Similar differences observed with respiratory rate and mean arterial pressure. In addition, also observed a significant difference in temperatures between both groups. Hypothermia was significantly high among the non survivors (47.6%) compared to survivors (18.3%). The association was statistically significant ($p < 0.002$) (Table 2).

On comparing the laboratory parameters, there was a statistically significant difference in capillary blood

glucose, and serum bicarbonate levels between survivors and non survivors. Low levels of serum bicarbonate were witnessed more among non survivors (66%) compared to survivors (38.3%). The observed difference was statistically significant ($p<0.003$). Among the various hematological parameters analyzed, there was a statistically significant difference in the hemoglobin levels and hematocrit values between survivors and non survivors. There was a statistically significant difference in the total leukocyte counts between the two groups. A low leukocyte count <5000 cells/cu.mm was witnessed more among the non survivors (58.5%) compared to the survivors (10%). The observed difference was statistically significant ($p<0.0001$) (Table 3).

On comparing various treatment modalities initiated for the management of septic shock, observed a statistically significant difference in fluid bolus administration and initiation of antibiotic within one hour of arrival to the ER. While 76.7% of survivors received antibiotics within one hour, only 54.9% of non survivors had received antibiotics within 1 hour. The observed difference was statistically significant ($p<0.008$) (Table 4).

Between both groups, inotropic were increasingly required in the non-survivor group compared to the

survivor groups. More non survivors required dopamine (36.6%), dopamine and adrenaline (31.7%) and adrenaline (20.7%) compared to the survivors (33.4%, 25% and 15% respectively) (Figure 2).

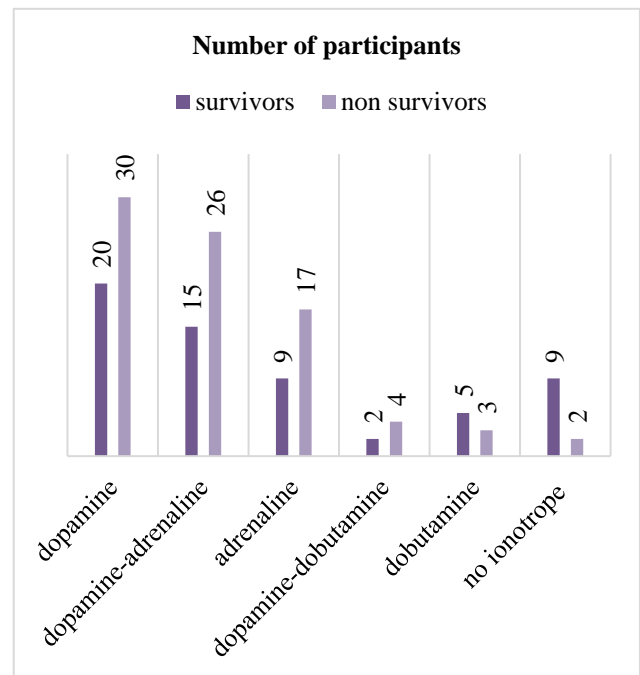


Figure 2: Inotropic requirement.

Table 1: Background characteristics of the study participants.

Characteristics	Survivors N=60 (%)	Non survivors N=82 (%)
Age (years)		
<1	16 (26.7)	27 (33)
1-10	32 (53.3)	36 (44)
>10	12 (20)	19 (23)
Gender		
Male	37 (62)	46 (56)
Female	23 (38)	36 (44)
Co-morbidities		
Present	24 (40)	33 (40.2)
Absent	36 (60)	49 (59.8)
Site of infection		
Lung	20 (33.3)	33 (40)
Abdomen	9 (15)	16 (20)
CNS	2 (3.3)	3 (3.7)
UTI	3 (5.5)	1 (1.2)
Cardiac	1 (1.7)	0 (0)
Skin and soft tissue	4 (6.7)	6 (7.3)
Bone	1 (1.7)	0 (0)
Dengue	8 (13.3)	10 (12)
Scrub typhus	7 (11.7)	8 (9.8)
Enteric infections	3 (5.0)	4 (4.9)
Malaria	2 (3.3)	1 (1.2)

Table 2: Hemodynamic parameters.

Parameters	Survivors N=60 (%)	Non survivors N=82 (%)	P value
Heart rate (1-10 years) (beats/min)			
<70	0 (0)	0 (0)	
70-140	9 (28)	26 (72.2)	
>140	23 (71.9)	10 (27.8)	0.001*
Heart rate (>10 years) (beats/min)			
<60	0 (0)	1 (5.3)	
60-100	2 (16.7)	11 (57.9)	
>100	10 (83.3)	7 (36.8)	0.02*
Respiratory rate (1-10 years) (breaths/min)			
<18	6 (18.8)	8 (22.2)	
18-38	9 (28.1)	19 (52.8)	
>34	17 (53.1)	9 (25)	0.047*
Respiratory rate (>10 years) (breaths/min)			
<12	0 (0)	2 (10.5)	
12-16	2 (16.7)	13 (68.4)	
>16	10 (83.3)	4 (21.1)	0.002*
Mean arterial pressure (1-10 years) (mmHg)			
<60	13 (40.6)	26 (72.2)	
60-90	19 (59.4)	9 (25)	
>90	0 (0)	1 (2.8)	0.01*
Temperature (°C)			
<37	11 (18.3)	39 (47.6)	
37-39	28 (46.7)	25 (30.4)	
>39	21 (35)	18 (22)	0.002*

*Statistically significant.

Table 3: Laboratory parameters.

Parameters	Survivors N=60 (%)	Non survivors N=82 (%)	P value
Capillary blood glucose (mg/dl)			
<60	6 (10)	7 (8.5)	
60-120	15 (25)	50 (61)	
>120	39 (65)	25 (30.5)	0.0001*
Serum bicarbonate (mg/dl)			
<15	23 (38.3)	54 (66)	
16-22	36 (60)	28 (34)	
>22	1 (1.7)	0 (0)	0.003*
Hemoglobin (g%)			
<8	10 (16.7)	18 (22)	0.039*
8-10	34 (56.7)	29 (35.4)	
>10	16 (26.6)	35 (42.6)	
Hematocrit (%)			
<24	10 (16.7)	18 (22)	0.039*
24-40	34 (56.7)	29 (35.4)	
>40	16 (26.6)	45 (42.6)	
Total leukocyte count (cells/cu.mm)			
<5000	6 (10)	48 (58.5)	0.0001*
5000-15000	15 (25)	10 (12.2)	
>15000	39 (65)	24 (29.3)	

*Statistically significant.

Table 4: Treatment required.

Treatment	Survivors n=60 (%)	Non survivors n=82 (%)	P value
Fluid Bolus (ml/kg)			
20	5 (8.3)	4 (4.9)	
20-40	11 (18.3)	8 (9.8)	
40-60	19 (31.7)	12 (14.7)	
60-80	16 (26.7)	19 (23.2)	
80-100	7 (11.7)	21 (25.6)	
100-120	2 (3.3)	8 (9.8)	
120-140	0 (0)	5 (6.0)	
140-160	0 (0)	5 (6.0)	0.0001
Stress dose steroid			
Required	28 (46.7)	49 (59.8)	
Not required	32 (53.3)	33 (40.2)	0.12
Intubation needed			
Required	32 (53.3)	53 (64.6)	
Not required	28 (46.7)	29 (35.4)	0.18
Antibiotic within 1 hour			
Received	46 (76.7)	45 (54.9)	
Not received	14 (23.3)	37 (45.1)	0.008

DISCUSSION

Clinical manifestations of sepsis vary depends on the inflammatory process, severity of infection and organ systems involved. The response of organ systems in sepsis could be compensate in early stage, and will be exhausted or failure in later stage. The ability of organs to response and compensate differ according to preexist condition such as age, underlying diseases and comorbidities.²

In this study assessed the clinical and laboratory parameters that represent the organ function and inflammatory process and compared between the survivors and non survivors of septic shock. Both the groups were comparable in terms of age, gender and Glasgow coma scale score. Observed a significant difference between the two groups in terms of temperature, total leukocyte counts, and certain other hemodynamic parameters including heart rate, respiratory rate and mean arterial pressure ($p < 0.05$). In terms of treatment provided, while in 76.7% of the survivors, the antibiotic was initiated within one hour, the same was the case only in 54.9% of the non survivors, and the association was statistically significant. This indicates the need for aggressive initiation of therapy for arresting the infection, without delay in time. Study was comparable with studies done by Lee and Kaur et al which demonstrated a statistically significant difference in the hemodynamic parameters between survivors and non survivors, especially heart rate and mean arterial pressure.^{6,7} Although a greater number of non survivors received inotropes compared to survivors, persistence of infection, evidenced by elevated total leukocyte count resulted in significant mortality.

Effective management of septic shock depends on rapid diagnosis and early resuscitation. Identifying children at a higher risk of mortality using simple clinical and laboratory parameters is essential to improve the survival. It is essential to predict mortality in ER, based on clinical presentation, treatment required and laboratory parameters. Normal HR, RR and hypothermia are simple bedside indicators of failing compensatory mechanisms. Hypotension and need for large fluid boluses signify poor cardiac output and poor perfusion.⁸ Laboratory parameters such as low bicarbonate, high haematocrit, normoglycemia and leucopenia signify higher mortality.⁹

Several studies have been carried out to explore a single, quick and reliable method of predicting the risk of septic shock and death in the ER. One such method that has been validated and tested includes electronic sepsis alert based on initial assessment of heart rate, temperature and infection.¹⁰ However, there are very few feasible and concrete methods for reliability of these alerts. Moreover, in a resource limited setting like India, there is a need for developing a simple mathematical model which predicts the septic shock risk, in an easy, cost effective and user-friendly manner.

CONCLUSION

This study has elucidated the need for evaluating clinical and laboratory parameters in the event of sepsis for early diagnosis and rapid case management. Moreover, monitoring of temperature and other hemodynamic parameters from the entry in to the ER helps in predicting the risk for progression into septic shock and SIRS. Further studies are required to develop a single, valid and reliable parameter which may be used for detecting the

risk for septic shock at the ER level during the immediate phase of resuscitation. In addition, our study has elaborated on the need for aggressive management of the infection by early and rapid initiation of antibiotic within one hour of diagnosis so as to abort the infection.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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