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Original Research Article

A Prospective Observational Assessment of the Predictors of Outcome in Pediatric Septic Shock

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Abstract

Aim: The aim of the present study was to determine the predictors of the outcome and progression of pediatric sepsis and septic shock.

Material & Methods: A prospective, observational study was undertaken to analyze predictors of poor outcome in septic shock in Upgraded Department of Pediatrics in a time period of 12 months (March 2012 to Feb 2013). A total of 74 patients of septic shock were admitted to the PICU during the study period of whom 60 patients were finally included as per the study protocol.

Results: 50 of 60 (83.34%) cases enrolled in the study were discharged after recovery while 10 (16.66%) expired. On analysis of clinical symptoms as predictors of outcome, fever was the most common symptom present in all the patients. On analysis of the vital parameters, a delayed capillary refill time (>3 seconds) was a statistically significant (p=0.007) predictor of poor outcome with all the 10 patients having failed to survive, having a prolonged CRT on admission. Amongst the laboratory predictors, a low mean pH on admission had a statistically significant (p=0.007) association with a poor outcome. None of the other laboratory markers and Microbiological positivity of sepsis was found to have significant statistical association with outcome.

Conclusion: SIRS can progress to septic shock if not identified early. The predictors of mortality were positive blood cultures, multiorgan dysfunction, late hospital admissions, severe acute malnutrition, and requirement of supportive care. The predictors of progression to septic shock were abnormal leukocyte count, culture positivity, and severe acute malnutrition.

Keywords: Blood Culture, Intensive Care Unit, Malnutrition, Mortality, Multiple Organ Dysfunction.

Introduction

Historically, the term sepsis was “sepsin” from Greek, meaning “rot, make putrid”. It has been used to characterize life-threatening infections usually caused by Bacterial pathogens if untreated progress to shock and death. [1] It is a distinct entity from adults and neonatal sepsis, given the unique characteristics of children. Pediatric sepsis remains as a major cause of mortality and morbidity worldwide. It includes a clinical spectrum of severity - Systemic Inflammatory Response Syndrome (SIRS), sepsis, severe sepsis, septic shock and multi-organ failure. It is important to identify the determinants that predict the progression and mortality in SIRS, so as to deal with such patients in a timely manner. [2]

The mortality rate of sepsis in children from pediatric intensive care unit (PICU) of developing countries is higher than 50%. [3] World Health Organization statistics have shown that 80% of death in children <4 years can be classified as sepsis-related deaths. [4] Septic shock is a dreaded and potentially fatal complication of sepsis. Septic shock has been found to be the most common type of shock occurring in Pediatric Intensive Care Unit with an incidence of around 35%. [5] In India, overall mortality rate in patients with pediatric septic shock is around 47% which is comparable to global figure of around 50%. [5]

The three most common causes of sepsis related deaths among children were infections related to neonatal disorders, lower respiratory tract infections, and diarrheal diseases. [6] Assessment of severity of illness at admission is important for effective patient management, prognostication, and optimum utilization of resources. [7] Simple interventions such as early rapid fluid administration, early antibiotics therapy, oxygen supplementation, and early use of inotropes through peripheral intravenous access have shown to improve the outcome of pediatric sepsis. [8]

Patients presenting with sepsis or septic shock progress rapidly, if left untreated, may rapidly progress to death. It is estimated that it is the 4th leading cause of hospital admission.[9] The severity and high mortality highlight a major challenge in front of the health care system. Early identification and appropriate resuscitation and management are therefore critical to optimizing outcomes for children with sepsis.

Hence, the present prospective study was designed to assess the predictors of mortality among septic patients admitted to PICU in Bihar.

Material & Methods

A prospective, observational study was undertaken to analyze predictors of poor outcome in septic shock in Upgraded Department of Pediatrics, Patna Medical College and Hospital, Patna, Bihar, India in a time period of 12 months(March 2012 to Feb 2013). A total of 74 patients of septic shock were admitted to the PICU during the study period of whom 60 patients were finally included as per the study protocol.

Inclusion Criteria

All children aged 1 month – 18 years, admitted with or having developed septic shock during the course of hospital stay.

Exclusion Criteria

Patients of malignancy, on immunosuppressive or chemotherapy drugs, who left the treatment in between or whose parents did not consent, were excluded.

Diagnostic criteria

Septic Shock: Sepsis plus cardiovascular organ dysfunction as described below[10]

Despite >40ml/kg of isotonic intravenous fluid in one hour:

Hypotension of blood pressure less than fifth percentile for age or systolic blood pressure less than two SD below normal for age, or

Need for vasoactive drug to maintain blood pressure, or

Any two of the following:

1. Unexplained metabolic acidosis: base deficit > 5mEq/L.
2. Increased arterial lactate > two times upper limit of normal.
3. Oliguria: urine output < 0.5mL/kg/hour.
4. Prolonged capillary refill time: > five seconds.
5. Core to peripheral temperature gap > 3° C (5.4° F).

Systemic Inflammatory Response Syndrome (SIRS): Two of four criteria, one of which must be abnormal temperature or abnormal leukocyte count.[10]

1. Core temperature > 38.5ºC (101.3ºF) or < 36ºC (96.8ºF) (rectal, bladder, oral or central catheter)

2. Tachycardia:

- Mean Heart Rate > two SD above the normal for age in absence of external stimuli, chronic drugs or painful stimuli, or
- Unexplained persistent elevation of heart rate over 0.5 - 4hr, or
- In children less than one-year old, persistent bradycardia over 0.5hr (mean heart rate less than tenth percentile for age in absence of vagal stimuli, beta blockers, congenital heart diseases).

3. Respiratory Rate more than two SD above normal for age or acute need for mechanical ventilation not related to neuromuscular disease or general anesthesia.

4. Leukocyte count elevated or depressed for age (not secondary to chemotherapy) or more than 10% immature neutrophils.

Sepsis: SIRS in the presence of or as a result of suspected or proven infection.[10]

Refractory Septic Shock: Septic shock which lasts for more than one hour and does not respond to fluid or pressor administration.[10]

Multi Organ Dysfunction Syndrome (MODS):

MODS is defined as a clinical syndrome characterized by the development of progressive and potentially reversible physiologic dysfunction in two or more organs or organ systems that is induced by a variety of acute insults, including sepsis and homeostasis cannot be maintained without intervention.[10]

Methodology

Outcome was defined on the basis of survival. The patients who completely recovered from septic shock and got discharged uneventfully, were categorised as survivors while those who expired during the treatment were categorised as non-survivors.

A written informed consent was obtained in a language well understood by the parents/guardians.

A detailed history, general physical examination and systemic examination findings at the time of diagnosis of septic shock, were recorded on a standardized proforma.

Statistical Analysis

Data were entered into Microsoft Excel were analyzed using SPSS Version 15.0, Chicago, SPSS Inc. Categorical variables were expressed as

proportions and continuous variables as mean (standard deviation [SD]) or median (interquartile range [IQR]) . Association between qualitative variables was assessed by Chi-Square test and Fisher's Exact test. Comparison of Quantitative data by outcome among the cases (death and discharge) was done using Mann-Whitney Test and comparison by degree of sepsis was done by Kruskal-Wallis one-way analysis of variance on ranks. Regression analysis was used to determine the predictors of outcome. $P < 0.05$ was considered as significant.

Results

Table 1: Clinical symptoms as a predictor of outcome

Characteristics	Expiry(n=10)	Discharge (n=50)	Statistical significance
Fever	10 (100%)	50 (100%)	-
Altered mental status	3 (30%)	23 (46%)	p=0.714
Breathlessness	9 (90%)	30 (60%)	p=0.142
Abdominal pain	3 (30%)	22 (44%)	p=0.720
Decreased urine output	1 (10%)	11 (2%)	p=0.672
Bleeding	1 (10%)	4 (8%)	p=1.000

50 of 60 (83.34%) cases enrolled in the study were discharged after recovery while 10 (16.66%) expired. On analysis of clinical symptoms as predictors of outcome, fever was the most common symptom present in all the patients.

Table 2: Vital parameters as a predictor of outcome

Characteristics	Expiry (n=10)	Discharge (n=50)	Statistical significance
Heart rate (according to age)			
Below normal	0	0	
Normal	0	8 (16%)	p=0.565
Above normal	10 (100%)	42 (84%)	
Blood pressure			
Below normal	10 (100%)	48 (96%)	
Normal	0	2 (4%)	p=1.000
Above normal	0	0	
Respiratory rate			
Below normal	0	0	
Normal	0	1 (2%)	p=1.000
Above normal	10 (100%)	49 (98%)	
Temperature			
Below normal	0	0	
Normal	2 (20%)	13 (26%)	p=1.000
Above normal	8 (80%)	37 (74%)	
Capillary refill time			
Normal	0 (0%)	24 (48%)	
Delayed CRT	10 (100%)	26 (52%)	p=0.007

On analysis of the vital parameters, a delayed capillary refill time (>3 seconds) was a statistically significant (p=0.007) predictor of poor outcome with all the 10 patients having failed to survive, having a prolonged CRT on admission.

Table 3: Arterial Blood gas parameters as a predictor of outcome

Characteristic	Expiry (n=10)	Discharge (n=50)	Statistical significance
Mean pH+SD	7.23+0.08	7.33+0.07	p=0.007
Mean pO_2+SD	89.61+22.88	122.88+66.34	p=0.125
Mean pCO_2+SD	41.09+9.31	36.24+12.24	p=0.100
Mean HCO_3^-+SD	16.84+3.57	19.08+4.66	p=0.180

Amongst the laboratory predictors, a low mean pH on admission had a statistically significant (p=0.007) association with a poor outcome.

Table 4: Laboratory markers of sepsis as a predictor of outcome

Characteristic	Expiry (n=10)	Discharge (n=50)	Statistical significance
Mean TLC+SD (‘000)	15.25+7.33	14.66+8.12	p=0.848
Mean Polymorphs+SD	71.0+22.28	72.78+17.73	p=0.790
Mean RBS+SD	122+48.16	115.95+42.58	p=0.675
Mean CRP+SD	3.77+2.56	5.58+6.84	p=0.445
Mean ESR+SD	24.46+12.48	25.75+13.57	p=0.642

None of the other laboratory markers of sepsis was found to have significant statistical association with outcome.

Table 5: Microbiological positivity as a predictor of outcome

Characteristic	Expiry (n=10)	Discharge (n=50)	Statistical significance
Positive blood culture	0	1 (2%)	-
Positive urine culture	2 (20%)	5 (10%)	p=0.314
Other body fluid positivity	1 (10%)	14 (28%)	p=0.276

None of the other laboratory microbiological positivity was found to have significant statistical association with outcome.

Discussion

Sepsis is the most common cause of morbidity and mortality in pediatric population, in the developing countries. [11,12] The global data on sepsis estimates that infection accounts for more than 80% mortality in under-five children. Septic shock is a dreaded and potentially fatal complication of sepsis. Septic shock has been found to be the most common type of shock occurring in Pediatric Intensive Care Unit with an incidence of around 35%. In India, overall mortality rate in patients with pediatric septic shock is around 47% which is comparable to global figure of around 50%. [13] Assessment of severity of illness at admission is important for effective patient management, prognostication, and optimum utilization of resources. [14] Patient's outcome in PICU of developing country is affected by not only by clinical diagnosis at admission but also by demographic characteristics of the population, available infrastructure, and admission policies of PICU. Simple interventions such as early rapid fluid administration, early antibiotics therapy, oxygen supplementation, and early use of inotropes through peripheral intravenous access have shown to improve the outcome of pediatric sepsis. [15]

50 of 60 (83.34%) cases enrolled in the study were discharged after recovery while 10 (16.66%) expired. Khan et al [16] reported a series of severe sepsis and septic shock cases with mortality rate of 24%, although the septic shock patients were studied for a time frame of 2 years. On analysis of clinical symptoms as predictors of outcome, fever was the most common symptom present in all the patients. In another study, Kurade and Dhanawade in their study reported fever as the most common presenting symptom and predictor of mortality associated with sepsis. [17] On analysis of the vital parameters, a delayed capillary refill time (>3 seconds) was a statistically significant (p=0.007) predictor of poor outcome with all the 10 patients having failed to survive, having a prolonged CRT on admission. Amongst the laboratory predictors, a low mean pH on admission had a statistically significant (p=0.007) association with a poor outcome. None of the other laboratory markers and Microbiological positivity of sepsis was found to have significant statistical association with outcome. There was no significant association between the different laboratory and biochemical parameters between the two groups. Kurade and Dhanawade in their series identified leucopenia as a predictor of mortality. [17] In the present study, acidosis (low arterial pH) had a significant statistical association with poor outcome of septic shock. Kellum in his study discussed that acidosis may be a result of the underlying pathophysiology (e.g. respiratory failure, shock, renal failure) or may also result from the way critically ill patients are managed. Understanding the effects of acid-base on the inflammatory response is relevant as all forms of metabolic acidosis appear to be associated with prolonged hospital and ICU length of stay. [18]

Conclusion

A delayed capillary refill time on admission and a low mean pH were statistically significant predictors of mortality in this study.

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