Original Research Article

A study on the role of paediatric assessment triangle, clinical scoring and serum lactate in the management of septic shock in children

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ABSTRACT

Background: There is dearth of studies in India on the management of paediatric septic shock. So it is prudent to do a study on paediatric septic shock management. The objective of the study is to determine the correlation between Paediatric Assessment Triangle and serum lactate levels., to determine the role Paediatric Assessment Triangle in predicting mortality in septic shock and to the determine the role of elevated lactate levels in predicting mortality in septic shock.

Methods: Descriptive study of 100 children from 31 days to 12 years of age who are admitted with septic shock in a tertiary care hospital are assessed with paediatric assessment triangle and clinical score and serum lactate was tested along with other standard tests and the children are managed as per the standard protocols. Outcome is analysed.

Results: In this study, septic shock children with total clinical score >22 are having statistically significant low levels of diastolic blood pressure and low mean arterial pressure. There was a significant difference in median serum lactate levels between the survivors (28.08 mg/dl) and non-survivors (40.92 mg/dl).

Conclusions: Paediatric assessment triangle and clinical scoring based on it more than 22 and serum lactate levels of more than 2mmol/L or 18mg/dl predict the mortality.

Keywords: Clinical scoring system, E.D emergency departments, PAT- Paediatric assessment triangle, Serum lactate, SOFA (Sequential organ failure assessment) score

INTRODUCTION

Sepsis is one of the most common life threatening conditions encountered in paediatric emergency department and is the major cause of mortality and morbidity especially in the developing countries.[1] Paediatric sepsis due to infections are the leading cause of death killing millions globally (1 out of every 4) septic patients.[2] In many instances these infections have been encountered in patients with malnutrition, immunosuppression, malignancies and cardio-respiratory illness. The presentation of sepsis in children may be varied, posing a great challenge for diagnosis. Early recognition and prompt treatment can prevent anaerobic metabolism, acidosis and cell death. Laboratory variables used to predict and diagnose sepsis may not be available in a timely manner in Emergency Department settings. Hence there is a need for a clinical tool that can rapidly diagnose sepsis and septic shock in this-patient and E.D settings.

Definition of sepsis[3]

Sepsis is defined as a life-threatening organ dysfunction caused by a dysregulated host response to an infection. The organ dysfunction can be identified by an increase in SOFA score of more than or equal to 2 points from the baseline. This definition emphasizes the non-homeostatic

response of the host to infection and its lethality there by necessitating early identification and prompt intervention.

Definition of septic shock

Septic shock is a subset of sepsis in which there is persistent hypotension requiring vasopressors to maintain mean arterial pressure >65 mmHg and serum lactate >2 mmmol/L (18mg/dl).

Diagnosis of sepsis and septic shock[4]

The causative organism and the source of infection need to be identified by a range of diagnostic tests.

- Elevated Total WBC count with elevated polymorphonuclear cells, though not specific may suggest a possibility of bacterial infection
- Markers like procalcitonin and C-reactive protein may help differentiate bacterial and non-bacterial causes of sepsis.
- Isolation of organism by cultures of blood, urine, cerebrospinal fluid, respiratory secretions, wounds and other body fluids.
- Serological tests, polymerase chain reaction can be performed in settings where resources are available.
- Imaging studies like X-ray, ultrasound, computerized tomography may be performed depending on the clinical situations.
- Other parameters like arterial blood gas, total-bilirubin, platelet count and serum creatinine may be needed to calculate SOFA SCORE
- Serum lactate >2mmol/l has been found to be diagnostic of septic shock.[5]

Role of serum lactate in septic shock

- Hatherill et al, showed that the children with persistent hyperlactatemia >2mmol/l after 24 hours had mortality rate of 93% as compared to 30% in those with normalized level.[6]

Paediatric assessment triangle[7]

Paediatric assessment triangle is another such clinical parameter which can be used to predict septic shock in children in resource limited and out-patient settings. However no such studies are available in paediatric population to validate the role of clinical parameters to predict sepsis and septic shock. The Paediatric Assessment Triangle (PAT) is a rapid evaluation tool that uses clinical parameters to establish a child's clinical status as shown in figure-1 and help physician derives his or her category of illness to direct initial management priorities. The following are the components of PAT.[8]

The aim of the study is to determine the correlation between Paediatric Assessment triangle with clinical

scoring and septic shock in children using serum lactate as a surrogate marker of septic shock.

Objective of study is to determine the correlation between Paediatric Assessment Triangle with clinical scoring and serum lactate levels, to determine the role Paediatric Assessment Triangle in predicting mortality in septic shock and to determine the role of elevated lactate levels in predicting mortality in septic shock.

Study justification

Septic shock is characterized by severe organ dysfunction. The organ dysfunction can be identified by Sequential Organ Failure Score (SOFA) which use clinical and laboratory variables. In OPD settings these laboratory variables may not be available in a timely manner. Though there are not many studies in paediatric age group, studies in adults have shown that the use of quick SOFA score (which relies only on clinical variables) in OPD and outside ICU settings had predictive values similar to that of SOFA score in ICU settings.[10] Hence, this study was undertaken to determine the role of Paediatric Assessment Triangle in predicting septic shock in OPD and outside ICU settings.

The present study was conducted to study awareness and perception about dog bite among the population in the rural area of Maharashtra.
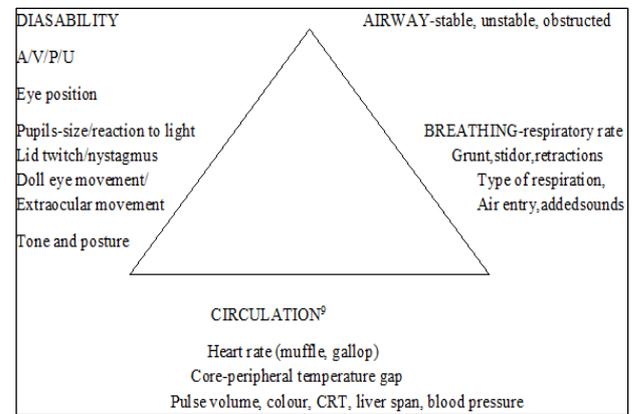

Figure 1: Paediatric assessment triangle.

METHODS

This prospective observational descriptive study was done in the paediatric tertiary care hospital from august 2016 to November 2017 in all children from 31days month to 12 years admitted with septic shock.

The sample size of the study was 100 as calculated from the previous studies on paediatric septic shock. Children with co-morbidities like, chronic liver disease, chronic kidney disease developmental delay, seizure disorder, inborn errors of metabolism and Children with partially

treated septic shock or pre-treated with antibiotics are excluded.

Study maneuver

100 children were recruited after satisfying the inclusion and exclusion criteria. The patients were subjected to the following detailed clinical history which included age sex, fever(duration), breathlessness (duration, onset-acute, acute on chronic, episodic), altered level of consciousness (lethargy, incessant cry, not as usual, excessive sleepiness), vomiting, diarrhoea, bleeding manifestations, toxin ingestion, trauma and co-morbidities.

Rapid cardiopulmonary cerebral assessment was done using the variables of Paediatric Assessment Triangle (PAT) and the interpretation of the variables of PAT is the following:

Respiratory rate

- Tachypnoea- respiratory rate more than the upper limit of age-adjusted cut-off.
- Relative bradypnea-within normal limits of age-adjusted cut-off.

- Bradypnea-less than age-adjusted cut-off.

Heart rate

- Tachycardia- more than upper limit of age-adjusted cut-off.
- Relative bradycardia-within normal limits of age-adjusted cut-off.
- Bradycardia-less than age-adjusted cut-off.

Blood pressure

- Relative hypotension-systolic BP within normal limits of age-adjusted cut-off.
- Scoring system was used for clinical variables which were more specific for septic shock.

On arrival to the emergency department all clinical parameters are assessed and marked from 1 to 4 according to the severity as shown in the Table-1.[8] The mean total score was 22. The patients were categorized in 2 groups. Those with clinical score of >22 and those with score <22 and the variables were compared among the two groups.

Table 1: Clinical score.

Parameter	1	2	3	4
Airway	Stable	Unstable		
Respiratory rate	Normal	Relative bradypnea	Bradypnea	Tachypnea
Grunt	No		Yes	
Retractions	No			Yes
Heart rate	Normal	Relative bradycardia	bradycardia	Tachycardia
Pulse pressure	<40 mm Hg			>40 mm Hg
MAP	Normal			Low
Mental status	Alert	Verbal responsive	Pain responsive	unresponsive

After clinical assessment venous blood samples were drawn for analysis of complete blood count. serum urea and creatinine. Arterial blood gas analysis was also done on arrival. 2 ml of venous blood was collected in a separate fluoride containing test tube and was processed within 30 min in the institute's Biochemistry laboratory for estimation of serum lactate. Enzymatic method was used for analysis of serum lactate. Serum arterial lactate was derived from venous lactate using the formula, Arterial lactate=-0.259+venous lactate (in mmol/l) *0.996. Child's mean clinical score was analysed with serum lactate. The mean clinical score and lactate were compared with survivors and non-survivors. Statistical analysis was done using Chi-square test and Student t-test. The patients were treated for septic shock as per unit's protocol.

The study was undertaken after Institutional Ethical Committee approval and with CTRI All children were followed up till discharge or death in case of mortality.

RESULTS

For our prospective descriptive study, we included 100 children presented with septic shock whose parents gave consent and excluded children with comorbid conditions and chronic illnesses and whose parents didn't gave consent. As per the protocol they are clinically assessed, routine investigations are done along with serum lactate, ABG and treated. 76 survived and 24 succumbed to death even with appropriate treatment.

Median diastolic blood pressure and clinical score

Median diastolic BP in group-1 was 0.00 with 25th to 75th interquartile percentile of 0.00 and 0.00 respectively. Median diastolic BP in group-2 was 60 with 25th to 75th Interquartile percentile of 50 and 80 respectively Median p=0.00 by Mann Whitney U test as per Table 2.

Table 2: Diastolic BP in group 1 and 2.

Total score	N	median	p Value
Group 1(>22)	67	0.00(0.00-0.00)	0.000
Group 2(<22)	33	60.00(50.00-80.00)	

Clinical score among survivors and non-survivors

Out of 67 children with clinical score of >22 in group-1, 49(64.5%) survived and 18(75%) died. Whereas 27(35.5%) survived and 6(25%) died in group-2 with33 children with clinical score of <22. The p-value 0.01 which is statistically significant as depicted in figure 2.
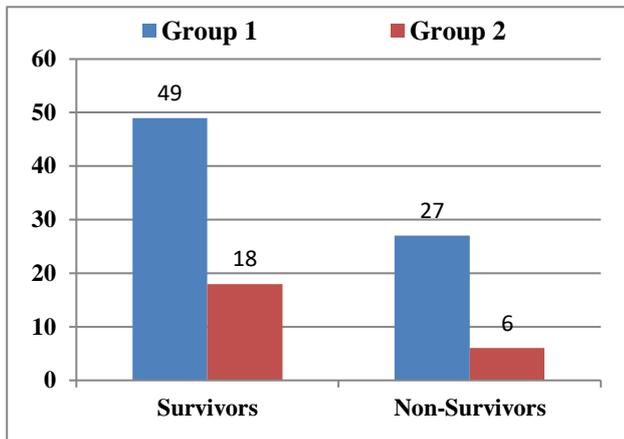

Figure 2: Clinical score among study population.

Median serum lactate in survivors and non-survivors

Median serum lactates in SURVIVORS was 28.08 with 25th to 75th interquartile percentile of 15.73 and 39.62 respectively. Median serum lactate in non-survivors was 40.92 with 25th to 75th Interquartile percentile of 28.57 and 50.17 respectively Median p=0.009by Mann Whitney U test (Table 3) which is statistically significant.

Table 3: Serum lactate in non-survivors and survivors.

Group	N	median	p Value
survivors	76	28.08(15.73-39.62)	0.009
Non-survivors	24	40.92(28.57-50.17)	

Median lactate and clinical score

Median serum lactate in group-1 was 30.96 with 25th to 75th interquartile percentile of 16.56 and 41.7

respectively. Median serum lactate in group-2 was 27.90 with 25th to 75th Interquartile percentile of 16.56 and 39.53 respectively Median p=0.035 by Mann Whitney U test as shown in table 4.

Table 4: Serum lactate in group 1 and 2.

Total score	N	median	p Value
Group 1(>22)	67	30.9600(16.56-41.76)	0.035
Group 2(<22)	33	27.9000(16.56-39.53)	

DISCUSSION

In this study 100 children were recruited for the study based on inclusion and exclusion criteria. Gender, age, clinical variables, serum lactate and outcome were compared between the two groups. Gender distribution revealed male female ratio of 1.5:1. The median age was 18 months in survivors and 42 months in non-survivors.

In this study there was a significant difference in median lactate between the survivors (28.08 mg/dl) and non-survivors (40.92 mg/dl). This explains that serum lactate can be used a predictor of mortality in septic shock. Similar results have been shown in the previous studies done worldwide

Patients were also categorized based on the total clinical score, one with total score >22, other with score <22 and variables were compared among them. The mean age among two groups .The median age between the 2 groups were 5 months and 18 months respectively. The mean respiratory rate was 55.52±14.48 and 48.78±18.99 among the two groups there was no significant difference in the median heart which was 160 and 140 in group-1 and group-2 respectively.

Both the groups had median systolic blood pressure of 100 mm hg; however the median diastolic pressure was o in patients with total clinical score >22 and their mean pulse pressure was 77.01 both were statistically significant. There was a significant difference in median lactate 30.96 in group-1 and 27.90 in group-2. Serum lactate can be also used as a diagnostic marker of septic shock. The use of clinical variables to predict septic shock has been proven in adults. Mervyn Singer, MD et al in their study have shown that qSOFA score which uses only clinical variables can be used to predict sepsis in adults.[3]

The score had a predictive value similar to that of SOFA score in ICU settings. The prediction of septic shock solely on the basis of clinical variables in children is yet to be validated. In this study we have shown that the patients with higher clinical score had a high lactate levels and also higher mortality (18), thereby explaining the correlation of clinical variables with septic shock and mortality. 66 patients had a median lactate of 31.90 mg/dl.

CONCLUSION

In this study, the overall survival and mortality rate was 76% and 24% respectively. The low diastolic pressure, narrow pulse pressure and high lactate predict mortality significantly. There was a correlation between of clinical variables used in the Paediatric Assessment Triangle with serum lactate level and mortality. Though not diagnostic, it can be used as a predictor of septic shock in children as well as a predictor of mortality in septic shock.

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