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Original Research Article

A study of prevalence and outcome of shock in patients admitted to the pediatric intensive care unit at a tertiary care hospital

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ABSTRACT

Background: Shock is the most common condition in children admitted in PICU with high morbidity and mortality rate in children. The knowledge about the etiology and risk factors will give an early clue in identifying and prioritizing management of Shock and its outcome in children. To study the prevalence of shock in children admitted in PICU and identify the etiology and response to treatment and assess the PRISM score and compare it with the outcome in Children.
Methods: Prospective Observational study in children admitted in PICU at a tertiary care hospital.
Results: Out of 878 cases admitted in PICU, shock was observed in 43 children (4.9%). shock at the time of admission and duration of stay in the hospital were found in 26 (70.3%) and 11 (29.7%) respectively. M: F ratio was 1.1:1. Children in the age group of <1 year, 1-5 years and 6-12 years were 17(46%), 16 (43.2%) and 4 (10.8%) respectively. Among the children with shock the distribution of etiology was septic shock 19 (51.4%), hypovolemic shock 10 (27%), distributive shock 4 (10.8%) and cardiogenic shock 4 (10.8%). The mortality rate was 16 (43.3%) and highest in Infants 14 (82.4%) with PRISM Score>30. The mortality rate was highest with septic shock 14 (71.4%) whereas all children with hypovolemic shock survived. Children presented with Compensated shock, decompensated shock and MODS in 14 (37.8%), 23 (62.2%) and 19 (51.4%) children respectively. The most common causes of mortality were MODS and decompensated shock.
Conclusions: Early screening, identification and intervention are key to improve the outcome in children with shock.

Keywords: Children, Infant, Inotropes, Mortality, Shock

INTRODUCTION

Shock, a clinical state characterized by inadequate tissue perfusion, is one of the most life threatening condition faced by the physician in a critical care setting.[1] Shock or circulatory failure is an acute process characterized by body's inability to deliver adequate oxygen to meet the metabolic demands of vital organs and tissues.[2] Its delayed recognition and treatment results in progression to multiple organ system failure and death.[3] Shock is one of the commonest paediatric emergencies and it occurs in approximately 2% of all hospitalized infants, children and adolescents in developed countries.[2] It accounts for more morbidity and mortality in children worldwide than any other diagnosis.[4,5] About 10 million children die of shock every year in the world.[6] Highest mortality is observed in under 5 children in developing countries.[6] High index of suspicion, rapid and focused cardiopulmonary assessment is needed for early identification of shock.[7] The shock in children are classified according to the etiological factors namely hypovolemic shock due to volume depletion, cardiogenic shock due to cardiac dysfunction, distributive shock due to abnormal vasodilatation, septic shock due to increased vascular permeability and obstructive shock

due to lesion that creates a mechanical barrier that impedes cardiac output.[8-10] Early recognition, anticipatory and aggressive management of shock and early restoration of tissue perfusion to normalcy will determine the immediate outcome. The final outcome will depend upon the nature of etiology, risk factors and availability of intervention measures. The Pediatric advanced life support has emphasized early recognition and intervention and rapidly transfer of critically ill patients to intensive care setting.[10] Though it is a common problem, only scanty data are available in Indian literature.

The purpose of this study is to evaluate the morbidity pattern, etiology, risk factors and stage of presentation of Shock in PICU would give a better understanding of the illness to will give us an early clue in identifying and prioritizing management strategies to improve the clinical outcomes.

Aims and objectives

Primary objective

To study prevalence of shock in children admitted in PICU. To identify possible etiology and response to treatment and outcome in shock in pediatric population admitted to PICU.

Secondary objective

To assess PRISM SCORE and compare with the outcome.

METHODS

A prospective cross sectional observational study was done among children admitted in pediatric intensive care unit at a tertiary care hospital at Puducherry, South India over 2-year period after approval from the Institute scientific and ethical committee. Informed consent was taken to enroll the patient for the study. All children between 1 month and 12 years of age admitted with the clinical evidence of shock in the pediatric intensive care unit were included. Children with trauma and burns were excluded from the study. Shock was identified by the presence of at least one of the following parameters, i.e., tachycardia, along with signs of systemic hypoperfusion with or without hypotension.

Tachycardia

>160 beats/min in infants, >140 beats/minute in toddlers, >120 beats/minute in school going and >100 beats/minute in adolescents

Hypotension

Systolic BP in infants <70 mm Hg and Systolic B.P. above 1 year <70 mm Hg + (2X age in years). Pulse volume, skin temperature / color, capillary refill time >2 sec, level of consciousness, urine output.

Patients were classified into compensated or decompensated shock according to the presence of hypotension. Shock was then classified functionally into hypovolemic, cardiogenic, septic and distributive on the basis of history and physical examination.

The etiology, risk factors, type and severity of shock was arrived at using a target history clinical examination and relevant laboratory investigations. These children were managed as per the pediatric advanced life support guidelines for shock with modifications for individual cases, as necessary. The clinical details were entered in a clinical proforma and the outcome was assessed in relation to the various clinical and monitoring parameters and compared with PRISM Score17.

Statistical analysis

Prevalence of shock

Minimum number of PICU cases to calculate prevalence is calculated using the formula.

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Z- z statistics for the level of confidence (1.96 for 95 % level of confidence interval)

P- Expected prevalence (15%)

d- Precision (5%)

Using this formula minimum number of PICU cases 196.

The data collected was analyzed using SPSS software version 22.0. Result was explained by descriptive and inferential statistics. Descriptive statistics were explained by frequencies, mean, standard deviation and range for numerical variables and by proportions and percentages for categorical variables. Inferential statistics was done by t-test for continuous variables and Chi-square test for proportions and categorical variables. P-value <0.05 was taken as statistical significant.

RESULTS

Out of 878 cases admitted in PICU, Shock was observed in 43 children (4.9%) and among them 6 patients were referred to other hospitals and 37 cases (4.2%) were enrolled in the study. Shock at the time of admission and duration of stay in the hospital were found in 26 (70.3%) and 11 (29.7%) respectively. Male to Female ratio was 1.1:1. Children in the age group of < 1 year, 1-5 years and 6-12 years were 17 (46%), 16 (43.2%) and 4 (10.8%) respectively. Among Children with Shock, hypovolemic

shock, septic shock, distributive shock and cardiogenic shock were 10 (27%), 19 (51.4%), 4 (10.8%) and 4 (10.8%) cases respectively. Compensated and decompensated shock were found in 14 (37.8%) and 23 (62.2%) respectively (Table 1). Out of 37 patients, 20 patients (54%) required mechanical ventilation, 15 patients (40.5%) required no inotrope, 3 patients (8%) required 1 inotrope and 19 patients (51.5%) required more than 1 inotrope (Table 1). Among the children with shock compensated metabolic acidosis, uncompensated metabolic acidosis and mixed acid base disorders were found in 16 (43.2%),14 (37.8%) and 7 (19%) respectively. 18 patients (48.6%) had prothrombin time elevated and 19 patients (51.4%) had normal prothrombin time. The total Platelet count >1.5 lakh, 1-1.5 lakh, 50,000-1 lakh, <50,000/mm3 were seen in 19 (51.4%), 6 (16.2%), 6 (16.2) and 6 respectively (16.2) had <50,000 platelets. The total leukocyte counts >15000, 4000-15000 and <4000/mm3 were seen in 16 (43.2%), 19 (51.4%) and 2 cases (5.4%) respectively. Out of 37 patients, 31 patients (83.8%) had normal blood glucose, 4 patients (10.8%) had hypoglycaemia and 2 patients (5.4%) had hyperglycaemia. Out of 37 patients, 8 patients (21.6%) had elevated serum creatinine and 29 patients (78.4%) had normal serum creatinine Out of 37 patients, 20 patients (54.1%) had elevated SGPT and 17 patients (45.9%) had normal SGPT levels.

Out of 37 children with shock 21 (56.7%) Children survived and there were 16 (43.3%) deaths. The mortality among children with 1 month- 1 year and 1-5 years were 14 (82.4%) and 2 (12.5%) respectively and there were no deaths between 6-12 years of age. The mortality rate among children with septic shock, cardiogenic shock and distributive shock were 14 (73.7%) and 2 (50%) respectively whereas all children with hypovolemic shock and distributive shock survived. Among the children with decompensated shock there were deaths in 16 (69.6%) cases (Table 2). Shock at the time of admission were seen in 26 children and among which 15 patients died (57.7%) whereas shock during hospital stay were seen in 11 children and among which death was seen in child 1 (9.1%) and was statistically significant (Chi square 7.43, p<0.001).

MODS were found in 19 (51.4%) cases and among them their deaths in 16 children (84%). Mechanical Ventilation was required in 20 children (54.1%) and among them there were 15 deaths (75%) and was statistically significant (Chi-square 17.88, p value<0.001) The mortality rate among children who received more than one inotrope were seen in 19 children and among them there were 16 (84%) deaths. Serum creatinine was elevated in 8 children and among them there were 7 deaths (87.5%) and was statistically significant (Chi square 8.14, p value<0.012).

The mortality rate among children with uncompensated metabolic acidosis and mixed acid base disorders were 9 (64%) and 6 (78%) respectively and was statistically significant. (Chi-square 16.59, P<0.001). The mortality rate among children with elevated prothrombin time was 14 (78%) and was statistically significant (Chi-Square 17.0, p value<0.001). The mortality rate among children with total platelet count <50,000, total leucocyte count>15,000 and elevated SGPT levels were 6 (100%), 12 (75%) and 16 (80%) respectively. The mortality among children with PRISM score 21-25, 26-30 and 31-35 were 1 (50%), 3 (50%) and 12 (100%) respectively (Table 3).

Table 1: Clinico-demographic Profile.

Clinical profile	Shock cases
Total cases	878
Shock	37 (4.2)
Male	19 (51.3)
Female	18 (48.7)
Shock at admission	26 (70.3)
Shock during hospital stay	11 (29.7)
1 Month-1	17 (46)
1 Year-5	16 (43.2)
6 Years-12	04 (10.8)
Hypovolemic shock	10 (27)
Septic shock	19 (51.4)
Distributive shock	4 (10.8)
Cardiogenic shock	4 (10.8)
Obstructive shock	0 (0)
Compensated	14 (37.8)
Decompensated	23 (62.2)
MODS	19 (51.4)
Mechanical ventilation	20 (54%)
>1 Inotrope	19 (51.5)
Compensated metabolic acidosis	16 (43.2)

Continued.

Clinical profile	Shock cases
Uncompensated metabolic acidosis	14 (37.8)
Mixed acid base disorder	07 (19%)
Elevated prothrombin time	18 (48.6)
Platelet count <50000	6 (16.2)
TLC>15000	16 (43.2)
PRISM score > 30	12 (32.4)
Mortality	16 (43.3)

Table 2: Clinical outcome in children with shock.

Clinical variable	Survival (%)	Death (%)
1 month- 1 year	3 (17.6%)	14 (82.4)
1-5 years	14 (87.5)	02 (12.5)
6-12 years	04 (100)	0 (0)
Hypovolemic shock	10 (100)	0 (0)
Septic shock	05 (26.3)	14 (73.7)
Distributive shock	04 (100)	0 (0)
Cardiogenic shock	02 (50)	02 (50)
Compensated shock	14 (100)	0 (0)
Decompensated shock	07 (30.4)	16 (69.6)
Shock at admission	11 (42.3)	15 (57.7)
During stay at hospital	10 (90.9)	01 (9.1)
Mechanical ventilation	05 (25)	15 (75)
>1 Inotrope	03 (16)	16 (84)
Compensated Metabolic acidosis	15 (94)	1 (6)
Uncompensated Metabolic acidosis	05 (36)	09 (64)
Mixed acid-base disorder	1 (14)	06 (86)
Elevated prothrombin time	04 (22)	14 (78)

Table 3: Distribution of PRISM score in shock patients.

PRISM score	Number	Death
0-5	6 (16.2)	0 (0)
6-10	8 (21.6)	0 (0)
11-15	1 (2.8)	0 (0)
16-20	2 (5.5)	0 (0)
21-25	2 (5.5)	1 (50)
26-30	6 (16.2)	3 (50)
31-35	12 (32.4)	12 (100)

Table 4: PRISM score.

Variable	Value	Score
Systolic BP infant	45-65	3
	<45	7
Child	55-75	3
	<55	7
Infant heart rate/min	215-225	3
	>225	4
Child heart rate/min	185-205	3
	>205	4
Temperature	<33° C or >40° C	3
Mental status (GCS)	<8	5
Pupillary reflex	One fixed	7
	Both fixed	11

Continued.

Variable	Value	Score
PH	7.0-7.28	2
	7.48-7.55	2
	<7.0	6
	>7.55	3
Total CO_2 (mmol/l)	>34.0	4
PaO_2 (mmHg)	42-49.9	3
	<42	6
PCO_2 (mmHg)	50-75	1
	<75	3
Glucose	>200 mg/dl	2
Variable	Value	Score
Potassium (meg/l)	>6.9	3
Creatinine	>0.9 mg/dl	2
Blood urea	>14.9 mg/dl	3
WBC counts	<3000	4
Platelets	1-2 lakh	2
	50,000-99,999	4
	<50,000	5
PT/ATT (sec)	PT>22 or APTT>57	3

Table 5: PRISM score and probability of death.

Score	Probability of death
5	9
10	15
15	23
20	35
25	49
30	63
35	75

DISCUSSION

Shock is one of the most common emergencies in paediatrics. In our study the prevalence of shock was found to be 4.9% which was similar to the study done by Singh et al 4.3% whereas in the studies done by Vasundhara et al and Gadappa et al shock constituted around 8% of total admissions in PICU. In study done by Ravikant et al it was accounted for 12.6%. In a study done by Mbevi et al in Kenya the prevalence was found to be 1.5%.[11,18-23] In the study male patients constituted about 51.3% and female patients 48.7%. The male: female proportion was similar to the previous studies conducted by Gobinathan et al (56%, 44%), Gadappa et al (57%, 43%). In a study done by Ravikanth et al the male proportion was slightly high 61%.[18,20,21] Majority of the patients were under 5 years, of which children below 1 year, 1-5 years and 6-12 years were 46%, 43% and 11% respectively. The present study findings were consistent with most of the previous studies done by Gopinathan et al, Vasundhara et al, Gadappa et al and Singh et al which showed that maximum patients were observed in infancy followed by under 5 age group.[11,19,21] In the study, aetiologies of shock were septic shock (51.4%), hypovolemic shock (27%), distributive shock (10.8%) and cardiogenic shock (10.8%). This was like the previous studies done by Vasundhara et al, Ravikanth et al, Gobinathan et al, Chang et al and Gadappa et al where septic shock was the most common shock encountered followed by hypovolemic shock. It was in contrary to the study done by Singh et al hypovolemic shock was the most common type of shock. Obstructive shock was not studied in the present and previous studies because most of the causes of obstructive shock being managed by cardiovascular surgery department. [11,12, 18-21]

In the study 70% were presented with shock at admission and 30% developed shock during the hospital stay. This is due to the late presentation of patients and referral of shock cases from the peripheral centres in later stage. The time of presentation of shock was not studied in any of the previous studies. In the study, decompensated shock (62%) was more compared to the compensated shock (38%) similar to the previous studies done by Gobinathan et al and Gadappa et al. This is in contrary to the study done by Singh et al where compensated shock (60%) was

more compared to decompensated shock (40%). This difference in our study was due to late presentation and a greater number of children with septic shock.[11] In the present study 54% required mechanical ventilation and 59.5% required inotropes out of which 8% required 1 inotrope and 51.5% required multiple inotropes similar to the study done by Gadappa et al in which septic shock frequency was more common.[20] Mechanical ventilation and inotrope requirement in our study was higher than Singh et al where 22.4% required mechanical ventilation and 46% required inotropes.[11] This can be explained by the fact that in the study most cases were septic shock in comparison to the study by Singh et al where it was hypovolemic shock. Children with septic shock required more ventilatory support and inotropes.

In the present study around 50% of the patients had abnormal laboratory values like uncompensated metabolic acidosis, mixed acid base disorders, leucocytosis, thrombocytopenia, elevated prothrombin time, elevated SGPT values and raised serum creatinine which was similar to previous study done by Gadappa et al.[20] However, in the previous study done by Singh et al the proportion of patients with abnormal lab parameters are lesser than the present study because of less number of septic shock patients and decompensated shock compared to the present study.[11]

In the present study MODS was present in 51.4% which was much higher than that of Singh et al which was 19.45% which was explained by the greater number of septic shock and decompensated shock in the study. Goh et al in their study observed the presence of sepsis, severe sepsis and septic shock was associated with increased number of multiorgan dysfunction.[14] In the present study 56% survived and mortality rate was 44% and was similar to the study done by Chang et al.[12] The mortality rate was higher in study done by Gadappa et al (73%) in comparison to the present study and lower in studies done by Gobinathan et al, Singh et al and Ravikanth et al.[11,12,21]

There is no significant influence of gender on the outcome in present study similar to the previous studies done by Singh et al, Gopinathan et al, Gadappa et al and Ravikanth et al.[11,18,20,21] In the present study children of age group 1month -1 year showed higher mortality rate and children between 6-12 years showed higher survival rate similar to most of the previous studies by Singh et al, Gopinathan et al, Vasundhara et al. In studies done by Ravikanth et al, Gadappa et al the mortality was higher in the age group 1-5 years compared to children of 1 month-1 year.

And in a study by Chang et al on non-traumatic shock cases, age less than 2 years tend to have poor outcome.[11,12,10-21] In the present study septic shock had maximum mortality followed by cardiogenic shock and was similar to the previous studies by Gobinathan et al, Chang et al and Ravikanth et al.[12,18,21] The mortality was high in cardiogenic shock in studies done by Gadappa et al, Vasundhara et al and Singh et al.[11,19,20] The mortality in septic shock was high due to more number of septic shock cases in the present study. There is 100% survival rate in hypovolemic shock and distributive shock in the present study. The better outcome for hypovolemic shock in the present study compared to other studies is due to earlier recognition of shock and its effective management. The outcome in the distributive shock is similar to the previous studies done by Vasundhara et al, Singh et al.[11,19]

The mortality was high in decompensated shock similar to studies done by Gobinathan et al, Singh et al and Gadappa et al. There were more ventilated patients in the non survivors than in survivors similar to the studies done by Gopinathan et al, Gadappa et al and Vasundhara et al.[11,19-21] The need for mechanical ventilation predicted the mortality in shock cases because of the need for mechanical ventilation per the severity of shock and the multiple complications associated with ventilation which contributes to the mortality. The requirement of multiple inotropes was associated with poor outcome in this study similar to the study done by Vasundhara et al, KutKo et al.[13,19]

Uncompensated metabolic acidosis, mixed acid base disorders, elevated prothrombin time, thrombocytopenia, leucocytosis, leucocytopenia, hypoglycaemia, elevated urea and creatinine levels, elevated SGPT levels, shock at the time of admission were high in non survivors compared to survivors which is similar to Ravikanth et al, Gobinathan et al, Singh et al, Gadappa et al and Chang et al.[11,12,18,20,21] In the present study the mortality was high in patients with MODS 84% similar to the studies done by Daljit singh et al, KutKo et al, Tantalean et al and Goh et al. The mortality rate was high in prism score above 20. PRISM score above 30 are associated with 100% mortality similar to study done by KutKo et al and Munde et al.[11,13-15,20,22]

In the present study Septic shock was the most common type of shock followed by hypovolemic shock. The most age group effected were <5 years of age. The highest mortality was with septic shock and cardiogenic shock whereas hypovolemic and distributive shock were having better outcome. The clinical parameters which were identified as risk factors for mortality were infancy, decompensated shock, shock at the time of admission, need for ventilator support and multiple inotropes, MODS, PRISM score above 20. Lab parameters of high risk for mortality were elevated PT, SGPT and creatinine levels, thrombocytopenia, leucocytosis, leukocytopenia, uncompensated metabolic acidosis and mixed acid base disorders.

Limitations

The other markers of shock such as hyperlactatemia, IL 1, NO, procalcitonin were not done due to limited resources. Efficacy of bedside ultrasound abdomen,

ECHO, CVP monitoring should be evaluated by further studies with a larger sample size.

CONCLUSION

The most risk factors for high mortality were shock at the time of admission, septic shock, infancy, PRISM Score>20. Early Screening for sepsis, early recognition, continuous hemodynamic monitoring and intervention can reduce the morbidity and mortality in shock in children.

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