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Original Research Article

Clinical profile and outcome of shock in mechanically ventilated patients in pediatric intensive care unit of tertiary care centre

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ABSTRACT

Background: The clinical syndrome of shock, a clinical state characterized by inadequate tissue perfusion, is one of the most dramatic, dynamic and life-threatening problems faced by the physician in the critical care setting.
Methods: Retrospective observational study of all critically ill children between 1month-12years who were admitted and mechanically ventilated in our 8-bedded PICU between January 2015 to June 2016; and had clinical evidence of shock. PIM3 (Paediatric Index of Mortality 3) was calculated. Authors noted morbidity and mortality pattern in all types of shock including outcome in Paediatric ICU. The data collected were compiled and tabulated.
Results: The frequency of shock in authors' Paediatric intensive care unit was 8.6% (n=780). However, among mechanically ventilated patients it was present in 65.5% patients. Septic shock was the most commonly encountered shock (n=48, 61.5%). Mortality was highest in cardiogenic shock (n=12, 80%) and obstructive shock (n=4, 80%). Survival was best in Hypovolemic shock. Authors found significant correlation between LOS MV and mortality (p=0.018). Type of shock had no correlation with PIM3 score (p=0.374) and mortality (p=0.884). Blood culture yield was positive in 26.9% patients with *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and MRSA being most common organisms isolated.
Conclusions: Shock is a major cause of morbidity and mortality in children especially below 5yrs of age. Septic shock was the commonest form of shock in children. Severe pneumonia was the commonest illness causing septic shock. Mortality was associated with longer length of stay on mechanical ventilation. Larger prospective multicentric study in developing countries is desirable.

Keywords: Mechanical ventilation, Outcome, PICU, PIM3, Shock

INTRODUCTION

The clinical syndrome of shock, a clinical state characterized by inadequate tissue perfusion, is one of the most dramatic, dynamic and life-threatening problems faced by the physician in the critical care setting.[1] Shock is an acute syndrome in which the circulatory system is unable to provide adequate oxygen and nutrients to meet the metabolic demands of vital organs.[2] Due to the inadequate ATP production to support function, the cell reverts to anaerobic metabolism, causing acute energy failure.[3] This energy failure results in the cell being unable to maintain homeostasis, the disruption of ionic pumps, accumulation of intracellular sodium, efflux of potassium, accumulation of cytosolic calcium and eventual cell death. Widespread cell death results in multi-organ dysfunction. Shock accounts for more morbidity and mortality in children worldwide than any other diagnosis, esp. if shock is accompanied by need of mechanical ventilation.[4,5] There is a paucity of data on the epidemiology of shock in developing countries.

METHODS

The present study is retrospective analytic-descriptive study in Pediatric intensive care unit of a tertiary care hospital. Authors serve low to middle income population as an economical and tertiary referral unit for pediatric medical and surgical cases, however this excludes pediatric patients who are post-cardiac surgery or those who need extracorporeal membrane oxygenation.

Inclusion criteria

All critically ill children between 1month to 12yrs of age, who were mechanically ventilated and developed shock in authors' 8-bedded PICU between January 2015 to June 2016; were included in the study.

Exclusion criteria

- New-borns, preterm infants, patients intubated for more than 24hours prior to PICU admission with us or
- Patient having incomplete data for PIM3.

Authors followed standard antibiotic policy and management algorithms for paediatric shock and sepsis.

Authors utilized database through file records of those children between 1month to 12years of age who were admitted and mechanically ventilated in authors' 8-bedded PICU between January 2015 to June 2016 and had clinical evidence of shock. Authors recorded the age, sex, weight, clinical assessment on admission, duration of admission to PICU, duration of mechanical ventilation, reintubations if any, chief etiology that required admission, any comorbidities developed during the PICU stay and investigation profile including arterial blood gas analysis, radiographic investigations. Shock was identified as per standard PICU protocol.

Shock was identified by the presence of at least one of the following parameters i.e., tachycardia and/or hypotension along with signs of systemic hypoperfusion.[4].

- Tachycardia: Infants >160beats per minute, toddlers >140bpm, school going age >120bpm, adolescents >100bpm.[5]
- Hypotension: Systolic blood pressure in Infants <70mmHg; above 1 year <70mmHg + (2 × age in years).[6]
- Signs of systemic hypoperfusion are taken by noting the following: pulse volume, skin temperature/ color, capillary refill time >2 seconds, level of consciousness, urine output. Patients were classified into compensated or decompensated shock according to the presence of hypotension.

Warm septic shock was identified by the presence of bounding pulses, CFT <2 seconds, wide pulse pressure, normal urine output. Cold septic shock was identified with the presence of hypotension and cold extremities.[7,8] Shock was then classified functionally into hypovolemic, cardiogenic, septic, obstructive and distributive on the basis of history and physical examination.

PIM -3 (Paediatric index of mortality) was calculated as

Calculation of PIM3 (and PIM3 risk of death%)- PIM3val= (3.8233 * Pupils) - (0.5378 * Elective) + (0.9763 * MechVent) + (0.0671 * (absolute BaseExcess)) - (0.0431*SBP) + (0.1716*(SBP*SBP/1000)) + (0.4214 *(100*FiO2/PaO2)) -(1.2246*Recov_CardBypPr) - (0.8762*Recov_CardNonBypPr) - (1.5164*Recov_NonCardPr) +(1.6225* VHRdiag) + (1.0725*HRdiag) - (2.1766*LRdiag) - 1.7928.

PIM3 risk of death = ePIM3val / (1 + ePIM3val)

Where, SBP:Systolic Blood Pressure, Recov_CardByp/ NonBypPr: Recovery from a Cardiac Bypass/Non Bypass procedure, HR/VHR/LRdiag: High risk/Very high risk/Low risk diagnosis.

Categorisation of diagnosis will be done based on PIM3 guidelines. This will be calculated automatically through data entered in Anzics CORE -Severity Score and Risk of Death Calculator-PIM3(Excel version).[9]

PICU LOS (length of stay) is a commonly used clinical endpoint reflecting both severity of illness and resource utilization. However, because LOS is influenced by a variety of clinical and logistic factors that may not be completely apparent in a retrospective chart review, hence we will analyse the data in relation to the duration of mechanical ventilation (LOS MV) and outcome (survived, death).

Statistical analysis

All the data collected were compiled and tabulated. The statistical analysis was done by chi-square test, ANOVA and paired t-test whichever applicable. The p value was calculated and <0.05 was considered significant.

RESULTS

During the study period, 119 patients were mechanically ventilated of which 78 (65.5%) were diagnosed with shock and were included in the study.

Overall frequency of shock during the study period in authors' PICU was 8.6%. 78 children with Shock and requiring mechanical ventilation included 45 (57.7%) males and 33 (42.3%) females. Median age was 2.28 years i.e. 16months (min.0.16yr- max 12yrs). 26 (33.3%) patients were <1yr age, 45 (57.7%) were between 1-5yrs age and 07 (8.9%) between 6-12yrs age.

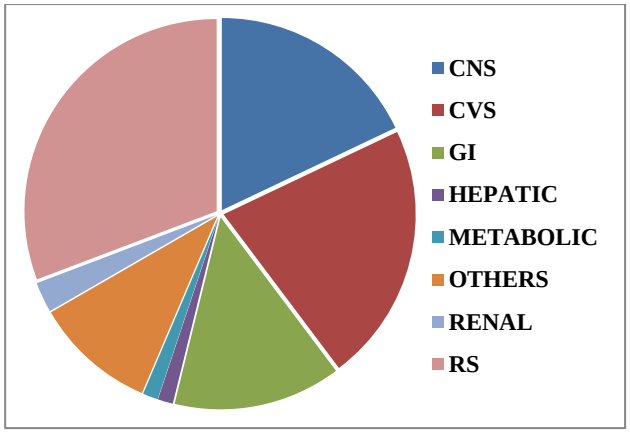

Figure 1: Disease distribution in cases with shock.

Severe acute Malnutrition was seen in 29 (37.2%) patients, whereas 44.9% had no malnutrition. Median PIM3 Score was 12.43. Majority (n=44, 56.4%) required intubation within 24hours of admission to PICU due to clinical deterioration. The chief systems requiring mechanical ventilation and developing shock during admission or PICU stay were as follows: respiratory disease (n=24, 30.7%); cardiovascular disease (n=17,21.8%); neurological disease (n=14,17.9%), gastroenterology (n=11, 14.1%) and hepatic diseases (n=01, 1.3%); renal disease (n=2, 2.5%) and Others (n=8,10.2%) (Figure 1).

By analyzing through two-tailed hypothesis on t-test, authors found significant correlation of mortality with LOS MV [length of stay on mechanical ventilation (p=0.018)]. Only on utilizing one-tailed hypothesis, age and duration of MV had statistically significant association with mortality (Table 1). Gender, malnutrition, anemia, CRP showed no correlation with mortality in shock on mechanical ventilation. There was no significant correlation between PIM3 score and mortality.

Septic shock was the most commonly encountered shock (n=48, 61.5%). However, mortality was highest in cardiogenic shock (n=12/15, 80%) and obstructive shock (n=4/5,80%). Survival was best in hypovolemic shock. (Table 2). Since most hypovolemic shock did not require mechanical ventilation, their number is low in this study. 61 patients (78%) had decompensated shock and required more than one Inotropic support. Overall mortality in patients with shock on mechanical ventilation was 73.1%. Authors found no correlation between type of shock and mortality (p=0.884). Type of shock showed no significant correlation with PIM3 score (p=0.374).

Anemia was present in 61.5% (n=48) patients. Thirty four (43.6%) children had hyponatremia. Leucocytosis was noted in 67.9% (n=53) of patients. The mean LOS MV was 6.3days (min 1day-max 52days).

Table 1: Group statistics.

	Survived	N	Mean	Std. deviation	Std. error Mean	p
Age	No	57	1.9630	2.41164	0.31943	0.045
	Yes	21	3.1224	3.24356	0.70780	
Total LOS days	No	57	9.67	10.345	1.370	0.018
	Yes	21	6.05	2.692	0.587	
Duration of MV days	No	57	6.72	7.210	0.955	0.047
	Yes	21	4.14	2.330	0.508	
PIM3 Score	No	57	7.09627757	25.767813379	3.413030259	0.87
	Yes	21	26.92696734	48.557447503	10.596103749	

Table 2: Frequency and survival in shock.

			Survived		Total
			No	Yes	
Type of shock	Cardiogenic	Count	12	3	15
		% within type of shock	80.0%	20.0%	100.0%
	Septic	Count	34	14	48
		% within type of shock	70.8%	29.2%	100.0%
	Obstructive	Count	4	1	5
		% within type of shock	80.0%	20.0%	100.0%
	Distributive	Count	6	2	8
		% within type of shock	75.0%	25.0%	100.0%
	Hypovolemic	Count	1	1	2
		% within type of shock	50.0%	50.0%	100.0%
Total		Count	57	21	78
		% within type of shock	73.1%	26.9%	100.0%

Table 3: Causative organisms, frequency and associated mortality.

ORG	Number	Survived - Yes		Survived - No	
		Number	%	Number	%
Acinetobacter baumannii	3	1	33%	2	67%
E. coli	1	1	100%	0	0%
Enterococcus	1	0	0%	1	100%
Klebsiella pneumoniae	4	0	0%	4	100%
MRCONS	1	1	100%	0	0%
MRSA	4	3	75%	1	25%
Pseudomonas aeruginosa	4	1	25%	3	75%
Nonfermenting Gram Neg Coccobacilli	1	0	0%	1	100%
Streptococcus spp	2	1	50%	1	50%
No Growth	57	13	23%	44	77%

Pneumonia was noted in majority of patients (n=48, 61.5%). 65.4% (n=51) had sepsis, while ventilator associated pneumonia was noted in 51.3% cases (n=40). 32 patients (41%) had coagulopathy. Hepatic dysfunction and acute kidney injury were seen in 24 (30.8%) and 17 (21.8%) patients respectively. CRP was positive in 49 patients (62.8%). Parenteral nutrition was provided to 24 patients (30.8%). Blood culture demonstrated growth in 26.9% patients (n=21) (Table 3).

DISCUSSION

Shock is a major cause of morbidity and mortality in critically ill children worldwide. The frequency of shock noted in paediatric intensive care was 8.6%. Septic shock was the most commonly encountered shock in these children followed by cardiogenic shock. In the Western countries, shock occurs in approximately 2% of all hospitalised infants, children and adults. The mortality considerably varies depending on the etiology and clinical scenario.[10] There is sparse data about the incidence of shock in developing countries. Few Indian studies have reported a frequency of 4.3%, while another has reported it to be 9% which corresponds to present study findings.[11,12] Majority of patients (91%) in present study were under 5years of age, of which 36% were infants. Present study findings are consistent with the previous studies.[11,13-15]

Critically ill and mechanically ventilated children were found to have leukocytosis (67.9%), anaemia (61.5%), positive CRP (62.8%) and hyponatremia (43.5%). Benamer et al, reported leucocytosis in 50% patients, anemia in 40% and raised liver enzymes in 43%.[15] Authors observed higher proportion of the above data in present study, which could be attributed to most children being under 5yrs age and one-third of the patients being infants. Also, malnutrition (37.2% in present study) being common in a developing country like ours can make children vulnerable to infections as well as higher incidence of anemia. Authors noted evidence of sepsis in 65.4% patients. However, due to financial constraints and logistic reasons, authors could not perform quantitative CRP and arterial lactate levels.

Severe pneumonia was the commonest illness leading to mechanical ventilation and presenting with septic shock. Militaru et al, from Romania also reported respiratory infection to be the most (64%) common etiology followed by digestive tract infection and urinary tract infection.[14]

Majority of patients with cardiogenic shock had decompensated shock requiring early intubation and inotropic support. Ventilator associated pneumonia developed in 40 patients. This could be attributed to Longer LOS MV and vice versa, which was statistically significant in present study (p=0.018). Authors also noted Hepatic dysfunction and acute kidney injury in 30.8% and 21.8% patients respectively.

In the present study, we obtained Blood culture yield of 26.9%. The most common organisms isolated were Klebsiella pneumoniae, Pseudomonas aeruginosa and MRSA. While mortality rate was highest in *Klebsiella pneumonia*, the survival was better in Methicillin resistant *Staphylococcus aureus*. Authors obtained very few culture proven cases of septic shock as compared to other studies and more cases with Gram negative organisms as reported in other studies.[16-18] Low culture positivity may be attributed to patients having received oral or parenteral antibiotics prior to referral to authors' ICU. Majority of patients were fluid refractory and in decompensated shock and required multiple inotropic support. Lack of early recognition of sepsis and shock and delayed referral may have contributed to decompensation. Early detection and management of shock increases the rate of survival before hypotension develops.[5,7]

Mortality noted in present study was high (73%). Critically ill children requiring Mechanical ventilation have high chance of morbidity and mortality. In addition,

Shock in children is difficult to diagnose in early stages and contributes significantly to mortality in children.[4,5] Pollack et al, reported mortality rate of more than 50% in paediatric patients with septic shock.[18]

Valoor et al, also reported high mortality of 65.8% in fluid refractory shock.[19] A few other Indian studies have also reported mortality rates of 47% in Punjab, 58% in Haryana and 50% in AIIMS, New Delhi.[11,20,21] Another study in Romania reported a mortality rate of 53% in children with shock.[14] Need for mechanical ventilation and decompensated shock were significantly associated with mortality. Han YY et al, reported that non-survivors required more inotropic therapies as compared to survivors.[22] Since authors have included on those children who required mechanical ventilation, present study mortality rate is proportionately higher in intensive management as per standard Surviving Sepsis guidelines and other standard protocols. Authors did not find any correlation of mortality in shock with PIM3 score. Kaur G et al, demonstrated that mortality among children with sepsis, severe sepsis, and septic shock were not predicted by any individual factors including the time lag to PICU transfer, duration of PICU stay, presence of multiorgan dysfunction, and PRISM score at admission.[20] However, it had small sample size hence further research in this is imperative. Present study being retrospective had its limitations since management decisions could not be effectively standardized in poor resource setting.

Han YY et al, noted reversal of shock at a median time of 75 minutes associated with 96% survival and more than 9-fold increased odds of survival while each additional hour with persistent shock was associated with more than 2-fold increased odds of mortality.[22] Thus, the role of early detection of shock in improving survival rate is indispensable.[23]

Management of Septic shock esp. in those children requiring mechanical ventilation requires good infrastructure, trained staff and protocol-based management. Inspite of these, the morbidity and mortality in this condition is high. Developing countries need more feasible, clear and practical guidelines which can be utilized in resource limited settings.

CONCLUSION

Shock is a major cause of morbidity and mortality in children especially below 5yrs of age. Septic shock is the commonest form of shock in children who developed shock and required mechanical ventilation. Severe pneumonia was the commonest illness causing Septic shock. Mortality was associated with longer length of stay on mechanical ventilation. Larger prospective multicentric study in developing countries is desirable.

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REFERENCES

1. McConnell MS, Perkin RM. Shock states. In: Zimmerman JJ, Fuhrman BP, editors. Textbook of Pediatric Critical Care, 2nd ed. St. Louis: Mosby;1998:293-306.
2. Bell LM: Life threatening emergencies, Shock. In: Textbook of Pediatric Emergency Medicine 4th ed. Fleisher GR, Ludwig S (Ed.), Lippincott Williams & Wikins, PA, USA;2000:47-55.
3. Carcillo JA, Han K, Lin J, Orr R. Goal-directed management of pediatric shock in the emergency department. Clin Pediatrc Emergency Med. 2007 Sep 1;8(3):165-75.
4. Schwarz A. Shock. eMedicine Specialties >Pediatrics> Critical Care. Available at: http:// www.emedicine.com/ped/topic3047.htm. Accessed 4 October, 2005.
5. Joseph R, Randall T, Wetzel C. Shock and multi organ system failure. In: Rogers MC, Nichols DG, eds. Textbook of Pediatric Intensive Care. 3rd ed. Maryland: Williams and Wilkins;1996:589-605.
6. Recognition of Respiratory Failure and Shock. In: Hazinski ME, editor. Textbook of Pediatric Advanced Life support. Philadelphia: American Heart Association;2002:23-42.
7. Singhi S. Shock. In: Sachdev HPS, Choudhury P, Bagga A, Chugh K, Ramji S, Puri RK, eds. Principles of Pediatric and Neonatal Emergencies, 2nd ed. New Delhi: Jaypee Medical Publishers; 2004;46-62.
8. Prego Petit J. International pediatric sepsis consensus conference: Definitions for sepsis and organ dysfunction in pediatrics. Arch Pediatr Uruguay. 2005; 76 (3): 254-6.
9. Information Booklet: PIM2 & PIM3 for the ANZPIC Registry; March 2016. Available at: http://www.anzics.com.au/www.anzics.com.au/Downloads/PIM2%20%26%20PIM3%20Information%20Booklet%20Mar16.pdf.
10. David A. Turner, Ira M. Cheifetz. Shock. In:Behrman RE, Kliegman RM. Nelson Textbook of Pediatrics. 20th ed. Hardcourt Asia; WB Saunders;2016:516-528.
11. Singh D, Chopra A, Pooni PA, Bhatia RC. A clinical profile of shock in children in Punjab, India. Indian Pediatr. 2006 Jul 1;43(7):619-23.
12. Kurade A, Dhanawade S, Clinical profile and outcome of septic shock in children admitted to a tertiary care referral hospital: Int J Pediatr Res. 2016;3(4):225-30.
13. Watson RS, Carcillo JA. Scope and epidemiology of pediatric sepsis. Pediatric Critical Care Med. 2005 May 1;6(3):S3-5.
14. Militaru M, Martinovici D. Our experience in paediatric sepsis. J Pediatr. 2005;8:26-31.

15. Benamer HM, Alsaiti AA, Bofarraj M, Abud H, Tip RM. Diagnosis, management and outcome of sepsis at Benghazi children hospital (1 year review). Pediatr Therapeut. 2015;5(267):2161-0665.
16. Dahmash NS, Chowdhury MN, Fayed DF. Septic shock in critically ill patients: aetiology, management and outcome. J Infection. 1993 Mar 1;26(2):159-70.
17. Cotran RS, Kumar V, Robbins SL. Shock in Fluid and Hemodynamic Derangements. In: Robbins Pathologic Basis of Disease.Philadelphia: WB Saunders;1989:114-119.
18. Pollack MM, Fields AI, Ruttimann UE. Sequential cardiopulmonary variables of infants and children in septic shock. Critical Care Medicine. 1984 Jul;12(7):554-9.
19. Valoor HT, Singhi S, Jayashree M. Low-dose hydrocortisone in pediatric septic shock: an exploratory study in a third world setting. Pediatr Critical Care Med. 2009 Jan 1;10(1):121-5.
20. Kaur G, Vinayak N, Mittal K, Kaushik JS, Aamir M. Clinical outcome and predictors of mortality in children with sepsis, severe sepsis, and septic shock from Rohtak, Haryana: a prospective observational study. Indian J Critical Care Med. 2014 Jul;18(7):437-41.
21. Sarthi M, Lodha R, Vivekanandhan S, Arora NK. Adrenal status in children with septic shock using low-dose stimulation test. Pediatr Critical Care Med. 2007 Jan 1;8(1):23-8.
22. Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, et al. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatr. 2003 Oct;112(4):793-9.
23. Biban P, Gaffuri M, Spaggiari S, Zaglia F, Serra A, Santuz P. Early recognition and management of septic shock in children. Pediat Reports. 2012 Jan 2;4(1):e13.

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