STUDY OF CLINICAL PROFILE AND OUTCOME OF SHOCK IN PAEDIATRIC INTENSIVE CARE UNIT OF A TERTIARY REFERRAL HOSPITAL

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CERTIFICATE

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DECLARATION

I declare that this dissertation entitled **"STUDY OF CLINICAL PROFILE AND OUTCOME OF SHOCK IN PEDIATRIC INTENSIVE CARE UNIT OF A TERTIARY REFERRAL HOSPITAL"** has been conducted by me at the Institute of Child Health and Hospital for Children, under the guidance and supervision of **Prof. Dr. R. Kulandai Kasthuri, M.D., DCH.,** Director and Superintendent, and my unit chief, **Prof. Dr. R. Duraisami, M.D., DCH.** It is submitted in part of fulfillment of the award of the degree of M.D (Pediatrics) for the March 2007 examination to be held under the Tamil Nadu Dr. M. G. R. Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

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CONTENTS

Introduction

INTRODUCTION

Shock occurs in approximately 2% of all hospitalized children and adults in the united states [1]. Majority of the childhood illness have the potential to lead to shock. Shock accounts for more morbidity and mortality in children world wide than any other diagnosis.[2,3] Shock is one of the most dramatic, dynamic and life-threatening problems faced by the physician in critical care setting[4].

High index of suspicion is needed for early identification of shock. Early institution of treatment will definitely reduce the chances of progression of shock to end up in cardio respiratory failure. Rapid and focused cardiopulmonary assessment adds in the early recognition of shock state.[5]

Many studies have been done to classify shock at presentation and emphasize that there exists a wide range of etiologies for shock.

The mortality rate of shock in pediatric patients has declined as a consequence of educational efforts (pediatric advance life support), which emphasize early recognition and intervention and rapid transfer of critically ill patients to a PICU via a transport service[1].

DEFINITION:

Shock is a clinical state characterized by inadequate tissue perfusion resulting in delivery of oxygen and metabolic substances that is insufficient to meet tissue metabolic demands.

It is a state of respiratory failure at the cellular level.

PATHOPHYSIOLOGY:

Circulatory function depends on the blood volume, vascular tone and cardiac function. Shock state results from abnormalities in one or more of these functions or from cellular metabolic dysfunction due to inability to utilize substances delivered via the circulatory system.

When the delivery of oxygen fails to meet cellular oxygen demands, metabolic acidosis results from lactic acid formation.

In the early phases of shock, a number of compensatory physiologic mechanisms act to maintain blood pressure and preserve tissue perfusion. These responses include increase in heart rate,stroke volume and vascular smooth muscle tone, regulated through neurohormonal changes in sympathetic nervous system activation and other hormonal responses to help preserve blood flow to vital organs such as the brain, heart and kidneys. The respiratory rate is increased to promote the excretion of CO_2 ,to compensate for increased CO_2 production and

the metabolic acidosis[1]. Increased renal excretion of hydrogen ions and retention of bicarbonate occurs in an effort to maintain normal pH[1].

Loss of vascular volume decreases the mean systemic filling pressure which leads to a fall in venous return.

Compensation occurs by altering the ratio of the pre and post capillary resistance to allow movement of fluid from the interstitial space to the intra vascular space. Oxygen extraction is increased and venous compliance is reduced.

When the fluid loss overwhelms the compensatory mechanisms, the cardiovascular system fails to maintain blood pressure in addition to tissue perfusion. Tissue injury and cell death occurs, affecting all organs. Progression and perpetuation of the shock state, leads to irreversible shock, multi organ failure and ultimately death.

STAGES OF SHOCK:

- Compensated
- Decompensated
- Irreversible

Compensated Shock:

Compensated shock is defined by the presence of systolic BP within normal range with signs and symptoms of inadequate tissue and organ perfusion. Vital organ function is maintained.

Decompensated Shock:

When signs of shock are associated with systolic hypotension that is called as decompensated shock. Hypotension is a late sign of shock.

Irreversible Shock:

Irreversible shock implies damage to key organs of such magnitude that death occurs even if therapy returns cardiovascular measurements to normal level.

CLASSIFICATION OF SHOCK:

- Hypovolemic Shock
- Septic Shock
- Cardiogenic Shock
- Distributive shock
- Obstructive Shock

Hypovolemic Shock and septic shock are the most common causes of shock in children[1]. In a given child with shock, significant overlap between the causes may exist. However this classification helps us to come to an initial conclusion regarding the underlying etiology and start the management.

I.HYPOVOLEMIC SHOCK:

Abnormality of the preload, characterized by inadequate intravascular volume relative to the vascular space. It is perhaps the most common shock occurring in infants and children.[5,6]

Upto 10 to 15% of fluid loss is tolerated by healthy children. Acute loss of 25% of fluids results in hypovolemic shock.

Etiology:[4]

1. **Whole blood loss**.

a. Absolute blood loss: Haemorrhage – External or internal

b. Relative blood loss:

Pharmacological – Barbiturates, Vasodilators

Positive pressure ventilation

Spinal cord injury

Sepsis

Anaphylaxis

2.Plasma Loss:

a. Burns

b. Capillary leak syndromes (Inflammation ,sepsis, anaphylaxis)

c. Protein losing syndromes

i. Nephrotic syndrome

ii. Intestinal disorders (obstruction, perforation).

3. Fluid and electrolyte loss:

1. Vomiting and diarrhoea
2. Excessive diuretic use
3. Endocrine
    a. Adrenal insufficiency
    b. Diabetes insipidus
    c. DKA

Most common cause is dehydration following gastro enteritis although, burns, traumatic haemorrhage, diabetic ketoacidosis, third space loss[5], reduced intake and adrenal insufficiency are not to be forgotten.

Hemodynamically, these patients have

1. Normal to reduced filling pressure
2. Increased systemic vascular resistance
3. Decreased cardiac output with normal blood pressure.

II. SEPTIC SHOCK:

Septic shock is a sepsis with hypotension despite fluid resuscitation along with presence of perfusion abnormalities [1].

Septic shock is a combination of multiple problems including,

1. Infection
2. Relative or absolute hypovolemia
3. Maldistribution of blood flow
4. Myocardial depression

Shock in sepsis contains many elements: Hypovolemic, cardiogenic and distributive.

The **"SEPTIC CASCADE"[1]** can be summarized as

↓ **Infection**

Systemic inflammatory response syndrome (SIRS)

Response to wide variety of clinical insults

- Hyper or Hypothermia
- Tachycardia
- Tachypnoea
- Leucocytosis or Leucopenia

↓

Sepsis

SIRS with hypotension in response to infection [1,7]

Severe Sepsis

Sepsis with organ dysfunction, hypoperfusion or hypotension may include change in mental status, oliguria, hypoxemia, or lactic acidosis.

Septic Shock

Severe sepsis with persistent hypotension despite adequate fluid resuscitation

Multiple organ dysfunction syndrome (MODS)

Presence of altered organ function such that homeostasis cannot be maintained without intervention.

Death

III. CARDIOGENIC SHOCK:

Cardiogenic shock is the pathophysiological state in which the abnormality of cardiac function is responsible for the failure of the cardio vascular system to meet the metabolic needs of the tissues. The common denominator is depressed cardiac output which in most instances is the result of depressed myocardial

contractility. The decreased cardiac output which results in increased systemic vascular resistance and hence the after load. This further decreases the cardiac output. Hence a self perpetuating viscious cycle is started.

Etiology:

A:**Heart rate abnormalities:**

1. SVT
2. Ventricular dysrythmias
3. Bradycardia

B**. Cardiomyopathies and carditis:**

1. Hypoxic – Ischaemic Insults
    a. Cardiac arrest
    b. Prolonged shock
    c. Head injuries
    d. Anomalous coronary arteries
    e. Excessive catecholamine state
    f. Cardio pulmonary bypass

2. Infections: Viral, Bacterial, Fungal etc.
3. Idiopathic or familial cardiomyopathies

4. Metabolic:

A. Acidosis, Hypothermia, Hypocalcaemia

B. Hypo or Hyperthyroidism

C. Pheochromocytoma

D. Abnormal fatty acid metabolism

E. Glycogen storage disorders

F. Mucopolysaccharidosis

G. Carnitine deficiency

5.Connective tissue disorders:

Acute rheumatic fever, Kawasaki disease, SLE, PAN.

6.Neuro muscular disorders:

DMD, other muscular dystrophies, SMA, Freidrich's ataxia, multiple lentigenes.

7.Toxic reactions:

Sulphonamides, Penicillin, Anthracyclines

C. **Congenital heart diseases**

D. **Trauma**

Myocardial dysfunction and cardiogenic shock is frequently a late manifestation of shock of any etiology. The following mechanisms have been proposed as the cause of myocardial dysfunction in these patients.

1. Specific toxic substances released during the course of shock that have a direct cardiac depressant effect.
2. Myocardial oedema
3. Adrenergic receptor dysfunction.
4. Impaired sarcolemmal blood flow resulting in impaired myocardial systolic and diastolic function.

IV: DISTRIBUTIVE SHOCK:

Abnormalities in vascular tone can cause maldistribution of normal circulatory volume, which if severe enough may lead to shock. Consequent peripheral pooling and vascular shunting lead to a state of RELATIVE HYPOVOLEMIA. In addition loss of arterial tone leads to marked hypotension. Although distributive shock may clinically resemble hypovolemic shock, it generally arises from different causes.

Etiology:

- Sepsis
- Anaphylaxis

- Spinal or Epidural Anaesthesia
- Disruption of the spinal cord
- Inappropriate use of vasodilator medications
- Scorpion sting
- Toxins (Carbon monoxide, Cyanide, Metformin)[1].
- Allergic reactions
- Hypoxia [1]

V. OBSTRUCTIVE SHOCK:

Obstructive shock is caused by the inability to produce adequate cardiac output despite normal intravascular volume and myocardial function.

This is due to abnormalities of the after load.

Causes:

- Acute pericardial tamponade
- Tension Pneumothorax
- Pulmonary or Systemic hypertension
- Congenital or acquired outflow obstructions

Recognition of characteristic features of these syndromes is essential because most of the causes can be treated provided the diagnosis is made early.

RECOGNITION OF SHOCK:

Rapid and focused cardio pulmonary assessment aids in early recognition of shock.

CARDIO PULMONARY ASSESSMENT FOCUSES ON:

- **Airway**: whether stable/unstable/obstructed.
- **Breathing:**

  Tachypnoea is one of the signs of shock .Bradypnoea or normal respiratory rate in the presence of shock (relative bradypnoea) occurs in profound shock.

- **Work of Breathing**:

  Increased work of breathing is evidenced by nasal flaring, head bobbing, grunting, inspiratory chest retractions and abdominal respiration.

- **Bilateral airentry**: Usually Normal
- **Added sounds**:

  Crackles and rhonchi may be heard in cardiogenic shock and in ARDS, which occurs in late stage of shock.

- **Skin Colour:**

  Normal (or) abnormal(cyanosis/dusky/pallor/mottling/hyperpink) Hyperpink or flushed skin colour enables recognition of warm septic shock.

- **Heart rate:**

  Tachycardia, is the earliest sign of shock. Bradycardia or normal heart rate in the presence of shock (relative bradycardia) may occur in late decompensated shock.

NORMAL HEART RATES IN CHILDREN:

S.No.	Age	Awake State	Mean	Sleeping Rate
1.	Newborn to 3 months	85-205	140	80-160
2.	>3months to 2 years	100-190	130	75-160
3.	>2years to 10 years	60-140	80	60-90
4.	>10years	60-100	75	50-90

- **Pulse volume:** Pulse volume is assessed by simultaneously palpating the central (femoral) and distal (dorsalis pedis) pulses. In shock there may be thready distal pulse or absent distal pulse.

In warm shock of sepsis, there will be bounding distal pulses.

- **Core – peripheral temperature gap:**

Feeling simultaneously the warmth of the trunk and that of the peripheries assesses the core-peripheral temperature gap. The difference greater than 2 degree celsius presenting with warm trunk and cool clammy extremities is a sign of poor skin perfusion provided ambient temperature is warm.

- **Capillary refill time (CRT):**

When capillary refill is evaluated, lift the extremity slightly above the heart level to ensure assessment of arteriolar capillary and not venous stasis.

Normal CRT= 2 seconds. It is prolonged in shock, rising fever and cold ambient temperature.

- **Liver Span:**

It provides non invasive information of myocardial contractility. Increase in liverspan suggests cardiogenic component.

- **Blood Pressure:**

Shock may be present with normal or low or high BP.

Normal BP: Compensated shock

Hypotension: Decompensated shock

Hypotension is not synonymous with shock.

Hypotension is characterized by:

Age	Systolic BP
Term Neonates	<60mm of Hg
1Month – 12 months	<70mm of Hg
1year – 10years	<70 + (2x age in years)
>10 years	<90mm of Hg

- **Cerebral hypoxia and hypoperfusion**

This is assessed by level of consciousness. Rapid measure of level of consciousness should be recorded by AVPU scale.

A-Alert

V-Verbal Responsive

P-Pain responsive

U-Unresponsive

Assessment of verbal responsiveness in pre communicative infants is by inconsolable cry, impaired alertness, hyperalertness or alert/anxiousness.

Loss of eye contact (not focusing on parent's eyes) in infants >2 months is an early ominous sign of cerebral hypoperfusion.

- **Tone and posture:**

Abnormality in tone and posture (hypotonia, floppiness, flexor or extensor posturing) is also a sign of cerebral hypoxia and hypoperfusion.

- **Reaction of pupils to light**: Sluggish reaction to light indicates cerebral hypoxia and hypoperfusion. Size of the pupils whether equal or unequal is looked for.

- **Renal Perfusion**: Organ perfusion pressure =mean arterial pressure – central venous pressure.

Normal organ perfusion is one of the targets for correcting shock. Urine output <1ml/kg/hr in the absence of known renal disease is a sign of poor renal perfusion.

TREATMENT OF SHOCK:

1.The initial resuscitation in emergency room is given in the algorithm

Algorithm: Approach and goal directed management of pediatric shock in the emergency room

0 Min Assess: Recognize shock in the critically ill child in the appropriate clinical scenario.

Decreased mental status and peripheral perfusion

5 Min: Airway If airway is stable provide 100% oxygen thro' non re-breathing mask.

Breathing Airway not maintainable and bradypnoeic support ventilation with bag mask.

Consider early intubation using RSI technique

Circulation Establish venous access.

If difficult intraosseous access

Start isotonic fluids @ 20ml/kg over 15-20 minutes

Push using 3 way stop cock and syringe if hypotensive for age.

Perform rapid cardiopulmonary assessment following each fluid bolus

Reassess
Improvement, Status quo or Deterioration

Improvement: fluid responsive

Treat till attainment of therapeutic goals:	No improvement after 20ml/kg:
Normalization of RR, HR, peripheral warmth, pulses, CRT<2 secs.	Hypovolemia, sepsis or anaphylaxis fluid requirement @ 40-100ml/kg
Liver Span, BP, Mental Status, pupils (equality and reaction) Urine output>1ml/kg/hr, SaO2>95%	Hypovolemic shock due to AWD needs large volume fluids but rarely needs inotropes for shock correction.
	Continue to titrate volume following intubation and

	during inotrope therapy in sepsis and anaphylaxis. Asthma, Status epilepticus, Scorpion sting, Submersion injury etc (distributive shock due to hypoxic-ischemic etiology)fluid @ 20-30 ml/kg (max). Suspicion of sepsis in asthma or CSE will warrant more fluids and initiation of inotrope therapy. Trauma: Control bleeding and if shock not responsive to 50ml/kg, consider blood transfusion and surgical exploration if site of bleed not apparent. Isolated closed Head Trauma: Evaluate and treat spinal cord injury, tension pneumothorax, cardic tamponade and avoid more fluids. DKA: Shock not responsive to 20ml/kg over 1-2 hours, 40 ml/kg over 4 hours. Cardiogenic shock due to CHD, CMY, myocarditis: max fluid 20ml/kg in aliquots of 5-10 ml/kg. Dopamine infusion @ 10mcg/kg/min if BP is low normal Dobutamine infusion @ 10mcg/kg/min if BP is high Epinephrine infusion @0.05-1 mcg/kg/min if BP is low or following cardiopulmonary arrest. Catheterize when vasoactive medications are needed for shock correction. Correct documented hypoglycemia and hypocalcemia

*** Recognize cardiogenic shock on arrival or during fluid therapy in sepsis, CHD, scorpion sting, submersion injury etc.
Stop fluid, start appropriate vasoactive medications, Plan intubation:

- Airway instability , Pink froth, Bradypnoea, Grunt, Chest retractions
- Abdominal respirations, Onset of new rales, Gallop rhythm
- Liver span increase, Agitation or fighting the oxygen mask
- Fall in O_2 saturation.

Consider early intubation (Call for Help) Intensivist / Anesthetist

- Airway unstable/gasping, Hypoventilation or respiratory failure
- Cardiogenic shock: Respiratory distress with shock on arrival or after fluid therapy
- GCS$\leq$ 8

Each step in the management of shock is guided by repeated rapid cardiopulmonary assessment.

These are broad guidelines and treatment may be individualized for the patient at hand.

2.Treatment of underlying condition e.g. Antibiotics in septic shock

3. Correction of metabolic disturbances: Hypocalcemia, hypoglycemia, hypomagnesemia, hypokalemia and metabolic acidosis.

4. Treatment of complications: Treat associated renal, GIT and coagulation abnormalities.

COMPLICATIONS:

MULTIORGAN DYSFUNCTION SYNDROME: (MODS)[1,8,9]

MODS is the presence of altered organ function in acutely ill patients such that homeostasis cannot be maintained without intervention. It usually involves two or more organ systems.

System Involved	Disorder
1. Respiratory	ARDS, Respiratory muscle fatigue, Central apnoea
2. Renal	Prerenal failure, Renal failure
3. Haematologic	Coagulopathy (DIVC), Thrombosis
4. Gastrointenstinal tract	Stress ulcers, ileus, bacterial translocation.
5. Endocrine	Adrenal insufficiency, Primary (or) secondary to chronic steroid therapy.
6. Metabolic	Metabolic acidosis
7. Liver	Hepatocyte injury, Elevated liver enzymes

PROGNOSIS AND RISK FACTORS OF MORTALITY IN CHILDREN WITH SHOCK:

The mortality rate in shock is 20-50%[1]. Multiple organ dysfunction syndrome increases the probability of death (one organ system involved, 25%; two organ systems, 60%; 3 or more organ systems > 85%). The mortality of shock in infected patients increases as one progress from sepsis to septic shock to refractory sepsis[1].

The mortality for septic shock depends on the initial site of infection, the bacterial pathogen, the presence of MODS and the host immune response[1]. The mortality may be as high as 40-60% for patients with gram negative sepsis.[1]

Prognostic signs in meningococcal sepsis include hypotension, coma, leucopenia (<5,000 cells / µl), thrombocytopenia (<1, 00,000/µl), low fibrinogen level (<150mg/dl), absence of CSF pleocytosis with bacteria noted on Gram stain of the CSF, rapid appearance of petechiae (with in hour) and hypothermia[1].

Review of Literature

REVIEW OF LITERATURE

Daljit Singh et al[10] , conducted a prospective study at Punjab, to determine the frequency, etiology, type and outcome of shock in hospitalized children in the age group of 1 month to 15years. There were 98 cases of shock in which maximum number of patients were seen in infancy. They observed hypovolemic shock due to acute diarrhoeal disease was the common type (45.9%), followed by septic, cardiogenic and distributive shock. Compensated stage was common in hypovolemic shock (88.9%) whereas majority of patients with septic shock presented in decompensated stage (73.5%). Overall survival was 73.6%. The survival was best in hypovolemic shock (97.7%) followed by septic (53.3%) and cardiogenic (43.7%). Inotropes and ventilatory support were required in 46% and 23% patients respectively in that study population.

Daljit singh et al[11], in a study of outcome of paediatric shock in Punjab,observed that survival was not influenced by age or sex. Presence of decompensated shock, respiratory failure,combined metabolic and respiratory acidosis increased mortality.

Chang P et al [12] ,in a retrospective study of risk factors determining outcome of non traumatic patients with shock in the paediatric emergency

service, conducted at Taipei, observed 22 patients with shock, including 11 with septic shock (50%), 7 with hypovolemic shock (32%) and 4 with cardiogenic shock (18%). They found gram – negative bacterial sepsis (6/11,55.5%) dilated cardiomyopathy (2/4, 50%) and acute gastroenteritis (7/7, 100%) were the most frequent causes of septic, cardiogenic and hypovolemic shock repectively. In total, 12 patients (55%) died in that study. They observed that the mortality rate was high in septic shock (9/11, 82%) and cardiogenic shock (3/4, 75%) but low in hypovolemic shock (0/7, 0%). They observed the risk factors for poor outcome includes thrombocytopenia, prolonged prothrombin time and partial thromboplastin time, leukopenia, a higher level of c-reactive protein, and under 2 years of age.

Kutko et al[13], in a retrospective study,observed that, the overall mortality rate in 80 patients with septic shock was 13.5%. There were differences in mortality rates between patients requiring one inotropic agent(0%) and patients requiring multiple inotropic agents (42.9%) and between patients with multiple system failure (18.6%) and those without multiple organ system failure (0%). They observed, there was no difference between mortality among patients with varying degree of neutropenia. Finally they concluded, the mortality rate in pediatric septic shock is lower than has been previously reported and also

concluded that mortality from septic shock occurs most frequently in the context of multiple organ system failure.

Goh A et al [8] ,in a study, observed 84 out of 495 patients developed multiple organ dysfunction syndrome. The incidence of sepsis, severe sepsis and septic shock in these patients was 10.7%, 23.8% and 17.9% respectively. They finally concluded, presence of sepsis, severe sepsis and septic shock was associated with an increasing severity of illness, increased number of organ dysfunctions and a distinct risk of mortality among critically ill children.

Tantalean JA et al [14] ,in a prospective, observational study, observed 156 patients(56.5%) out of total 269 patients had MODS in paediatric intensive care unit. There were 71 deaths during the study period, and 65 of them (91.5%) had MODS. They observed gastro intestinal tract and liver were the less frequently involved organs in MODS. They concluded MODS in children usually occurs early, and sepsis increases mortality.

Jacobs RF [15] et al, in a retrospective analysis of 2110 admissions to the paediatric intensive care unit, identified 564 cases of septic shock (26.7% of the total admissions). Study was conducted in university of Arkansas for medical sciences, Little Rock. In this study population, inotropic support was required in 268 (47.5%) patients. Septic shock with confirmed bacterial infection occurred in

143 patients (25.2%), 59 out of 143 (41.3%) were caused by H-influenzae-b, 26 out of 143 (18.2%) were caused by Neisseria meningitidis and 16 of 143 (11.2%) were caused by Streptococcus pneumoniae. They finally concluded that septic shock occurs more frequently in children than previously appreciated.

Justification of the Study

JUSTIFICATION OF THE STUDY

Shock is a common problem in children admitted in a PICU. It accounts for more morbidity and mortality in children world wide than any other diagnosis.[2,3] Though it is a common problem, scanty data only are available in Indian literature. Knowledge about the morbidity pattern and etiology of shock in PICU will give us better understanding of the illness to plan the appropriate management,and also to improve the outcome.

To know about the risk factors in a critically ill child with shock and its association with outcome, will give us an early clue in identifying and prioritizing management strategies.

Aim of the Study

AIM OF THE STUDY

To find the following in the paediatric intensive care unit:

1. Etiology and type of shock
2. Outcome of shock
3. Risk factors for mortality of shock in children admitted in PICU.

Materials and Methods

MATERIALS AND METHODS

Study Design: Descriptive Study

Study Place: Paediatric intensive care unit

Institute of Child Health and Hospital for children, Egmore, Chennai.

Study Period: One year, July 2005 – June 2006.

Study Population:

Inclusion Criteria:

Children in the age group of one month to 12 years presenting with shock (or) who later develop shock during PICU stay.

Exclusion Criteria:

1. Children who had received inpatient treatment prior to admission in PICU.
2. Post cardiac arrest shock
3. Traumatic shock / Burns.

Sample Size: At ALPHA ERROR of 5%, assuming precision of 6, sample size was fixed at 236.

MANOEUVER:

Patients (1 month-12years) admitted for shock in PICU, during the period 1st of July 2005 to 30th June 2006, who fulfill the inclusion and exclusion criteria were included in the study. Personal details and history were taken initially. Rapid cardio pulmonary assessment and physical examination including general and systemic examination were done and entry made in the data sheet.

All sick children were initially evaluated in the emergency room of the hospital and initial stabilization of the patient including airway, breathing followed by fluid resuscitation was carried out.Children presenting with acute watery diarrhea were admitted in the PICU only if they require some intensive care in the form of ventilation, inotrope support or dialysis.All other cases of shock were admitted in PICU.

The proforma was designed to notify the type of shock identified in the emergency room, the probable risk factors to mortality, the results of investigations and the progress of the patient. Routine investigations were taken in all the patients, specific investigations that are mentioned in the proforma were taken in required cases.

The patients were managed according to the protocol adapted from text book of the paediatric intensive care[3] and as per PALS guidelines .[5]

Management details and complications were recorded. During the PICU stay periodic vital signs and other measures like urine output and oxygen saturation were recorded. IV fluid therapy, rate and duration of inotrope and other organ support like ventilatory support were documented.

CASE DEFINITION :

Hypovolemic Shock:

Children were classified as having hypovolemic shock based on the definitive history of fluid loss and signs of dehydration.

Cardiogenic Shock:

Clinically diagnosed by features of shock and cardiac involvement as evidenced by the presence of gallop, muffling of heart sounds and signs of underlying heart disease if any and increased or increasing liver span.

Septic Shock:

History compatible with infection and children having features of systemic inflammatory response syndrome (Hyper / Hypothermia, Tachycardia, Tachypnoea, Leucocytosis or Leucopenia) and hypotension.

Distributive Shock:

Patients with acute exacerbation of asthma, status epilepticus and other causes of distributive shock, without evidence of sepsis and other causes of shock.

Risk Factors in modifying the outcome in shock:

The risk factors considered were:

Age of the child:

Categorized as less than one year or more than one year.

Under nutrition:

Children with grade 3 and grade 4 malnutrition (<or= 5years) according to ICMR classification and severe undernutrition (>5years) (less than 60% of expected body weight) were included in the study. It was thought that under nutrition has a poor outcome as it had several associated risk factors such as sepsis, late presentation etc.,

Decompensated Shock:

Features of shock with hypotension.

Sepsis:

SIRS with hypotension in response to infection.

Cardiogenic Shock:

This poses a unique risk to the child, in that, the compensatory mechanisms actually worsen the child's illness. Such children present with difficulties in diagnosis and management.

Duration of Shock:

Duration of shock was calculated from patient's arrival in emergency room to correction of shock.

Duration of Illness:

Children vary in their time of presentation in the emergency room, earlier the presentation better was the outcome. It was thought whether there was any cut off time interval beyond which the out come was poor.

Leucopenia:

Leucopenia is defined as total leucocyte count less than 4000/micro litre.

Hypocalcemia:

Defined as total serum calcium less than 7mg/dl or ionized calcium level less than 4 mg/dl.

Inotrope Requirement:

The number of inotropes required was recorded.

Ventilatory Support:

This factor was considered because previous studies reveal poor outcome with this factor .[10]

MODS:

MODS is the presence of altered organ dysfunction in acutely ill patients such that hemeostasis cannot be maintained without intervention. It usually involves two or more organ systems.

STATISTICAL ANALYSIS

As the data collected were discrete, the statistical method applied were proportions of morbidity and aetiology. The outcome as against the total number of cases was evaluated.

The risk factors of mortality were then evaluated by comparing the children who died (cases) and those who survived (controls).

Data was entered in Microsoft office excel and analysed using SPSS ver 11.0 for windows .As the variables are in qualitative form we have used chi-square test in the univariate analysis to observe the association between the study variables and the outcome. To quantity the magnitude of association we have used odds ratio and its corresponding 95% confidence interval to observe the precision of the estimates.

For observing the independent association between the risk factors and outcome, we have used logistic regression (as the variable is in binary form) and arrived at the adjusted odds ratios and the corresponding 95% confidence intervals.

Observations

OBSERVATIONS

Total cases studied: 236

PROPORTIONAL MORBIDITY OF SHOCK:

Proportional morbidity of shock in children 1 month to 12 years during the 1 year period.There were totally 567 children admitted with shock in this period in the whole hospital.

$$\frac{\text{Total Number of children with shock}}{\text{Total number of hospital admissions (in patients) during the study period}} \quad X \quad 100$$

$$= \frac{567}{34854} \times 100$$

= 1.63%

1.63% of all in hospital admissions had shock at presentation.

TABLE:1

AGE AND SEX DISTRIBUTION OF CHILDREN WITH SHOCK

S.No	Age Group	Male		Female		Total	
		Nos	%	Nos	%	Nos	%
1.	1 month-12months	60	61.9%	37	38.1%	97	41.1%
2.	>1 year-5 years	44	50.6%	43	49.4%	87	36.9%
3.	>5 years-10 years	26	63.4%	15	46.6%	41	17.3%
4.	>10 years-12 years	8	72.7%	3	27.3%	11	4.7%
	Total	138	58.5%	98	41.5%	236	100%

It is evident from the above table; the incidence of shock is higher in the younger age group and progressively reduces as the age advances. Male: Female ratio was 1.4:1.

TABLE:2

CLINICAL PRESENTATION OF SHOCK

S.No	Clinical Presentation	Number of Cases*	Percentage
1.	Fever	174	73.7%
2.	Breathlessness	122	51.7%
3.	Refusal of Feeds	73	30.9%
4.	Oliguria	70	29.7%
5.	Convulsions	54	22.9%
6.	Vomiting	47	19.9%
7.	Abdominal Pain	17	7.2%
8.	Polyuria	15	6.4%
9.	Scorpion Sting	14	5.9%
10.	Diarrhoea	10	4.2%
11.	Bleeding Manifestations	8	3.4%
12.	Poisoning	6	2.5%

*Total number of clinical presentations were more than total number of cases as some clinical presentations were overlapping.

From the above table, it is evident that the predominant presenting feature in children with shock was fever (174 cases, 73.7%), followed by breathlessness (122 cases, 51.7%), refusal of feeds (73cases, 30.9%) oliguria (70cases, 29.7%) convulsions (54 cases, 22.9%) vomiting (47 cases, 19.9%) other presenting features are showed in the table. 14 patients (5.9%) presented with scorpion sting. 6 patients (2.5%) presented with history of poisoning, out of which 4 were kerosene ingestion and 2 were neem oil ingestion.

TABLE: 3

TYPE OF SHOCK IN DIFFERENT AGE GROUPS

Age Group	Hypovolemic Shock		Septic Shock		Cardiogenic Shock		Distributive Shock		Total
	Nos	%	Nos	%	Nos	%	Nos	%	Nos
1mth-12 mths	7	7.2%	64	66.0%	18	18.5%	8	8.2%	97
>1yr-5yrs	13	14.9%	34	39.1%	13	14.9%	27	31.1%	87
>5yrs-10yrs	16	39.0%	10	24.4%	5	12.2%	10	24.4%	41
>10yrs-12yrs	5	45.4%	4	36.4%	1	9.1%	1	9.1%	11
Total	41	17.4%	112	47.4%	37	15.7%	46	19.5%	236

It is evident from the above table, septic shock was the commonest type of shock (112/236, 47.4%) followed by distributive shock (46/236, 19.5%), hypovolemic shock (41/236, 17.4%) and cardiogenic shock (37/236, 15.7%), in those who get admitted in the PICU.

In 1 month to 12 months age group, septic shock was the common type of shock (64/97, 66.0%) followed by cardiogenic shock, distributive shock and hypovolemic shock.

In >1 year to 5 years age group, septic shock (34/87, 39.1%) continues to be a common type of shock followed by distributive shock (31.1%). There were equal case of both hypovolemic and cardiogenic shock in this age group.

In more than 5 years to 10 years age group, hypovolemic shock was the common one (16/41, 39.0%), followed by both distributive and septic shock followed by cardiogenic shock.

In >10years to 12 years age group hypovolemic shock was the commonest one followed by septic shock, cardiogenic and distributive shock.

TABLE:4

FINAL DIAGNOSIS (ETIOLOGY) IN CHILDREN WITH SHOCK

S.No	Final Diagnosis	Number of Cases*	Percentage
1.	Bronchopneumonia	50	21.2%
2.	Sepsis without focus	33	14.0%
3.	Seizure disorder/Status Epilepticus	30	12.7%
4.	Acute CNS Infections	26	11.0%
5.	Congenital heart disease	22	9.3%
6.	Diabetic keto acidosis	20	8.5%
7.	Dengue shock syndrome	16	6.8%
8.	Scorpion Sting	14	5.9%
9.	Asthma	11	4.7%
10.	Acute watery diarrhoea	10	4.2%
11.	Bronchiolitis	5	2.1%
12.	Kerosene Ingestion	4	1.7%
13.	Myocarditis	3	1.3%
14.	Tetanus	3	1.3%
15.	Dilated cardiomyopathy	2	0.8%
16.	Hepatic encephalopathy	2	0.8%
17.	Bleeding Disorders	2	0.8%
18.	Neem oil ingestion	2	0.8%
19.	Renal tubular acidosis	1	0.4%
20.	Extra hepatic portal obstruction/PHT	1	0.4%
21.	Lepto Spirosis	1	0.4%

***** Total may exceed total number of shock cases, as there was more than one etiology in some cases.

It is evident from the above table, Bronchopneumonia was the common cause for shock in children (21.2%), followed by sepsis without focus (14.0%), seizure disorder (30 cases, 12.7%) acute CNS infection (26 cases, 11.0%). In some cases more than one cause was found , eg: Bronchopneumonia and acute CNS infection.

TABLE: 5

FINAL DIAGNOSIS IN CHILDREN WITH HYPOVOLEMIC SHOCK

S.No	Final Diagnosis	Number of Cases	Percentage
1.	Diabetic keto acidosis	20	48.8%
2.	Dengue shock syndrome	16	39.0%
3.	Bleeding disorder	2	5.0%
4.	Acute watery diarrhea	1	2.4%
5.	Extra hepatic portal obstruction/ portal hypertension	1	2.4%
6.	Renal tubular acidosis	1	2.4%

DKA was the common cause of hypovolemic shock (48.8%), followed by DSS (39.0%).

TABLE:6

FINAL DIAGNOSIS IN CHILDREN WITH SEPTIC SHOCK

S.No	Final Diagnosis	Number of Cases	Percentage
1.	Bronchopneumonia	50	44.6%
2.	Sepsis without focus	33	29.5%
3.	Acute CNS Infection	26	23.2%
4.	Acute watery diarrhoea	9	8.0%
5.	Bronchiolitis	5	4.5%
6.	Kerosene Poisoning	3	2.7%
7.	Tetanus	3	2.7%
8.	Hepatic encephalopathy	2	1.8%
9.	Congenital heart disease	2	1.8%
10.	Leptospirosis	1	0.9%

Bronchopneumonia (50 cases, 44.6%) was the commonest etiology found in patients presented with septic shock, followed by sepsis with out focus (33 cases, 29.46%).

Conditions such as kerosene ingestion, tetanus, congenital heart diseases, hepatic encephalopathy were included as they also had features of sepsis with positive blood culture.

In our study culture proven sepsis was found in 36 out of 112 cases (32.1%). Most of them were gram negative organisms. E-coli was grown in culture in 18 cases (18/36, 50%), Klebsiella in 14 cases (14/36, 39.0%), pseudomonas in 2 cases, and (2/36, 5.5%), Staphylococcus aureus was grown in culture in 2 cases (2/36, 5.5%).

TABLE:7

FINAL DIAGNOSIS IN CHILDREN WITH CARDIOGENIC SHOCK

S.No	Final diagnosis	Number of Cases	Percentage
1	Congenital heart disease	20	54.1%
2.	Scorpion Sting	12	32.4%
3.	Myocarditis	3	8.1%
4.	Dilated cardiomyopathy	2	5.4%

Congenital heart diseases were the commonest cause in patients presented with cardiogenic shock (20/37, 54.1%) followed by scorpion sting (12/37, 32.4%).

TABLE: 8

FINAL DIAGNOSIS IN CHILDREN WITH DISTRIBUTIVE SHOCK

S.No	Final diagnosis	Number of Cases	Percentage
1	Seizure Disorder / SE	30	65.2%
2.	Asthma	11	23.9%
3.	Scorpion Sting without myacarditis	2	4.4%
4.	Neem oil poisoning	2	4.4%
5.	Kerosene poisoning	1	2.1%

Seizure disorder / status epilepticus were the commonest cause of distributive shock (30/46, 65.2%) followed by acute exacerbation of asthma (11/46, 23.9%).

TABLE: 9

FINAL DIAGNOSIS IN CHILDREN AGED

1 MONTH TO 12 MONTHS

S.No	Final Diagnosis	Number of Cases	Percentage
1.	Bronchopneumonia	26	26.8%
2.	Sepsis without focus	25	25.8%
3.	Congenital heart disease	17	17.5%
4.	Acute CNS infection	11	11.3%
5.	Seizure disorder/Status epilepticus	8	8.2%
6.	Acute watery diarrhoea	7	7.2%
7.	Bronchiolitis	5	5.2%
8.	Dengue shock syndrome	4	4.1%
9.	Kerosene Ingestion	2	2.1%
10.	Dilated cardiomyopathy	1	1.0%
11.	Myo Carditis	1	1.0%
12.	Lepto Spirosis	1	1.0%
13.	Bleeding disorder	1	1.0%
14.	Renal tubular acidosis	1	1.0%

In this age group, Bronchopneumonia (26.8%) was the common cause found in patients presented with shock followed by sepsis without focus (25.8%) followed by congenital heart disease (17.5%).

1 case with shock due to renal tubular acidosis, presented with polyuria, failure to thrive, presented as hypovolemic shock.. Blood and radiological findings were suggestive of renal tubular acidosis type1.

In 17 cases of congenital heart disease, 15 were acyanotic CHD, 2 were cyanotic CHD.

In 8 patients who presented with status epilepticus and shock, the shock was transient and responded to airway management, volume expanders and control of seizures. The type of shock in status epilepticus is neurogenic shock, which is comes under distributive shock.

In 2 patients presented with kerosene ingestion, there was no shock at admission, patient developed fever and shock during PICU stay and shock did not responded to volume expanders. Sepsis was suspected inotropes were started and klebsiella was grown in culture in these 2 cases.Hence they were included under the septic shock type.

Of 7 patients presented with diarrhoea, 6 had septic shock.

TABLE: 10

FINAL DIAGNOSIS IN CHILDREN AGED >ONE YEAR TO FIVE YEARS

S.No	Final Diagnosis	Number of Cases	Percentage
1.	Bronchopneumonia	18	20.7%
2.	Seizure disorder/Status epilepticus	12	13.8%
3.	Scorpion sting	11	12.6%
4.	Acute CNS infection	10	11.5%
5.	Asthma	10	11.5%
6.	Diabetic ketoacidosis	9	10.3%
7.	Sepsis without focus	6	6.9%
8.	Dengue shock syndrome	3	3.4%
9.	Congenital heart disease	3	3.4%
10.	Acute watery diarrhoea	3	3.4%
11.	Tetanus	3	3.4%
12.	Kerosene Ingestion	2	2.3%
13.	Neem Oil ingestion	2	2.3%
14.	Dilated cardiomyopathy	1	1.2%
15.	Bleeding disorder	1	1.2%

Bronchopneumonia continues to be a common cause in this age group also followed by seizure disorder /status epilepticus

10 patients were presented with acute exacerbation of asthma (Life threatening and near fatal asthma) and shock. The shock in asthma was transient due to airway obstruction and hypoxia (Distributive shock), which improved with effective airway management and volume expanders.

9 patients presented with the history of altered sensorium and polyuria, in which 2 were known patients of IDDM and had shock. They were treated with slow infusion (over 1 hour) of volume expanders.

2 patients presented with neem oil ingestion and status epilepticus . Seizures were refractory to anticonvulsants child was intubated and ventilated. Shock could not be correct by volume expanders and required inotrope.

TABLE:11

FINAL DIAGNOSIS IN CHILDREN AGED>5YEARS TO 10 YEARS

S.No	Final Diagnosis	Number of Cases	Percentage
1	Seizure disorder / Status epilepticus	10	24.4%
2.	DKA	8	19.5%
3.	Dengue shock syndrome	7	17.1
4.	Bronchopneumonia	6	14.6%
5.	Acute CNS infection	5	12.2%
6.	CHD	2	4.9%
7.	Myocarditis	2	4.9%
8.	Scorpion sting	2	4.9%
9.	Extra hepatic portal obstruction/Portal hypertension	1	2.4%

Seizure disorder / status epilepticus (24.4%) the most common cause of shock in this age group, followed by diabetic Keto acidosis (19.5%).

TABLE: 12

FINAL DIAGNOSIS IN CHILDREN

AGED >10 YEARS TO 12 YEARS

S.No	Final Diagnosis	Number of Cases	Percentage
1	DKA	3	27.3%
2	Dengue shock syndrome	2	18.2%
3.	Sepsis without focus	2	18.2%
4.	Hepatic encephalopathy/PHT	2	18.2%
5.	Scorpion sting	1	9.1%
6.	Asthma	1	9.1%

DKA was the com mon cause in this age group

CLINICAL PRESENTATION IN VARIOUS TYPES OF SHOCK

TABLE:13

CLINICAL PRESENTATION IN CHILDREN WITH HYPOVOLEMIC SHOCK (TOTAL CASES 41)

S.No	Clinical Presentation	Number of Cases*	Percentage
1.	Fever	34	82.9%
2.	Polyuria	15	36.6%
3.	Breathlessness	14	34.1%
4.	Abdominal Pain	13	31.7%
5.	Vomiting	10	24.4%
6.	Bleeding Manifestations	8	19.5%
7.	Oliguria	6	14.6%
8.	Diarrhoea	1	2.4%
9.	Refusal of Feeds	1	2.4%

* Total number of clinical presentations more than number of cases as some presentations were overlapping.

Fever was the common presenting problem (34 cases, 82.9%) in hypovolemic shock, followed by polyuria (15 cases, 36.6%).

TABLE: 14

CLINICAL PRESENTATION IN CHILDREN WITH SEPTIC SHOCK

(TOTAL CASES 112)

S.No	Clinical Presentation	Number of Cases*	Percentage
1.	Fever	109	97.3%
2.	Breathlessness	59	52.7%
3.	Refusal of Feeds	58	51.8%
4.	Oliguria	51	45.5%
5.	Vomiting	29	25.9%
6.	Convulsion	24	21.4%
7.	Diarrhoea	9	8.0%
8.	Poisoning	3	2.7%
9.	Abdominal Pain	2	1.8%

* Total number of clinical presentations more than number of cases as some presentations were overlapping.

The predominant presenting problem in septic shock was fever (109 cases, 97.3%) followed by breathlessness, refusal of feeds and oliguria.

TABLE: 15

CLINICAL PRESENTATION IN CHILDREN WITH CARDIOGENIC SHOCK

(TOTAL CASES 37)

S.No	Clinical Presentation	Number of Cases*	Percentage
1.	Breathlessness and Increased work of breathing	37	100%
2.	Fever	17	45.9%
3.	Oliguria	13	35.1%
4.	Scorpion Sting	12	32.4%
5.	Refusal of Feeds	6	16.2%
6.	Vomiting	4	10.8%

* Total number of clinical presentations more than number of cases as some presentations were overlapping.

The predominant presenting problem in cardiogenic shock was breathlessness. It was present in 37 out of 37 patients (100%) with cardiogenic shock, followed by fever, oliguria. 12 patients (32.4%) with cardiogenic shock presented with history of scorpion sting.

TABLE: 16

CLINICAL PRESENTATION IN CHILDREN WITH DISTRIBUTIVE SHOCK (TOTAL CASES 46)

S.No	Clinical Presentation	Number of Cases*	Percentage
1.	Convulsions	30	65.2%
2.	Fever	14	30.4%
3.	Breathlessness	12	26.1%
4.	Refusal of Feeds	8	17.4%
5.	Vomiting	4	8.6%
6.	Poisoning	3	6.5%
7.	Abdominal Pain	2	4.3%
8.	Scorpion Sting	2	4.3%

* Total number of clinical presentations more than number of cases as some presentations were overlapping.

Convulsions were the most common presenting problem in this type of shock, followed by fever (14 cases, 30.4%) breathlessness (12 cases, 26.1%).

TABLE: 17
UNDERNUTRITION IN ALL AGE GROUPS OF CHILDREN PRESENTED WITH SHOCK

Age Group	Malnutrition		Total
1month-12months	9	9.3%	97
>1year-5years	32	36.0%	87
>5years-10years	14	34.1%	41
>10years-12years	6	54.5%	11
Total	61	25.8%	236

61 out of 236 cases presented with shock were under nourished. Out of 61 patients, 32 were in the >1year to 5 years age group (32/61, 52.5%)

TABLE: 18

CATEGORY OF SHOCK IN ALL AGE GROUPS OF CHILDREN

Age Group	Compensated Shock		Decompensated Shock		Total
	Nos.	%	Nos.	%	No
1mth-12mths	54	55.7	43	44.3	97
>1yr-5yrs	65	74.7	22	25.3	87
>5yrs-10yrs	28	68.3	13	31.7	41
>10yrs-12yrs	7	63.6	4	36.4	11
Total	**154**	**65.2**	**82**	**34.8**	**236**

Compensated shock was present in 154 cases (65.2%), decompensated shock was present in 82 cases (34.8%). Decompensated shock was maximally seen in the 1month to 12 months age group (43/97, 44.3%) compare to other age group.

TABLE: 19

INOTROPE REQUIREMENT IN VARIOUS TYPES OF SHOCK

Type of Shock	Inotrope Requirement				Total
	Yes	%	No	%	
Hypovolemic Shock	14	34.1%	27	65.9%	41
Septic Shock	112	100%	0	0	112
Cardiogenic Shock	37	100%	0	0	37
Distributive Shock	6	13.0%	40	87.0%	46
Total	**169**	**71.6%**	**67**	**28.4%**	**236**

Inotropes were required in 169 cases (71.6%) for the treatment of shock. Study showed there was 100% inotrope requirement in both septic and cardiogenic shock. In Hypovolemic shock 34.1% required inotrope, in distributive shock 6 patients (13.0%) required inotropes.

Mean duration at which maximum dose of inotropes, maintained was 26:20 hours, in survived patients. In patients who died inotropes were continued till death.Mean time taken to wean the patients from inotropic support was 14:20 hours.

TABLE: 20

INOTROPE REQUIRMENT AND RESPONSE IN SHOCK

S.No.	Inotrope Requirement and Response	Number of Cases	Percentage
1.	Not Required	67	28.4%
2.	Single Inotrope, Responsive	76	32.2%
3.	Single, Not Response	30	12.7%
4.	Double, Response	10	4.2%
5.	Double, Not Response	53	22.5%
	Total	**236**	100%

76 out of 169 cases were required single inotrope and responsive (45%). 30 out of 169cases (17.8%) were not responsive to single inotrope, in this group

most of them presented in decompensated stage and started directly on adrenaline infusion. 10 out of 169 cases (5.9%) were responsive to double inotropes. 53 out of 169 cases (31.3%) required double inotropes and were not responsive to them and finally died.

TABLE: 21

DURATION OF SHOCK

S.No	Duration of Shock	Number of Cases	Percentage
1.	>6hours	103	43.6%
2.	<6hours	133	56.4%

Duration of shock was more than 6 hours in 103 cases (43.6%), less than 6 hours in 133 cases (56.4%).

TABLE: 22

REQUIREMENT OF VENTILATORY SUPPORT IN SHOCK

S.No	Ventilatory Support	Number of Cases	Percentage
1.	Yes	151	64.0%
2.	No	85	36.0%
	Total	236	100%

Ventilatory support was required in 151 cases (64%).

TABLE:23

OUTCOME OF CHILDREN PRESENTED WITH SHOCK

S.No.	Outcome	Number of Cases	Percentage
1.	Survived	151	64.0%
2.	Died	85	36.0%
	Total	236	100%

Out of 236 cases, 151 survived (64.0%), 85 died (36.0%).

TABLE: 24

MULTIPLE ORGAN DYSFUNCTION SYNDROME IN SHOCK

S.No.	MODS	Outcome				Number of Cases	
		Survived		Died			
1.	Yes	24	28.6%	60	71.4%	84	35.6%
2.	No	127	83.6	25	16.4%	152	64.4%
	Total	151	64.0%	85	36.0%	236	100%

MODS occurred in 84 cases (35.6%). Out of 84 cases, 60 died (71.4%), 24 survived (28.6%).

TABLE: 25

AGE SPECIFIC OUTCOME IN SHOCK

S.No	Age Group	Outcome				Total
		Survived		Died		
1.	1month-12months	55	56.7%	42	43.3%	97
2.	>1year-5years	62	71.3%	25	28.7%	87
3.	>5years-10years	25	61.0%	16	39.0%	41
4.	>10years-12years	9	81.8%	2	18.2%	11
	Total	**151**	**64.0%**	**85**	**36.0%**	**236**

42 out of 97 patients in 1 month to 12 months age group died (43.3%). 25 out of 87 patients in >1 year to 5 years age group died (28.7%). 16 out of 41 patients in >5years to 10 years age group died (39.0%), and 2 out of 11 patients in >10 years to 12 years age group died (18.2%). In this study mortality rate was highest in the 1 month to 12 months age group, and lowest in >10 years to 12 years age group.

TABLE: 26

OUTCOME IN VARIOUS TYPES OF SHOCK

Type of Shock	Outcome				Total
	Survived	%	Died	%	
Hypovolemic Shock	32	78.1%	9	21.9%	41
Septic Shock	65	58.0%	47	42.0%	112
Cardiogenic Shock	14	37.8%	23	62.2%	37
Distributive Shock	40	87.0%	6	13.0%	46
Total	**151**	**64.0%**	**85**	**36.0%**	**236**

Mortality was highest in patients with cardiogenic shock (23/37, 62.2%), followed by septic shock (47/112, 42.0%), hypovolemic shock (9/41,21.9%) and distributive shock (6/46, 13.0%).

RISK FACTORS FOR MORTALITY OF SHOCK

Univariate analysis was done to know the statistically significant factors that were associated with poor outcome and multivariate analysis was done to know those factors that were individually responsible for the outcome. The following findings were noted.

ASSOCIATED BETWEEN THE RISK FACTORS AND OUTCOME (DEATH) (UNIVARIATE ANALYSIS)

S.No	Variables	Outcome				P-Value	OR for death	95% CI for OR
		Died		Survived				
		Nos	%	Nos	%			
1.	**Age** <1 yr >1yr	42 43	(49.4%) (50.6%)	55 96	(36.4%) (63.6%)	0.052	1.71	(0.994, 2.923)
2.	**Undernutrition** Yes No	30 55	(35.2%) (64.8%)	31 120	(20.5%) (79.5)	0.013	2.11	(1.16, 3.82)
3.	**Decompensated Shock** Yes No	60 25	(70.6%) (29.4%)	22 129	(14.6%) (85.4%)	<0.001	14.07	(7.34, 26.94)
4.	**Sepsis** Yes No	47 38	(55.3%) (44.7%)	65 86	(43.0%) (57.0%)	0.07	1.64	(0.958, 2.80)
5.	**Cardiogenic shock** Yes No	23 62	(27.1%) (72.9%)	14 137	(09.3%) (90.7%)	<0.001	3.63	(1.75, 7.52)
6.	**Duration of shock** > or =6 Hours <6 Hours	62 23	(72.9%) (27.1%)	41 110	(27.2%) (72.8%)	<0.001	7.23	(3.98, 13.15)
7.	**Duration of illness** >12 Hours <12 Hours	44 41	(51.8%) (48.2%)	89 62	(58.9%) (41.1%)	0.286	0.75	(0.44, 1.28)
8.	**Leucopenia** Yes No	19 66	(22.4%) (77.6%	7 144	(04.6%) (95.4%)	<0.001	5.92	(2.37, 14.78)

			)					
9.	**Hypocalcemia** Yes No	33 52	(38.8%) (61.2%)	17 134	(11.3%) (88.7%)	<0.001	5.00	(2.57, 9.75)
10.	**Inotrope requirement** Yes No	81 04	(95.3%) (04.7%)	88 63	(58.3%) (41.7%)	<0.001	14.49	(5.04, 41.59)
11.	**Ventilatory support** Yes No	84 01	(98.8%) (01.2%)	67 84	(44.4%) (65.6%)	<0.001	105.31	(14.29, 776.15)
12.	**MODS** Yes No	60 25	(70.6%) (29.4%)	24 127	(15.9%) (84.1%)	<0.001	12.69	(6.70, 24.05)

From the above table it is evident that there is highly statistically significant association between the following risk factors and adverse outcome. (Mortality)

Undernutrition

Decompensated shock

Cardiogenic Shock

Leucopenia

Hypocalcemia

Inotrope requirement

Ventilatory support

MODS.

Undernutrition was present in higher proportion of children who died (30/85, 35.2%) when compared to those who had survived (31/151, 20.5%). Odds of being undernourished is 2.11, among the children who died, when compared to those who had survived (2.11 (1.16, 3.82).

Decompensated shock was present in higher proportion of children who died (60/85, 70.6%) when compared to those who had survived (22/151, 14.6%).

Odds of having decompensated shock is 14.07, among the children who died when compared to those who had survived (14.07 (7.34, 26.94).

Cardiogenic shock was present in higher proportion of children who died (23/85, 27.1%) when compared to those who had survived(14/151, 9.3%). Odds of having cardiogenic shock is 3.63, among the children who died when compared to those who had survived. (3.63 (1.75, 7.52).

Duration of shock more than 6 hours was present in higher proportion of children who died (62/85, 72.9%), when compared to those who had survived(41/151,27.2).Odds of having shock more than 6 hours is 7.23, among

the children who died, when compared to those who had survived (7.23 (3.98, 13.15).

Leucopenia was present in higher proportion of children who died (19/85, 22.4%), when compared to those who had survived (7/151, 4.6%). Odds of having leucopenia is 5.92, among the children who died, when compared to those who had survived (5.92 (2.37, 14.78).

Hypocalcemia was present in higher proportion of children who died (33/85, 38.8%) when compared to those who had survived (17/151, 11.3%).

Odds of having hypoclacemia is 5.0, among the children who died when compared to those who had survived (5.00 (2.57, 9.75).

Inotrope was required in higher proportion of children who died (81/85, 95.3%), when compared to those who had survived (88/151, 58.3%). Odds of requiring inotropes is 14.49, among the children who died when compared to those who had survived (14.49 (5.04, 41.59).

Ventilatory support was required in higher proportion of children who died (84/85, 98.8%) when compared to those who had survived (67/151, 44.4%). Odds

of requiring ventilatory support is 105.31, among the children who died when compared to those who had survived (105.31 (14.29, 776.15)

Multi organ dysfunction syndrome was present in higher proportion of children who died (60/85, 70.6%) when compared to those who had survived (24/151, 15.9%). Odds of having multi organ dysfunction syndrome is 12.69, among the children who died when compared to those who had survived (12.69 (6.70, 24.05).

The other variables i.e. age, duration of illness and sepsis were not significantly associated as the corresponding 95% confidence interval for odds ratio contained1.

MULTI VARIATE ANALYSIS

S.No.	Variables	Outcome		Adjusted Odds Ratio for Death	95% CI for OR
		Died	Survived		
1.	Undernutrition Yes No	 30 55	 31 120	3.02	(1.19,7.64)
2.	Decompensated Shock Yes No	 60 25	 22 129	2.74	(1.07, 7.06)
3.	Leucopenia Yes No	 19 66	 07 144	6.91	(1.50,31.72)

4.	Inotrope requirement Yes No	 81 04	 88 63	5.69	(1.38,23.48)
5.	Ventilatory support Yes No	 84 01	 67 84	26.55	(3.22, 218.82)
6.	MODS Yes No	 60 25	 24 127	4.25	(1.57, 11.52)

All the 12 risk factors were analysed in the logistic regression model to find the independent association of risk factors and outcome.

Among the various risk factors analysed previously,

Under nutrition {3.02 (1.19, 7.64)}

Decompensated shock {2.74, (1.07, 7.06)}

Leucopenia {6.91, (1.50, 31.72)}

Inotrope requirement {5.69, (1.38, 23.48)}

Ventilatory support {26.55 , (3.22, 218.82)} and

MODS {4.25 (1.57, 11.52)}.

Were found to be the independent risk factors for mortality.

Discussion

DISCUSSION

In present study the frequency of shock was found to be 1.63%. According to Western data, shock occurs in approximately 2% of all hospitalized children and adults in united states[1]. In a study conducted by Daljit singh et al[10] they found frequency of shock was 4.3%.

The present study showed that maximum patients were observed in infancy, as is also reported by Daljit singh et al[10].

In our study, we found that fever was the common presentation in all age group followed by refusal of feeds in infant, breathlessness in other age groups.

In our study fever was the common presentation in septic and hypovolemic shock.. Breathlessness was the common presentation in cardiogenic shock, in our study it was uniformly presenting all cases of cardiogenic shock convulsions were the most common presentation in distributive shock.

In our study, we found that septic shock was the most common type of shock (47.4%), followed by distributive shock (19.5%), hypovolemic shock (17.4%), and cardiogenic shock (15.7%), This is contrary to the previous studies, where they found hypovolemic shock due to diarrhoea was the commonest cause of shock in children. This is because in our hospital children presenting with

diarrhoea and shock, after the initial fluid resuscitation in the emergency room, will be admitted in separate diarrhoea ward, unless they have associated complications. As the present study is confined to children who present with shock to the PICU, the causes will be mostly diseases other than acute watery diarrhoea. A few cases of diarrhoea may get admitted in PICU, if they develop some complications. The incidence of septic shock is increasing world over with a 10 fold increase in the past 20 years, the reason being that more patients are surviving with the disease which were fatal previously and due to increase in invasive procedures which constitute risk factors for developing sepsis[10]. In our study culture proven sepsis were found in 36 cases (32.1%), and most of them were Gram negative organisms, which is similar to the previous studies[1,15,16,17] . The other culture negative septic shock can be explained as majority of patients had received intravenous antibiotics as out patients before being referred to our hospital.

Jacobs RF et al [15] in their study of septic shock in children found an incidence 25.2% of culture proven sepsis, of which H.Influenzae B, N.meningitidis and S.pneumoniae were the predominant organisms.

In our study we found that infections were the common cause of shock in younger age group. DKA and status eplepticus/ seizure disorder were the common causes of shock in older age groups.

In our study DKA was found to be a common cause of hypovolemic shock. This is contrary to previous studies showing acute diarrhoea as the commonest cause of hypovolemic shock. This is again probably explained by the reasons attributed above.

In our study we found that congenital heart diseases were the common cause of cardiogenic shock., (54.1%) which is comparable to 53% as reported by Daljit Singh et al[10] and also reported in text books[4.]

In our study we found that seizure disorder / status epilepticus was the common cause of distributive shock, which was not quoted by other studies.

In our study we found that undernutrition was present in 61 patients (25.8%), which is again not a factor studied by others.

In our study most of the patients were presented with compensated shock (65.2%) and decompensated shock was seen in 34.8%. This is comparable to the study done by Daljit Singh et al[10], where they observed, out of 98 patients, 39 patients were presented with decompensated shock (39.8%). Most of the decompensated shock were seen in septic shock, which is also similar to the study done by Daljit Singh et al[10]. 44.3% of decompensated shock was seen in infancy, in our study.

In all types of shock crystalloids were the initial fluid of choice, as in other studies,[18,19,20.]

In our study inotrope was required in 169 patients (71.6%), which is high when compared to study done by Daljit Singh et al[10], where inotrope was required in 46.0% of patients. This may be explained by the difference in patient population between our study (PICU cases) and other study (patients brought to emergency). Mortality was high in patients requiring inotropes (47.9%), mortality was very high in patients requiring more than one inotrope (84.1%). It is much higher in our study when compared to previous study, by Kutko et al[13] who concluded that mortality was more in patients requiring multiple inotropes (42.9%) than patients requiring single inotrope (0%).

In our study MODS was present in 84 cases (35.6%). But in previous studies, conducted by Daljit singh et al[10] they found 19 cases of MODS (19.4%).In present study mortality was more in patients with MODS (71.4%). Kutko et al [13] in his study showed mortality in patients with MODS was 18.6%. Dajit singh et al [10] in his study reported 19 out of 24 patients died had MODS.

In our study ventilatory support was required in 151 cases (64.0%) which is very high when compared to study done by Daljit Singh et al [10] (22.4%). This can be explained by most cases of septic shock in our study instead of

hypovolemic shock due to diarrhea which has very good prognosis, not requiring ventilatory support and inotropes.

In our study the over all mortality rate was 36.0% which is comparable with previous reports[1,10].

In present study mortality was very high in cardiogenic shock (62.2%) followed by septic shock (42.0%) hypovolemic shock (21.9%), distributive shock (13.0%). This is comparable with previous studies [1,10].

In present study we found, undernutrition decompensated shock, need for vantilatory support, MODS, leucopenia and inotrope requirement were the independent risk factors for mortality as in previous studies.[1,11,12,13,14,21]. In a study conducted by Daljit Singh et al [11] they found malnutrition and inotrope requirement were not associated with increased mortality.

Summary and Conclusion

SUMMARY AND CONCLUSION

- Shock is a common presentation of a critically ill child contributing about 1.63% of hospital admissions.
- The etiology of shock varies with age groups with incidence decreasing as age advances.
- Bronchopneumonia and other infections are the most common cause of shock in infants and younger children.
- Seizure disorder / status epilepticus and diabetic keto acidosis are the common causes of shock in older children.
- Septic shock is the most common type of shock in children admitted in PICU.
- Under nutrition, Decompensated shock, inotrope requirement, MODS, leucopenia and ventilatory support are independently associated with poor outcome.
- Diagnosis and management of shock in early compensated stage carries better prognosis than in decompensated shock irrespective of the age of the patient

Recommendation

RECOMMENDATION

- Early identification and intervention in a patient with shock will improve the outcome.

Annexure 1

PROFORMA

NAME: AGE: SEX: UNDERNUTRITION: Yes/No

PICU NO: D.O.A: D.O.DISCHARGE/DEATH:

HISTORY:

Fever

Vomiting

Diarrhoea

Polyuria

Oliguria

Cold extremities

Bleeding tendencies

Abdominal pain

Refusal of feeds

Breathlessness

Convulsions

Snake bite

Scorpion sting

Poisoning

H/o Predisposing conditions

Nephrotic syndrome

Congenital heart disease

Congenital adrenal hyperplasia

Diabetes

Malignancy

GENERAL EXAMINATION:

SYSTEMIC EXAMINATION:

TYPE OF SHOCK: Hypovolemic Septic Cardiogenic Distributive

DEGREE OF SHOCK (on onset): Compensated Decompensated

RAPID CARDIOPULMONARY ASSESMENT

Date/Time										
Symptoms										
Airway										
RR										
TV										
WOB										
Air entry										
Added Sounds										
Colour										
SaO_2										
HR										
Distal pulse										
Core – Peri Temperature										
CRT										
Liver Span										
BP										
GCS										
Pupils										
Eye Movements										
Tone										
Posture										
Fits										
U/O										
Others										
Intervention										

INVESTIGATION CHART

WBC RBC Hb PCV Platelets DC ESR MP Smear Biochemistr y Sugar Urea Creatinine Sodium Potassium Bicarbonate Chloride Calcium Phosphate Lactate SAP SGOT SGPT Sr. Bilirubin Total Direct Indirect Albumin Globulin Sr. Protien ABG Serial Hct							NEC EC Widal MSAT Tracheal aspirate ETT tip Urine c/s C/s from other septic focus PT APTT CRP Dengue serology Viral Studies				
							CSF Microscopy Protein Sugar Gram stain AFB				
							X-Ray number:				
							Date: Findings;				

MANAGEMENT

FLUID

Initial Bolus given ml/kg

INOTROPES

Inotrope	Initial Dose	Maximum Dose	Time taken to reach maximum dose	Maximum dose maintained for	Weaning period
Dopamine					
Dobutamine					
Adrenaline					

CATEGORY OF SHOCK: fluid responsive; single inotrope, responsive: single inotrope, not responsive; double inotrope, responsive; double inotrope, not responsive;

DURATION OF SHOCK:

Ventilatory support: Yes/No

MULTI-ORGAN DYSFUNCTION SYNDROME [MODS] **Yes/No**

DIAGNOSIS:

OUTCOME: Survived Expired

Annexure 2

BIBLIOGRAPHY

1. Frankel LF, Mathers LH, Shock. Anne Stormorken and Powell KR, Sepsis and Shock. In : Behrman RE, Kliegman RM, Jenson HB. Nelson Text Book of Pediatrics. 17th Ed. Philadelphia: WB Saunders,
   Page: 296-301,846-850.
2. Schwartz A. Shock. e Medicine specialties > pediatrics > critical care. Available on http://www.e medicine.com/ped/topic3047.htm.accessed on October 4, 2005.
3. Tobin JR, Wetzel RC. Shock and Multiorgan system failure. In: Rogers MC, Nichols DG editors. Textbook of pediatric intensive care -3rd ed. Maryland: Willaims and Wilkins: 1996, PP 589-605.
4. Mc.Connell MS, Perkin RM, Shock States. In: Zimmerman JJ, Fuhrman BP, editors. Text Book of pediatric critical care, 2nd ed. ST. Louis; Mosby; 1998, PP 293-306.
5. Recognition of Respiratory failure and shock In: Hazinski MF, editor. Text Book of pediatric Advanced Life support. Philadelphia: American Heart Association: 2005, P 23-42.
6. Perkin RM, Levin DL. Shock in the paediatric patient. J. Pediatr 1982; 101; 163-169.

7. Goldstein B, Giroir B, Randolph A. International pediatric sepsis consensus conference. Definitions for sepsis and organ dysfunction in pediatrics. Pediatr crit care Med.2005; 6:2-8.
8. Goh A, Lum L. Sepsis, severe sepsis and septic shock in pediatric multiple organ dysfunction syndrome: J paediatr child health. 1999 Oct; 35(5): 488-92.
9. Sat Sharma, Gregg Eschun: Multisysterm organ failure of sepsis, e medicine: Available on http://www.emedicine.com. Last updated; June 26:2006.
10. Daljit Singh, Atul chopra, Puneet Aulakh Pooni and Bhatia R.C. A clinical profile of shock in children in Punjab, India. Indian pediatr, volume 43: July 17, 2006. 619-623.
11. Daljit Singh, Atul Chopra, Puneet Aulakh pooni, Bhatia. R.C. Outcome of pediatric shock in Punjab. Proceedings of 7th National Congress of Pediatric critical care, Intensive care chapter of Indian Academy of Pediatrics, Pune – 2005; Page 52-53.
12. Chang P, Hsu HY, Chang MH, Lin FY, Shock in the pediatric emergency service: Five years experience; Taiwan Erh K'oihseh Hui Tsa Chih 1999:40:9-12.

13. KutKo MC, Calarco MP, Flaherty MB, Helmrich RF, Ushay HM, Pon S, et al. Mortality rates in pediatric septic shock with or without multiple organ system failure. Pediatr crit care med 2003, 4:333-337.
14. Tantalean JA, Leon RJ, Santos AA, Eduardo Sanchez. Multiple organ dysfunction in children; Lima, Peru, Pediatr crit care med. 4(2); 2003.
15. Jacobs RF, Sowell MK, Moss MM, Fiser DH, Septic shock in children; bacterial etiologies and temporal relationships. Pediatr infect Dis J, 1990 mar; 9(3); 196-200.
16. Cotran RS, Kumar V, Robbins SL. Shock in fluid and Hemodyanamic Derangements. In: Robbins Pathologic basis of Disease. Philadelphia: WB saunders, 1989. 114-119.
17. Pollack MM, Fields AI, Ruttimann UE. Sequential candiopulmonary variables of infants and children in septic shock. Crit care med 1984:12 : 554-559.
18. Vincent JL, Gerlach H. Fluid resuscitation in severe sepsis and septic shock: An evidence based review. Crit care med 2004:32:S451-S454.
19. Beale R, Hollenberg SM, Vincent JL, Parrillo JE. Vasopressor and inotrophic support in septic shock: An evidence based review. Crit Care Med 2004:22:S455-S465.
20. Weil MH. Personal Commentary on the diagnosis and treatment of circulatory shock states-Curr opin crit care 2004:10:246-249.

21. Ruokonen E, Takala J, Kari A, Alhava E. Septic shock and multiple organ failure critcare med. 1991; Sep: 19 (9): 1146-1151.