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Pitfalls in the management of shock in children…the concept story

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Abstract

The clinical signs and symptoms of shock in newborns and children are often more subtle compared to adults. Recurring, avoidable factors for optimal outcome include failure of health care workers to recognize shock at the time of presentation. Children are able to compensate a shock state for longer periods than adults resulting in a sudden, sometimes irreversible, cardiopulmonary collapse. Different forms of shock, their therapy, and frequent errors are depicted and illustrated with practical examples. Early recognition of shock in children is crucial for optimal outcome but is not always obvious. Clinical experience, gut feeling, and careful and repeated interpretation of the vital parameters are essential to recognize and effectively treat the various forms of shock.

Conclusion: The management of children with shock is challenging. Some pitfalls include, Failure to recognize nonspecific signs of compensated shock (ie, unexplained tachycardia, abnormal mental status, or poor skin perfusion) could be due to Inadequate monitoring of response to treatment. Inappropriate volume for fluid resuscitation (usually too little for children with sepsis or hypovolemic shock, but possibly too much for those with cardiogenic shock also Failure to reconsider possible causes of shock for children who are getting worse or not improving,Failure to recognize and treat obstructive shock.

Case scenario:

- Lora is lovely 2-years-old previously healthy nice girl presents with 3 days of fever and decreased activity.
- Temperature: 39.6 °C, HR: 180 b/m, BP 70/30 mmHg, RR: 30 breaths/m,
- Oxygen saturation was 90% in room air.
- Extremities: cool and clammy, Pulses: weak, CRT: 4 s.
- Appeared lethargic with poor response to noxious stimuli.
- Connected with 100% oxygen
- Peripheral line was difficult, so
- Intraosseous access was inserted, blood and urine cultures were drawn
- 60 mL/kg of normal saline was rapidly infused. However, her vital signs and exam remain relatively unchanged.
- Started on epinephrine at 0.1 mcg/kg/min,

Is shock will pass ?Can we help more?
Discussion:

Shock: is a condition characterized by a significant reduction in tissue perfusion, resulting in decreased tissue oxygen delivery.

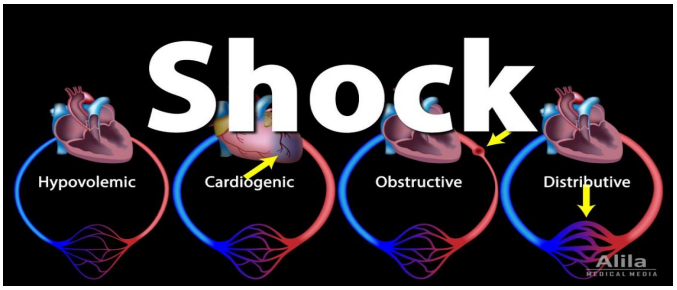
Compensated shock: The body compensate for diminished perfusion and SBP is maintained within the normal range by tachycardia and peripheral vasoconstriction (cool skin and decreased peripheral pulses).

Hypotensive shock: Compensatory mechanisms are overwhelmed. Heart rate is markedly elevated and hypotension develops.

Irreversible shock: Bradycardia and blood pressure becomes very low, irreversible organ damage and death.

Classification of Shock:

- Hypovolemic shock
- Distributive shock
- Septic shock
- Anaphylaxis
- Neurogenic shock
- Cardiogenic shock
- Obstructive shock



Common Features: (Early)

- Tachycardia
- Compromised organ perfusion
- Skin: cool, clammy, pale, or mottled

- Brain,: drowsy, lethargy .
- Kidneys: Oliguria .
- Lactic acidosis

Late: hypotension

Rapid Assessment:
Pediatric Assessment Triangle (PAT)

Appearance: (Poor tone, unfocused gaze, weak cry, decreased responsiveness to caretakers or painful procedures) may be indicators of decreased cerebral perfusion.

Breathing:Depressed respiration due to depressed mental status .

Respiratory distress: Obstructive shock (Tension pneumothorax, Cardiac tamponade, and Massive pulmonary embolism)

Cardiogenic shock: Ductal-dependent congenital heart disease

Circulation:

- Poor perfusion
- Skin temperature, mottled or cool .
- Capillary refill > 2 seconds suggests shock.
- Flash capillary refill (<1 second) may be present.
- Heart rate: Tachycardia
- Decreased intensity of distal pulses in comparison to central pulses
- Bounding pulses may be present.

Physical examination:

Vital signs: Respiratory rate, Heart rate, Temperature, Blood pressure

- Chest
- Stridor, wheezing, or abnormal breath sounds:anaphylaxis.
- crackles may have a pneumonia (septic shock) or heart failure (cardiogenic shock)
- asymmetric breath sounds: tension pneumothorax

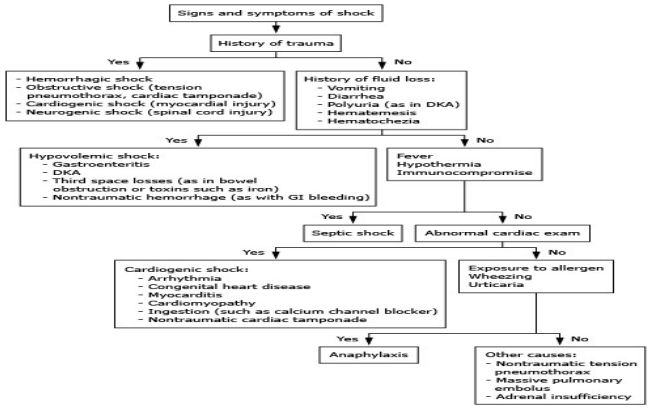
CVS:

- Distended neck veins in heart failure, or cardiac tamponade or tension pneumo- or hemothorax.
- Murmurs or a gallop rhythm: heart failure and cardiogenic shock.
- Muffled heart tones: cardiac tamponade.
- Pulse differential: coarctation of the aorta

Abdomen:

- Hepatomegaly: heart failure, cardiogenic shock.
- Abnormal skin findings:
- Urticaria or facial edema suggests anaphylaxis
- Purpura can be seen with septic shock.
- Bruises and/or abrasions may be noted with trauma.

Approach to the classification of undifferentiated shock in children:



Sepsis definitions:
Sepsis: SIRS in the presence of suspected or proven infection.
Systemic inflammatory response syndrome (SIRS) :The presence of at least 2 of the following 4 criteria, one of which must be abnormal temperature or leucocyte count:

- Core temperature of >38.5°C or <36°C.
- Leucocyte count elevated or depressed for age
- Tachycardia, or bradycardia
- Mean respiratory rate increased or decreased fro normal

Septic shock: Sepsis and cardiovascular organ dysfunction
Septic shock: initial resuscitation (first hour):

- In the first hour of resuscitation, the goals are to maintain: Airway, breathing and Circulation
- Obtain vascular access (IV or intraosseous [IO]) within 5 minutes
- Start appropriate fluid resuscitation within 30 minutes
- Begin broad-spectrum antibiotics within 60 minutes
- For patients with fluid-refractory shock, initiate peripheral or central inotropic infusion within 60 minutes

Airway and breathing:

- 100 percent oxygen, titrated to avoid SpO2 >97 percent.
- Rapid sequence intubation (RSI) if needed to protect the airway

Common used inotropes:

- 1- Epinephrine (adrenaline): (0.05 to 0.1 mcg/kg/minute, up to 1.5 mcg/kg/minute)
- The most common used inotrope, used in septic shock, anaphylactic shock, asystolic arrest.
- S/E: Constriction of renal and splanchnic vesssels, Tachyarrhythmias, Hyperglycaemia

2- Norepinephrine (noradrenaline):(0.01 - 0.1 mcg/kg/minute) up to 1 – 2 mcg/kg/min:

- Used alone in septic shock or with epinephrine in cases of resistant shock requiring high dose epinephrine
- S/E: Bradycardia, reducing tissue perfusion

3- Dopamine: 3–20mcg/kg/min:

- Used n septic shock if epinephrine and epinephrine not available
- S/E: tachyarrhythmias, and pulmonary vasoconstriction
- It can given prepherally in small dose if central line not available

Less commonly used inotropes :
4-Dobutamine: 5–20mcg/kg/min

- Used in cardiogenic shock
- S/E: Tachyarrhythmia, hypotension due to peripheral vasodilatation

5-Milrinone: 0.25–1mcg/kg/min

- Used in cardiogenic shock or low cardiac output state following cardiopulmonary bypass
- S/E: Arrhythmias, Hypotension, thrombocytopenia.

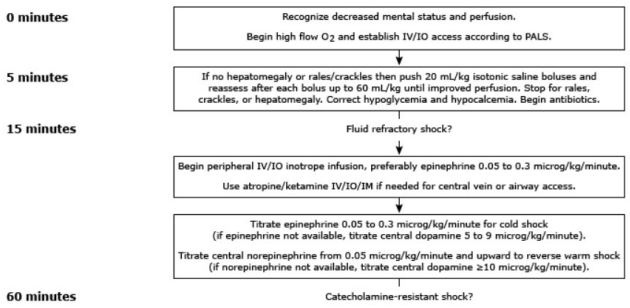
6-Vasopressin: 0.02–0.09U/kg/h

- Used in in children with septic shock who require high-dose catecholamines
- Side effects: splanchnic and peripheral ischaemia due to severe vasoconstriction.

laboratory studies for children with sepsis and septic shock:

1. Rapid blood glucose
2. Arterial or venous blood gas
3. Complete blood count with differential
4. Blood lactate
5. Blood urea nitrogen and serum creatinine
6. serum electrolytes
7. LFT
8. PT, INR and APTT
9. Fibrinogen and D-dimer
10. Blood culture urine culture csf culture
11. Other cultures as indicated by clinical findings
12. Inflammatory biomarkers (eg, C-reactive protein, procalcitonin)

Goal-targeted therapy for septic shock:



Therapeutic endpoints of septic shock:

- Quality of central and peripheral pulses (strong, distal pulses equal to central pulses)
- Skin perfusion (warm, with capillary refill <2 seconds)
- Mental status (normal mental status)
- Urine output (≥1 mL/kg/hour)
- Blood pressure (systolic pressure at least fifth percentile for age): 60 mmHg <1 month of age, 70 mmHg + [2 x age in years] in children 1 month to 10 years of age, 90 mmHg in children 10 years of age or older)
- Normal serum lactate (eg, <2 mmol/L)

Management of hypovolemic shock:
Goal: Restore circulating volume and tissue perfusion , correct the cause

- Assess airway, Administer oxygen and Establish IV access
- Fluid bolus of 20ml/kg isotonic fluid given over 5-10 minutes, Continue fluid boluses until perfusion improves or hepatomegaly develops

- In case of shock refractory to fluids, should be evaluated for ongoing blood loss or other causes of shock.
- Correct hypoglycemia and electrolytes disturbance if present
- Vasoactive medications have no place in the treatment of isolated hypovolemic shock

Management of cardiogenic shock:

- Assess airway , administer oxygen/mechanical ventilation, IV access
- A smaller isotonic crystalloid fluid bolus of 5 to 10 mL/kg, over 10 to 20 minutes
- Treatment with dobutamine or phosphodiesterase enzyme inhibitors can improve myocardial contractility and reduce systemic vascular resistance (afterload)
- Cardiac arrhythmias (eg, supraventricular or ventricular tachycardia) should be addressed prior to fluid resuscitation

Management of anaphylactic shock:

- The first and most important therapy in anaphylaxis is epinephrine. There are NO absolute contraindications to epinephrine in the setting of anaphylaxis.
- Airway: Immediate intubation if evidence of impending airway obstruction from angioedema. Intubation can be difficult and should be performed by the most experienced clinician available or by anesthesia doctor, give 100% oxygen
- IM epinephrine (1 mg/mL preparation = 1:1000 solution): Epinephrine 0.01 mL/kg should be injected intramuscularly in the mid-outer thigh. injection can be repeated in 5 to 15 minutes (or more frequently). If no response after three injections prepare IV epinephrine for infusion.
- Place patient in recumbent position, if tolerated, and elevate lower extremities.
- Normal saline rapid bolus: 20 mL/kg.
- Albuterol: For bronchospasm resistant to IM epinephrine, give albuterol 0.15 mg/kg (minimum dose: 2.5 mg) in 3 mL saline inhaled via nebulizer. Repeat, as needed.
- H1 antihistamine: Consider giving diphenhydramine 1 mg/kg (max 40 mg) IV.
- Glucocorticoid: Consider giving methylprednisolone 1 mg/kg (max 125 mg) IV.

Management of neurogenic shock:

- Intravenous fluids, and pharmacologic vasopressors as needed.
- Bradycardia caused by cervical spinal cord or high thoracic spinal cord disruption may require external pacing or administration of atropine
- Correct hypothermia,
- Observe and prevent DVT (due to peripheral pooling of blood)

Management of obstructive shock:

- Assess airway , administer oxygen/mechanical ventilation, IV access
- Causes of obstructive shock (eg, tension pneumothorax, cardiac tamponade, hemothorax, pulmonary embolism, or ductal-dependent congenital heart defects) require specific interventions to relieve the obstruction to blood flow.

Conclusion:

- The management of children with shock is challenging. Some pitfalls include:
- If peripheral line is difficult , don't waste time in multiple trials, don't try for central line insertion, just insert intraosseous access.
- Failure to recognize nonspecific signs of compensated shock (ie, unexplained tachycardia, abnormal mental status, or poor skin perfusion)
- Inadequate monitoring of response to treatment
- Inappropriate volume for fluid resuscitation (usually too little for children with sepsis or hypovolemic shock, but possibly too much for those with cardiogenic shock)
- Failure to reconsider possible causes of shock for children who are getting worse or not improving
- Failure to recognize and treat obstructive shock

Biography:

Dr. Said is a Pediatrician and Neonatologist whose experience in the field spans 15 years, backed by a higher education degree from royal college of pediatrics'and child health in UK,in addition to master degree from Ain Shams university in Egypt one of the oldest and top ranking universities in the MENA region. He is pioneering an open and contextual evaluation model based on constructive responses, which has led in the creation of new methods to improve pediatric healthcare, neonatology and pediatric nutrition. Dr. said has established

this model following his years of experiences in medical practice, research and evaluation, and teaching and administration in hospitals and medical universities in the reigion, including Egypt, kuwait and the UAE.

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