Shock in Pediatric Patients

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Objectives

- Describe the epidemiology of shock in pediatric patients
- Define shock and describe the types of shock
- Discuss treatment of shock in the prehospital setting
- Case presentations and discussion

Epidemiology

- Shock is seen in many settings
  - Traumatically injured patient
  - Infection
  - Dehydration
  - Heart failure

Take Home Point

- **Shock** is the most *reversible* cause of death in children

Leading Causes of Mortality in Children

Infants

	# of deaths
Congenital anomalies	6,554
Prematurity-related	3,933
SIDS	3,397
Severe sepsis	2,135
Resp distress syndrome	1,454
Maternal pregnancy complications	1,309
Accidents	787

Age 1-14yrs

	# of deaths
Accidents	5,824
Severe sepsis	1,570
Cancer	1,514
Congenital anomalies	1,144
Homicide	1,024
Diseases of the heart	545
HIV	399

Watson et al. Am J Respir Crit Care Med 2003;167:695-701

Sepsis causes more deaths in children than CANCER!!

Epidemiology

- Shock leads to thousands of children being admitted to intensive care settings per year
- Shock can lead to significant morbidity and death in many cases

Epidemiology

- Shock costs U.S. hospitals more than $1.9 billion annually

Epidemiology

- Death rates from shock in children are decreasing in the United States
  - Early recognition
  - Aggressive prehospital management

How we used to transport patients !!

How we transport now !!

Transport of Septic Shock

- Nine-year study of pediatric patients in septic shock
- 91 children
- 29% died, 54% within 48 hours
- 73% still in shock when transport team arrived at referring facility
- Only 25% of patients had received appropriate therapy as recommended by PALS

Han et al. Pediatrics 2003;112: 793-799.

Fluid, Fluid, Fluid !!!

Appropriate resuscitation at the initial presentation improved survival!!

Role of EMS in Pediatric Shock

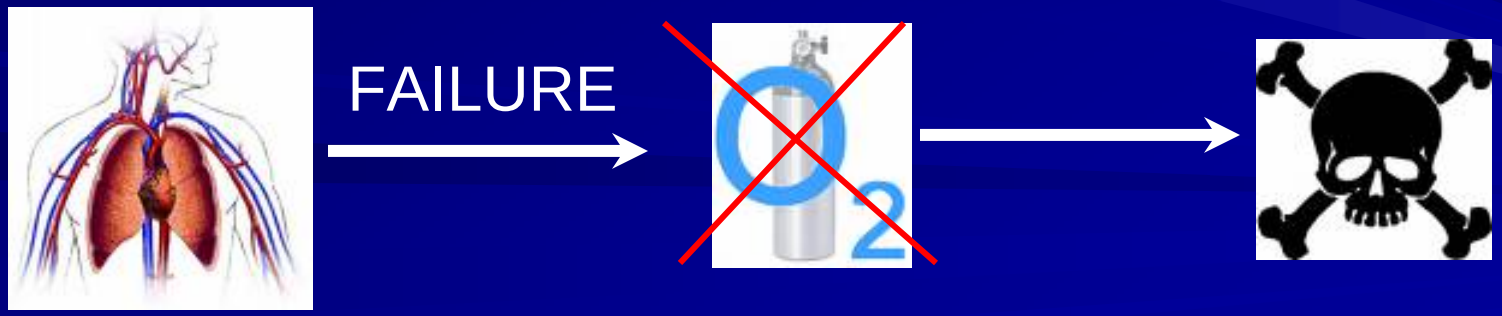
- EMS personnel are **ESSENTIAL** in the management of children with shock!
  - First on the scene
  - Decisions and management affect immediate and long-term outcomes

Decision-Making: Discomfort Zone

- The obvious is easy…
  - Cardiac arrest→ CPR
- Approach to trauma in children is similar to adults and protocolized nationally
- Until recently, no widely accepted guidelines for treatment of shock in children

Back to Basics: Definition of Shock

- An acute syndrome that occurs in the state of cardiovascular dysfunction which leads to inadequate oxygen delivery to meet the metabolic demands of the body's organs. In other words…



Clinical Presentation

- History
  - Traumatic injury
  - Bleeding
  - Vomiting and diarrhea
  - Infection/ Fever
  - Heart disease
  - Inadequate immune system

Stages of Shock

1. Compensated
2. Uncompensated
3. Irreversible

Vital Signs: Early Shock

- Tachycardia
- Mild tachypnea
- Orthostatic hypotension

WARNING!!!

- Blood pressure may be normal in early, compensated shock
- Low blood pressure does not occur until LATE shock
- Tachycardia is a non-specific sign of distress

Exam Findings: Early Shock

- Dry mucous membranes
- Skin warm or cool
- Palpable central pulses
- Slightly delayed capillary refill (3 seconds)

Take Home Point

- **Blood Pressure** has little to do with early shock recognition!

KEYS to Early Shock Recognition

- **ALTERED MENTAL STATUS**
  - Irritable, inconsolable
  - Does not interact with parent
  - Stares into space
  - Poor response to pain

- **ABNORMAL PERFUSION**
  - Decreased or bounding peripheral pulses
  - Poor capillary refill
  - Decreased urine output

Take-Home Point

- It is NOT OK to sit on a patient who has compensated shock!

Vital Signs: Late Shock

- Tachycardia
- Tachypnea
- **Hypotension**

LATE SHOCK = UNCOMPENSATED SHOCK

↓

UNABLE TO MAINTAIN PERFUSION

What is Normal Heart Rate?

Table 7. Heart rate (HR) changes (beats/min) by percent increase

Age	Basal HR	20% Increase	50% Increase
Newborn	145	174	218
6 months	120	144	180
1 year	115	138	173
5 years	95	114	143
10 years	75	90	113
Adult	70	84	105

What is a Normal Blood Pressure?

An easy rule of thumb:

Minimal acceptable SBP= 70+2(age)

Exam Findings: Late Shock

- Agitated, confused, decreased level of consciousness
- Poor tone
- Tacky mucous membranes
- Cool, mottled extremities
- Decreased pulses
- Delayed capillary refill, >4 seconds

Late Shock is a Pre-arrest State!!

A pediatric patient in LATE SHOCK may decompensate quickly!!

Irreversible Shock

- Complete failure of compensatory mechanisms
- Death even in the presence of resuscitation

Responses to Shock

- Progressive vasoconstriction
- Increased blood flow to major organs
- Increased cardiac output
- Increased respiratory rate and volume
- Decreased urine output

Types of Shock

- *Hypovolemic shock*
- *Distributive shock*
- *Cardiogenic shock*
- *Obstructive shock*

Hypovolemic Shock

- Most common cause of shock in children
- "Not enough fluid to fill the tank"
  - Vomiting and diarrhea
  - Blood losses: trauma
  - Water losses: heat stroke, burns

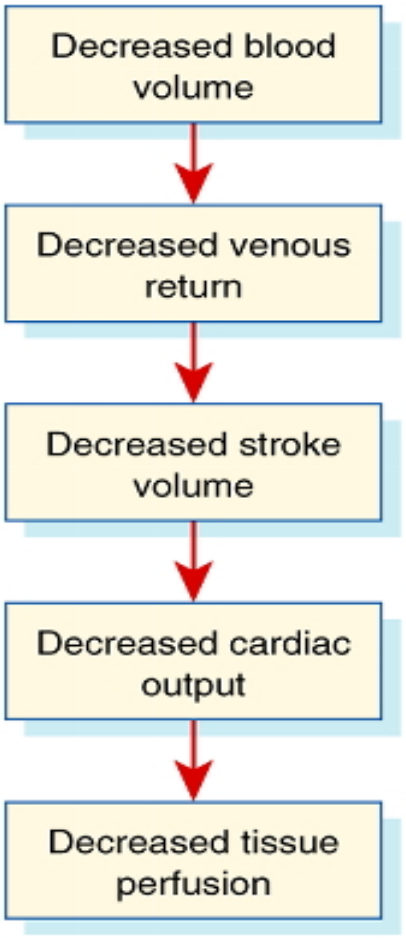
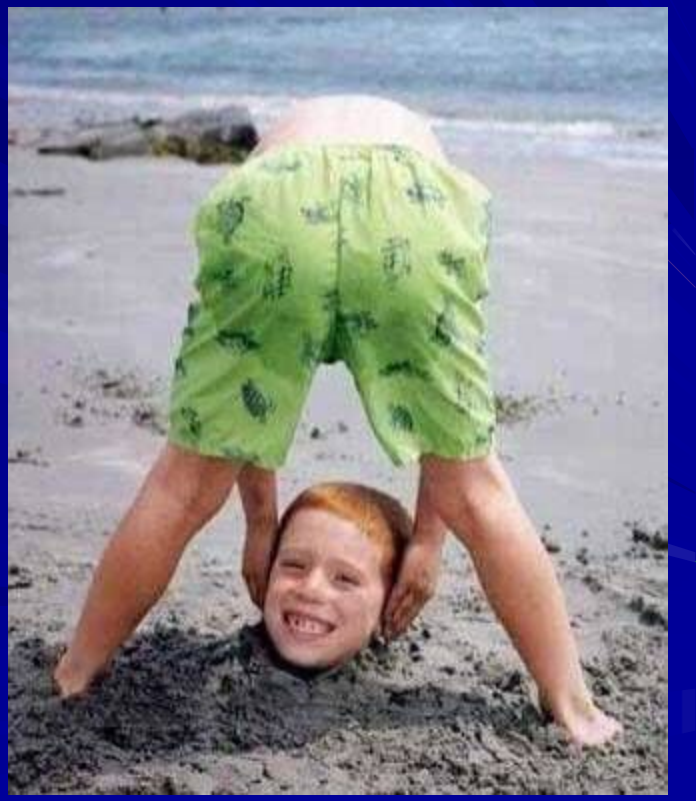


Figure 15-3 Pathophysiologic sequence of events in hypovolemic shock.

Distributive Shock

- Due to vasodilation and pooling of blood
- "Tank failure"
  - Anaphylaxis
  - Sepsis
  - Drug ingestion
  - Spinal cord injury
    - (Neurogenic)



Cardiogenic Shock

- "Pump failure"
  - Congenital heart disease
  - Abnormal heart rhythm
  - Heart infection: myocarditis
  - Drug ingestion

Clinical Features of Cardiogenic Shock

- Low blood pressure
- Cold, white or cyanotic periphery
- Sweatiness
- Tachycardia
- Low volume thready pulse
  - There may be additional signs
    - third or fourth heart sounds or a "gallop"

Cardiogenic Shock

- Not very common in children
- Rarely diagnosed in the prehospital setting, unless they have a history of congenital heart disease
- Fluid administration should be more cautious
- 10 cc/kg boluses then reassess

Obstructive Shock

- Blood flow to/from the heart is obstructed
  - Cardiac Tamponade
  - Tension Pneumothorax
- May occur following penetrating trauma to the chest.
- Fortunately, rare in children

How do I tell the difference?

- Take a good history
- Clues to congenital heart disease
  - Baseline status (are sats usually in 80's??)
  - Cyanosis
  - Cardiac meds
  - Surgical history
  - Sweating during feeds

Initial Assessment

- Initial assessment may detect shock, but the cause may be uncertain
- In most cases it does not matter, as the early treatment is the same
- When in doubt, treat as hypovolemic shock

Shock Management: Where to Start

#1

Recognize that a patient is in shock.

Know your ABC's: Airway

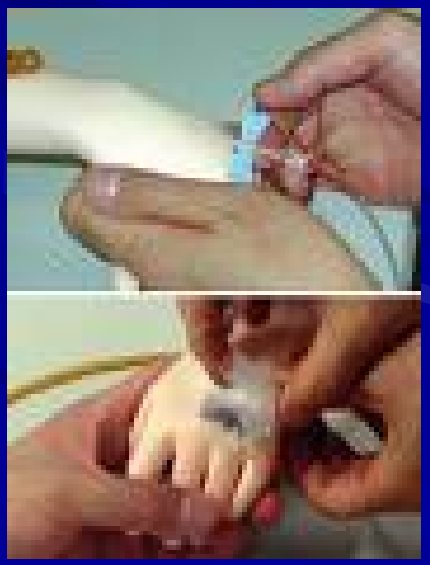
- Oxygen delivery to tissues is a primary goal in children with shock
  - 100% O2 for ALL shock
  - Chin-lift, jaw thrust
  - Bag-valve-mask if needed

Breathing: Indications for Advanced Airway Management

- Unable to maintain airway
  - Includes inability to handle secretions
- Able to maintain airway but BVM ventilation is needed
- Sats <95% or cyanotic on non-rebreather mask
- Irregular respirations or periods of apnea
- No cough or gag reflexes
- Severe retractions or use of accessory muscles

Circulation

- Fluid administration is key in shock management!
- Most common error is TOO LITTLE

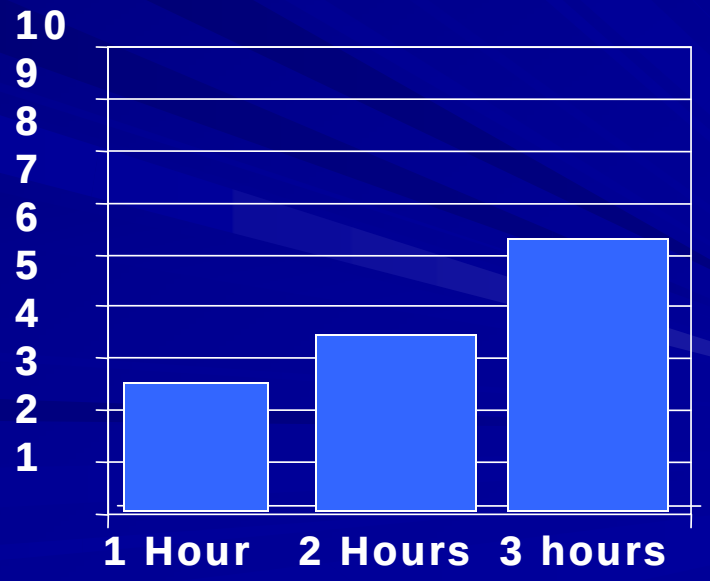


Take Home Point

- The majority of shock is fluid responsive!

Survival of Septic Patients

Every hour without appropriate resuscitation and restoration of capillary refill < 2 s and normal blood pressure increases mortality risk by **40%!**

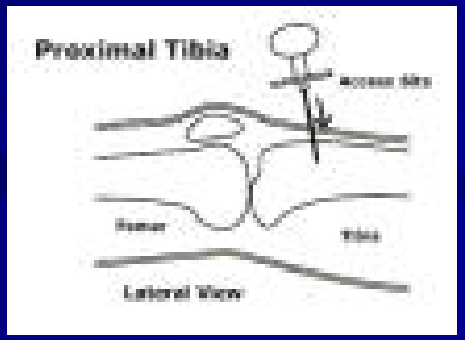


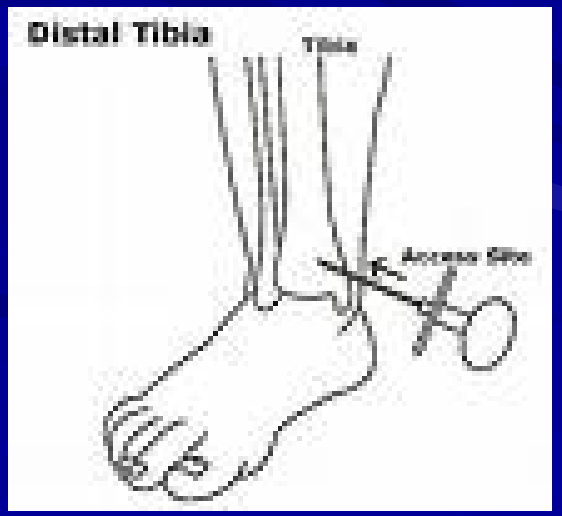
Vascular Access

- Large-bore IV catheter in peripheral vein is ideal
  - Peripheral extremities may be cool and poorly perfused
- Consider an intraosseous needle early

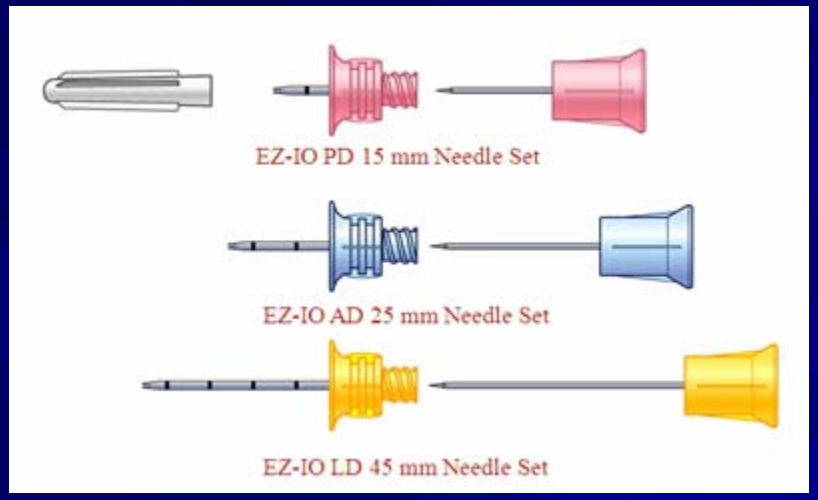
Intraosseous Access

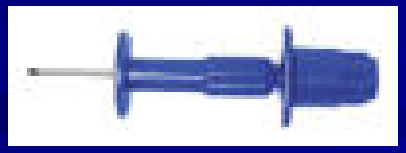
- Access marrow space
- Medial proximal tibia, 1-2 inches below the tibial tuberosity
- Children >5 years, 1-2 inches above the medial malleolus





Intraosseous Access





Fluid Administration

- What fluids?
  - 0.9% Normal saline or Ringer's Lactate
- How much?
  - 20mL/kg to start
- How fast?
  - As rapidly as possible

How Much is Too Much?

- Significantly greater survival when > 40 cc/kg given in first hour of presentation
- Pulmonary edema not associated with fluid volume or ↓ survival

Specific Situations

- In addition to aggressive fluid resuscitation, in some types of shock, specific therapies may be necessary:
- Some examples of these include:
  - Anaphylaxis: Epinephrine, ?Albuterol
  - Drug ingestions: Epi, Calcium
  - Dysrhythmias: Adenosine, Cardioversion
  - Cardiogenic: Earlier use of vasopressors

Glucose Check

- Hypoglycemia = glucose < 60

- Treatment
  - D25 2-4 ml/kg
  - D10 5-10 ml/kg

Parameters of Improvement

- Capillary refill brisk
  - Goal <2s
- Warm extremities
- Improving mental status
  - More alert and interactive

Parameters of Improvement

- Normal pulses with no differential between peripheral and central pulses
- Increasing blood pressure
- Decreasing heart rate

Take Home Point

- Reassess, reassess, reassess!!

Further Management in Hospital

- Antibiotics
- Vasoactive medicines
  - Epinephrine
  - Dopamine
- Inotropes
- Hydrocortisone
- Hemorrhage control

Case #1

- 4 mo old male, previously well
- Parents state he has had fever, vomiting and diarrhea for the past two days
- Today, extremely fussy and refusing feeds
- One wet diaper over the past 12 hours

Case #1: Physical Exam

- Toxic-appearing infant, irritable, does not console
- T-103.1 HR-206 RR-66 BP-129/109
- Sat probe is not picking up well
- Tacky mucous membranes
- Sunken fontanel
- Palpable femoral pulse, thready peripheral pulses
- Extremities cool and mottled

Case #1

- What history is concerning?
- What exam findings are concerning?
- What stage of shock is this infant in?
- What type of shock?
- How do you start management?

Case #1

- You place the baby on oxygen
- You are able to insert a peripheral IV
  - What fluids and how much?
  - What if you can’t get an IV?

Reassessment

- You estimate the baby is 5 kg and give NS 100ml rapidly
- Infant still fussy and mottled
- You give a second NS bolus of 100mL
- On reassessment, somewhat fussy, alert

  HR-180 RR-30 BP-130/100 O2sat 100% on 100%O2

  Femoral pulses 2+, cap refill 2s

Case #2

- 5yo male, history of sickle cell disease
- Flu-like symptoms for 5 days
- Now with fever to 102, rapid respiratory rate
- Parents called 911 because pt was difficult to arouse

Case #2: Physical Exam

- Lethargic and difficult to arouse, moderate respiratory distress
- T-102.5 HR-162 RR-60 BP-107/52
  O2sat-85% on room air
- Tachypneic, retracting
- Tachycardic, soft heart murmur
- Cap refill 3-4s, thready peripheral pulses

Case #2

- What history is concerning?
- What exam findings are concerning?
- What stage of shock is this child in?
- What type of shock?
- How do you start management?

Case #2

- You place the child on oxygen
- You place a peripheral IV and push NS 20ml/kg rapidly
- Cap refill is still >3s and pt still unarousable to deep sternal rub

- What are your next steps?

Putting It All Together

- Shock is a major cause of morbidity and mortality in pediatric patients
- Early and aggressive management leads to improved outcomes
  - Recognition of shock is key!
- EMS personnel are essential to early management of patients in shock

Take Home Points

- Shock is the most reversible cause of death in children
- BP has little to do with early shock recognition
- It is NOT OK to sit on a patient who has compensated shock

Take Home Points

- Late shock is a pre-arrest state
- The majority of shock is fluid-responsive
- Reassess, reassess, reassess

Questions???