

SHOCK: IS IT SEPSIS OR TRAUMA?

Amanda Hassinger, MD, MS
Clinical Associate Professor of Pediatrics

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

You arrive on the scene: "My child is not acting right"



2

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

In extremis

- "At the point of death"
- "At the farthest reaches"
- Impending circulatory collapse
- Peri-arrest

CLINICAL MANIFESTATIONS of "PERI-ARREST"	
Impending Neurologic failure	Unresponsive, obtunded
Impending Cardiovascular failure	Dwindling perfusion
Impending Respiratory failure	Agonal breathing

**Multi-organ failure
SHOCK**

3

What is SHOCK?

Hypotension

What it would feel like if the Bills EVER won a Super Bowl

Poor tissue perfusion

Failure to utilize oxygen even if delivered at the cellular level

Both C and D

Start the presentation to see how content, the screen above reflects, share the entire screen, Get help if you're having trouble

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

Shock

- ATP production failure
Typically from a lack of oxygen, cells suffocating
- Can occur at any level of the process/supply chain

The diagram illustrates the flow of oxygen from the heart to the mitochondria. It starts with the heart pumping oxygen-rich blood to the body. Blood vessels perfuse the tissues, and oxygen diffuses into the tissues across the capillaries. The cells uptake the oxygen from the RBCs, and the mitochondria use oxygen in aerobic metabolism to produce ATP.

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

Pathways to shock

Delivery Problem
(Blood not pumping)

Distribution Problem
(Not reaching vital organs)

Extraction Problem
(Blood with O₂ there, not being used)

6

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

Developments at the scene

- Child is no longer responsive
- Irregular, infrequent breaths
- Pulses now thready

COMPENSATED SHOCK

UNCOMPENSATED SHOCK

7

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

How do we *compensate* in shock?

- Anaerobic metabolism
- ↑ O₂ delivery
 1. ↑ CO (CO = HR x SV) to ↑ O₂ delivery
 2. ↑ respiratory rate to correct acidosis = improved SV and cell function
 3. ↑ tissue perfusion by ↑ systemic vascular resistance
- ↓ O₂ demand
 1. Shunt blood away from unnecessary organs
 2. ↓ organ function not needed (metabolism, muscle movements, body temp)

Tachypnea, tachycardia, hypertension

8

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

Compensated pediatric shock

Presentation
"Not acting right", irritable, inconsolable, agitated
Tachycardia
Tachypnea, grunting
Flushed, flash capillary refill, bounding pulses
Mottled, delayed capillary refill, cool hands/feet
Fewer / "drier" wet diapers
Gray, ashen skin, "Does not look right"

9

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Back to the scene: what **type** of shock is your patient in?

Who cares? When a child is in extremis, emergency management is the same no matter the cause, right?

- A, B, Cs
 - Secure the airway
 - Stabilize breathing
 - Improve/restore circulation

This is where the cause of shock matters!

10

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Resuscitation in SHOCK means fluids, fluids and more fluids!

A True B Not always

11

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Restoring tissue perfusion in *different* types of shock

	Delivery Problem	Distribution Problem	Extraction Problem
I/F bolus will correct	Hypovolemic shock Obstruction (PE or PFD)	Anaphylactic shock Septic Shock	CO poisoning Methemoglobinemia
I/FB worsen	Severe anemia Cardiogenic shock	Neurogenic shock	CN poisoning

I/FB may help, transient

I/FB does nothing

12

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

The key to resuscitation in SHOCK is determining cardiac function

- $CO = SV \cdot HR$
 ↑ ventricular end-diastolic volume (increasing preload) with IVFB = ↑ SV
 ↑ SV = ↑ CO
- There is a limit

**If you push fluids and the HR goes up...
STOP!**

13

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

When arriving at the scene how can you tell?

- Brief history of preceding symptoms
- Any previous medical problems
- Physical exam findings
- Home setting/family behaviors

**Sepsis and Trauma come from very different mechanisms...
Go Back to the Beginning!**

14

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Mechanisms

<p>TRAUMA</p> <p>Starts with an event or recurrent events</p> <p>Blunt force vs high speed vs penetrating</p> <p>Broken bones, abrasions</p> <p>May be witnessed or unwitnessed</p> <p>Can present within hours or take days*</p> <p><small>*if NAT in a non-verbal age-group</small></p>	<p>SEPSIS</p>	
--	----------------------	----------

15

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

“SEPSIS”

16

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

The evolution of “sepsis”

1992: Sepsis = SIRS + Infection

2002: Surviving Sepsis Campaign

2005: Pediatric Definitions

2016: Sepsis-3 qSOFA

Life-threatening organ failure due to *dysregulated host response*

17

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Pathology of sepsis

1. Vasodilation and Endothelial Activation

2. Leukocyte Recruitment and Activation

3. Coagulation and NET Formation

Immune defenses

- Nitric oxide (NO)
- ROS, NO, kinins, arachidonic acid
- TNF- α , IL-1 β , NO

Local reaction goes to entire body

©2012 by American Physiological Society
 Seeley, Am J Physiol Lung Cell Mol Physiol, 2012

18

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Septic shock: what kind of shock is it?

Level of Failure	Description
✓ Distribution	Blood flow/oxygen going to the wrong places because of endothelial dysfunction (low or high SVR = wrong organs and tissues getting perfused)
✓ Delivery	Cardiogenic: Inadequate cardiac output because of low SV Hypovolemic: Not enough blood to perfuse organs
✓ Extraction	Mitochondrial dysfunction in using the oxygen it has available

19

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

*Trauma: what kind of shock is it?

Level of Failure	Description
Distribution	Blood flow/oxygen going to the wrong places because of endothelial dysfunction (low or high SVR = wrong organs and tissues getting perfused)
✓ Delivery	Cardiogenic: Inadequate cardiac output because of low SV Hypovolemic: Not enough blood to perfuse organs
Extraction	Mitochondrial dysfunction in using the oxygen it has available

*Penetrating trauma = blood loss

20

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

**Trauma: what kind of shock is it?

Level of Failure	Description
✓ Distribution	Blood flow/oxygen going to the wrong places because of endothelial dysfunction (low or high SVR = wrong organs and tissues getting perfused)
✓ Delivery	Cardiogenic: Inadequate cardiac output because of low SV Hypovolemic: Not enough blood to perfuse organs
✓ Extraction	Mitochondrial dysfunction in using the oxygen it has available

**Blunt force trauma = internal bleeding, solid organ damage

21

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Recognition Pearls: sepsis vs trauma

- **Fever** prior to presentation could be suggestive of infection
 *BUT can happen in TBI, abdominal injury
- **Broken bones or abrasions** highly suggestive of trauma
 Bruising is non-specific, can occur in septic shock too

Otherwise, there is a LOT of overlap (esp. if it has progressed to shock)

When in doubt, treat BOTH.



22

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Which one of the following is recommended in septic shock treatment but NOT trauma resuscitation?

- Ensuring a patent airway
- Ensuring adequate respirations
- Assessing circulation
- Obtaining a blood culture
- Lactated Ringer's bolus of 10-20ml/kg

23

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Septic Shock management

Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children

Step 1: Initial resuscitation algorithm for children. Includes steps for identifying septic shock, obtaining blood cultures, administering antibiotics, and starting fluids. A flowchart shows the progression from septic shock to sepsis and then to shock, with corresponding interventions.

Step 2: Respiratory support. Includes assessing for Pediatric Acute Respiratory Distress Syndrome, infectious source control, continuous reassessment, and fluid and vasoactive titration. Advanced hemodynamic monitoring is recommended if shock persists.

Step 3: Medications. Includes IV hydrocortisone, broad-spectrum antibiotics, and nutritional support.

Step 4: Advanced hemodynamic monitoring. Includes VV or VV ECLS for refractory shock or organ dysfunction, and VV or VV ECLS for refractory shock or organ dysfunction (after addressing other causes of shock and respiratory failure).

24

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Biggest updates to pediatric septic shock management in 2020

1. Lactated Ringer's instead of NS, 10-20ml/kg aliquots
 - If in an under-resourced area, vasopressors early and stop fluid resuscitation
2. Epinephrine is first line pressor
 - No more "warm" or "cold" shock
3. No ETOMIDATE for intubation
4. [Sepsis → severe-sepsis → septic shock], NOW [sepsis → sepsis with organ dysfunction → septic shock]

25

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Pediatric TCA algorithm

- Global assessment
- Control hemorrhage
- Rapid volume expansion
- Follow standard life support algorithms

26

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Management differences: septic shock vs. trauma

1. Less focus on damage assessment
2. Less fluid volume, early vasopressors
3. Antibiotics (*"likely needed in blunt force trauma"*)
4. Source control/identification
5. No etomidate for intubation

If not sure → Treat BOTH with close attention to HR with IVFB + early antibiotics/bcx.

27

John B. Oakes Children's Hospital
Emergency Management Protocol for Sepsis-Associated Organ Dysfunction

UB|MD PEDIATRICS

INFECTION

Abnormal temperature? YES
Organ Dysfunction? YES

SEPSIS

Check for:
 IVF bolus w/in 2hrs?
 Antibiotics w/in 12hrs?
 Blood culture w/in 24hrs?

TREAT

1 Place IV/IO
2 Blood culture
3 Antibiotics
4 Serum lactate
5 LR bolus 10-20ml/kg*

Antibiotic delay = **4-fold** increase in mortality
Weiss SL, Crit Care Med 2014;42: 2409.


Bundle compliance = **7%** decrease in mortality
Weiss SL, Crit Care Med 2014;42:2409.

28

Jacobs School of Medicine and Biomedical Sciences

Of sepsis and trauma, which is a more frequent cause of death in children?

Septic shock A Trauma B

Trauma —  — Septic shock

Start the presentation to see live content. For screen share software, share the entire screen. Get help at pubs.com/app

Jacobs School of Medicine and Biomedical Sciences
Department of Pediatrics
University at Buffalo

UB|MD PEDIATRICS

Leading causes of death in children in the US

Ages 1-9

Cause	Rate
Other	27.5
Unintentional injuries	31.8
Cancer	11.9
Congenital malformations	9.8
Heart disease	7.3
Homicide	3.2
Influenza and pneumonia	2.7
Stroke	1.4
CLRD	1.3
Septicemia	1.2
Benign neoplasms	1.2

Ages 10-24

Cause	Rate
Other	13.4
Unintentional injuries	40.6
Suicide	19.2
Homicide	14.4
Cancer	5.1
Congenital malformations	1.5
Diabetes	0.8
CLRD	0.7
Influenza and pneumonia	0.7
Stroke	0.6
Heart disease	0.5

National Vital Statistics Reports Volume 68, Number 6, June 24, 2019, Deaths: Leading Causes for 2017


Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Are septic children like septic adults?

If septic adults survive to discharge:

- 1/3 die within 1 year, 50% due to sepsis complications
- 1/6 have severe, persistent impairments
 - 3-fold increase in moderate-severe cognitive impairment
- High prevalence of mental health problems:
 - 32% of survivors have anxiety
 - 29% have depression
 - 44% have PTSD
- 40% are re-admitted within 90 days
 - Re-hospitalization after sepsis = 12% of all US re-admissions, 14.5% of readmission costs
 - Increased risk of recurrent infection, acute renal failure, new cardiovascular events




Prescott HC. JAMA. 2018;319(1):62 43

Jacobs School of Medicine and Biomedical Sciences
 Department of Pediatrics
 University at Buffalo

UB|MD PEDIATRICS

Key take-home points

1. Shock from trauma or sepsis can look VERY similar
2. Key to restoring circulation is ensuring the heart is functioning
 Watch HR as you push fluids
3. If unsure if infection or trauma, treat both
 Add a blood culture and antibiotics while following trauma guidelines
4. High risk populations for occult NAT and sepsis are younger children and non-verbal children of any age
5. Unrecognized sepsis can lead to death or disability





44

University at Buffalo The State University of New York

QUESTIONS?

albrooks@buffalo.edu

Thank you for listening!
