CHEO
child & youth

Pediatric Telehealth Rounds

Today's topic:

Surviving Sepsis: Reviewing the Pediatric Guidelines

Speaker:

Hannah Wigle, MD BHSc
Pediatric Resident, PGY3

March 27, 2015

If you are connected by videoconference:

Please mute your system while the speaker is presenting.

Please feel free to ask questions!

By registering for today's event...

You will have had an opportunity to apply for **professional credits** or a **certificate of attendance**

You will receive an email with a link to today's **online evaluation**

You may also want to...

Visit our website to download **slides** and view **archived events**

Sign-up to our **distribution list** to receive our event notifications

Questions?
pedtelehealthrounds@cheo.on.ca

Declaration of conflict

Speaker has nothing to disclose with regard to commercial support.

Speaker does not plan to discuss unlabeled/ investigational uses of commercial product.

Objectives

- Review definition of shock
- Review types of shock
- Review Pediatric Recommendations from the Surviving Sepsis Guidelines
- Review PALS Septic Shock Algorithm
- Focus on approach to initial resuscitation
- Apply the guidelines to a clinical case

Case Presentation

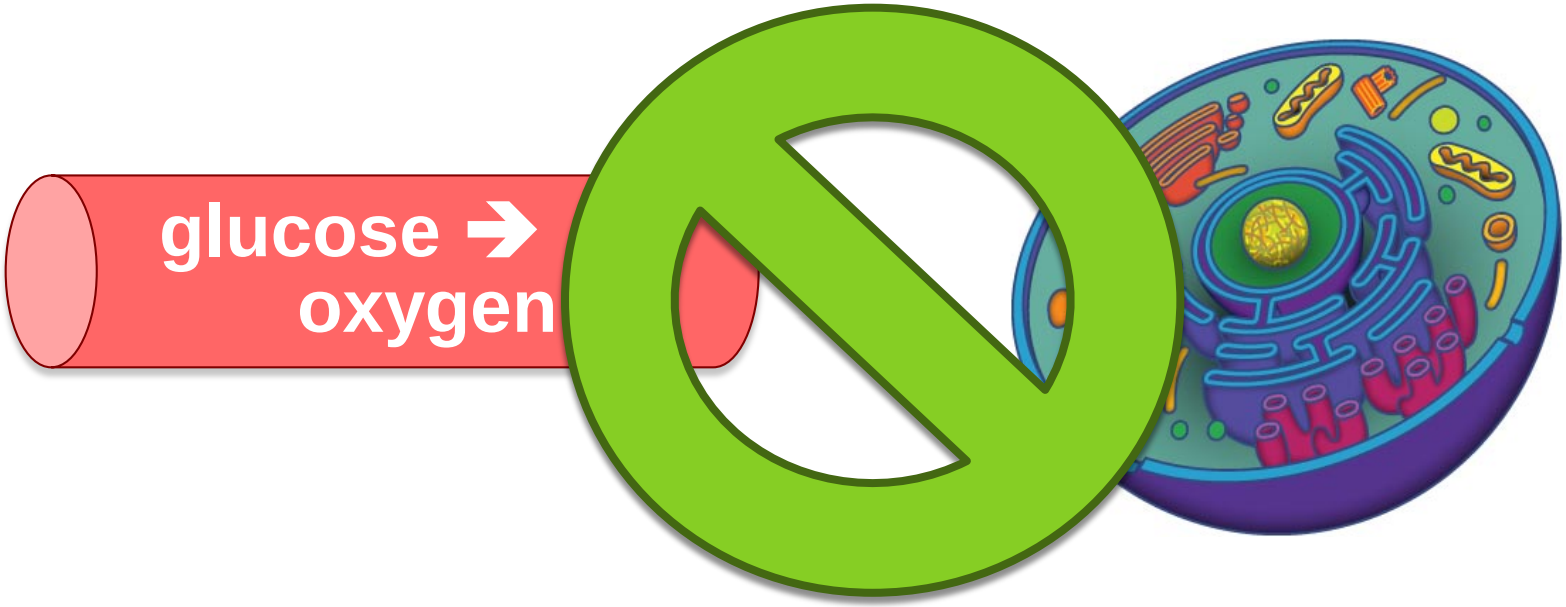
- 12 month male presents to your Emergency Department with a 2 day history of low-grade fevers, rhinorrhea, fussiness and decreased oral intake. Today, he developed a rash and vomiting.
- Triage Vitals:
  - T 39.6° C HR 170 RR 50 BP 80/50 SpO2 95% on room air CR 4-5 seconds
  - Rash present over lower limbs…

Question #1

- How would you describe this patient's condition:
  A. Hypotensive shock
  B. Compensated shock
  C. Septic shock
  D. This kid seems perfectly healthy to me!

Shock

- "Critical condition that results from inadequate tissue delivery of oxygen and nutrients to meet tissue metabolic demands"
- Supply & Demand Problem



Types of Shock

- Hypovolemic – low effective circulating volume
- Obstructive – inadequate cardiac output due to pump failure
- Cardiogenic – inadequate cardiac output due to physical obstruction
- Distributive - vasodilation
  - Anaphylaxis
  - Sepsis
  - Neurogenic

Sepsis

- Major cause of death
  - Even in industrialized countries with state of the art PICUs
- Mortality 2 – 10%
  - Previously healthy children 2%
  - Chronically ill children 8%

Pathophysiology

- Complex process, not fully understood
- Stimulation of host immune system by pathogen
  - Activation of neutrophils, inflammatory mediators, cytokines
- Results in:
  - Vasodilation
  - Increased endothelial permeability
  - Activation of coagulation pathways

HEART & STROKE FOUNDATION OF CANADA™

PALS

Vital Signs in Children

Heart Rate (per minute)

Age	Awake Rate	Sleeping Rate
Newborn to 3 months	85 to 205	80 to 160
3 months to 2 years	100 to 190	75 to 160
2 to 10 years	60 to 140	60 to 90
>10 years	60 to 100	50 to 90

Respiratory Rate (breaths/min)*

Age	Rate
Infant	30 to 60
Toddler	24 to 40
Preschooler	22 to 34
School-aged child	18 to 30
Adolescent	12 to 16

Definition of Hypotension by Systolic Blood Pressure and Age

Age	Systolic Blood Pressure (mm Hg)
Term neonates (0 to 28 days)	<60
Infants (1 to 12 months)	<70
Children 1 to 10 years (5th BP percentile)	<70 + (age in years × 2)
Children >10 years	<90

Question #2

- Which category does our patient fall into?
  A. SIRS
  B. Sepsis
  C. Severe Sepsis
  D. Septic Shock

Emergency Department

0 min

5 min

15 min

60 min

Recognize decreased mental status and perfusion.
Begin high flow O_2. Establish IV/IO access.

Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
Correct hypoglycemia & hypocalcemia. Begin antibiotics.

If 2nd PIV start inotrope.

shock not reversed?

Fluid refractory shock: Begin inotrope IV/IO.
use atropine/ketamine IV/IO/IM
to obtain central access & airway if needed.
Reverse cold shock by titrating central dopamine
or, if resistant, titrate central epinephrine
Reverse warm shock by titrating central norepinephrine.

dose range: dopamine up to 10 mcg/kg/min, epinephrine 0.05 to 0.3 mcg/kg/min.

shock not reversed?

Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency

Pediat

fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal C.I. > 3.3& < 6.0 L/min/m^2

shock not reversed?

Refractory shock: ECMO

Initial Resuscitation

- ***Respiratory Support & IV Access***
  - Face mask O2, high flow NC or CPAP
  - IV or IO access to begin fluid resuscitation
  - Ideally stabilize cardiovascular status prior to intubation

Initial Resuscitation

- ***End Points of Resuscitation***
  - Cap refill ≤ 2 seconds
  - Normal BP for age
  - Normal pulses, same centrally & peripherally
  - Warm extremities
  - U/O > 1cc/kg/hr
  - Normal mental status
  - $Scvo_2$ saturation ≥ 70%
  - Cardiac Index 3.3 – 6.0L/min/m^2

Initial Resuscitation

- ***Follow ACLS/PALS guidelines***
  - Septic Shock Algorithms
- ***In refractory shock, think:***
  - Pneumothorax?
  - Pericardial tamponade?
  - Endocrine emergencies?

Pediatric Septic Shock Algorithm

First hour

Recognize altered mental status and perfusion
Give oxygen and support ventilation; establish vascular access and begin resuscitation according to PALS guidelines
Consider VBG or ABG, lactate, glucose, ionized calcium, cultures, CBC

First hour: Push repeated 20 mL/kg boluses of isotonic crystalloid to treat shock. Give up to 3, 4, or more boluses unless rales, respiratory distress, or hepatomegaly develops.
Additional therapies:
- Correct hypoglycemia and hypocalcemia
- Administer first-dose antibiotics STAT
- Consider ordering STAT vasopressor drip and stress-dose **hydrocortisone***
- Establish second vascular access site if vasoactive infusion anticipated

Fluid responsive (i.e., normalized perfusion/hemodynamics)?

Yes → Consider ICU monitoring

No →

Begin vasoactive drug therapy and titrate to correct hypotension/poor perfusion; consider establishing arterial and central venous access
- **Normotensive:** Begin **dopamine**
- **Hypotensive vasodilated (warm) shock:** Begin **norepinephrine**
- **Hypotensive vasoconstricted (cold) shock:** Begin **epinephrine** rather than **norepinephrine**

Evaluate $ScvO_2$; goal $ScvO_2$ sat ≥70%?

$ScvO_2$ ≥70%, low BP ("warm shock")
Additional fluid boluses
Norepinephrine ± vasopressin

$ScvO_2$ <70%, normal BP but poor perfusion
Transfuse to Hgb >10 g/dL
Optimize arterial oxygen saturation
Additional fluid boluses
*Consider **milrinone** or **nitroprusside***
*Consider **dobutamine***

$ScvO_2$ <70%, low BP and poor perfusion ("cold shock")
Transfuse to Hgb >10 g/dL
Optimize arterial oxygen saturation
Additional fluid boluses
*Consider **epinephrine** or **dobutamine** + **norepinephrine***

***Fluid-refractory and dopamine- or norepinephrine-dependent shock defines patient at risk for adrenal insufficiency.**

Draw baseline cortisol; consider ACTH stimulation test if unsure of need for steroids

If adrenal insufficiency is suspected give **hydrocortisone** ~2 mg/kg bolus IV; maximum 100 mg

Modified from Brierley J, Carcillo JA, Choong K, et al. *Crit Care Med.* 2009;37(2):666-688.

Question #3

- Two attempts at peripheral IV access have been made, unsuccessfully. The BP is now 68/35. What is your next step?
  A. Attempt another peripheral IV insertion
  B. Prepare for a central line
  C. Start dopamine
  D. Obtain an interosseous line

Fluid Resuscitation

- ***Isotonic crystalloids or albumin***
  - 20cc/kg over 5-10min
  - Targeting end points
    - If overload develops, start inotropic support
  - If severe hemolytic anemia
    - Blood transfusion superior to crystalloid or albumin bolusing

Question #4

- You successfully obtain IO access. The patient's weight is 12kg. Which of the following do you administer?

A. D5NS 240cc
B. NS 240cc
C. RL 120cc
D. NS 120cc

Antibiotics & Source Control

- ***Empiric Antibiotics***
  - Within 1st Hour!!!
  - Ideally after blood culture, but don't delay!
  - Can be given IM
- ***Toxic Shock Syndromes***
  - Add clindamycin & anti-toxin therapies
- ***Source Control***
  - Timely identification and aggressive management
- ***C. diff***
  - Enteral antibiotics as tolerated, Vanco for severe disease

Inotropes/Vasopressors/Vasodilators

- ***Delivery***
  - May be initiated via peripheral access
- ***Vasodilator Therapies***
  - Use in low cardiac output, elevated systemic vascular resistance with normal BP

Inotropes/Vasopressors/Vasodilators

Blood Pressure	Peripheral Vascular Resistance	Type of Shock	Medication
↓	↓	**Warm**	**Norepinephrine** 0.1 – 2 mcg/kg/min
↓	↑	**Cold**	**Dopamine** 2 – 10 mcg/kg/min **or** **Epinephrine** 0.05 – 3 mcg/kg/min

Question #5

- You've administered three boluses of NS 240cc each in the first 5-10 minutes. The patient's BP is 75/40, HR 160, cap refill is 3 seconds, extremeties are cool with thready pulses, crackles are auscultated in bilateral lung fields. Your next step is:

A. Initiate another NS bolus
B. Begin chest compressions
C. Initiate dopamine
D. Initiate norepinephrine

Corticosteroids

- ***Consider Hydrocortisone if:***
  - Fluid refractory shock
  - Catecholamine resistant shock
  - History of adrenal insufficiency

Other Supportive Therapies

Beyond the 1st Hour…

Blood Products & Plasma Therapies

- ***Hemoglobin target***
  - > 70 mmol/L
  - > 100 mmol/L if $Scvo_2$ < 70%
- ***Platelet target***
  - ≥ 10 if no apparent bleeding
  - ≥ 20 if significant risk of bleeding
  - ≥ 50 for active bleeding, surgery, invasive procedures
- ***Plasma***
  - Use in sepsis-induced DIC, TTP, secondary thrombotic microangiopathy

Mechanical Ventilation

- ***Utilize lung protective strategies***
  - Minimize volutrauma and barotrauma
- ***Utilize adequate sedation***
- ***Monitor drug toxicity levels***
  - Drug metabolism altered in severe sepsis

Nutrition

- ***Nutrition recommended***
  - Preferably enteral, but may initiate parenteral if not possible to feed enterally
- ***Glycemic control***
  - Target glucose < 10mmol/L

Diuretics & Renal Replacement Therapy

- ***Diuretics***
  - Use to reverse fluid overload once shock has resolved
- ***Dialysis***
  - Use if diuretics unable to reverse fluid overload

ECMO

- ***Consider for refractory cases***

Lack of Recommendations

- ***DVT Prophylaxis in prepubertal children***
- ***Stress Ulcer Prophylaxis in children***

Emergency Department

0 min

5 min

15 min

60 min

Recognize decreased mental status and perfusion.
Begin high flow O_2. Establish IV/IO access.

Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
Correct hypoglycemia & hypocalcemia. Begin antibiotics.

If 2nd PIV start inotrope.

shock not reversed?

Fluid refractory shock: Begin inotrope IV/IO.
use atropine/ketamine IV/IO/IM
to obtain central access & airway if needed.
Reverse cold shock by titrating central dopamine
or, if resistant, titrate central epinephrine
Reverse warm shock by titrating central norepinephrine.

dose range: dopamine up to 10 mcg/kg/min, epinephrine 0.05 to 0.3 mcg/kg/min.

shock not reversed?

Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency

Pediat

fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal C.I. > 3.3& < 6.0 L/min/m^2

shock not reversed?

Refractory shock: ECMO

To Recap

- ***Sepsis:*** SIRS, in presence of proven or suspected infection
- ***Goals within 1st Hour:***
  - Oxygen delivery & airway management
  - Gain access (IV/IO or central)
  - Fluid resuscitation
  - Empiric antibiotics
  - +/- Vasopressors/dilators/inotropes
  - +/- Hydrocortisone

Questions or Comments?

Video-conferencers:
Unmute your system to ask a question

Webcasters:
Type your question

References

- Berg et al. Pediatric Advanced Life Support: Provider Manual. *American Heart Association* 2011; 69 – 108.
- Dellinger RP et al. Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock: 2012. *Crit Care Med* 2013; 41(2): 580-637.
- Kanaparthi LK et al. Distributive Shock. *Medscape* 2013. http://emedicine.medscape.com/article/168689-overview
- Kleinman ME et al. Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010; 122(suppl 3): S876-S908.

Thank you!

for participating in today's

Pediatric Telehealth Rounds

Join us next time:

Concussions

Dr. Sasha Litwin

April 10th, 2015

pedtelehealthrounds@cheo.on.ca