Septic Shock and Awe

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“Aka: She wants us to do what?”

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“Keeps Dr. Patel and Dan in Line”
Disclosures

• We do not have any relevant financial relationships with the manufacturers of any commercial products and/or provider of commercial services discussed in this lecture
Johnny Jones

• 8 yo with lung transplant for pulmonary hypertension
• Presents with fever, decreased po, cough, vomiting
• Triage vital signs
  - T 103.2, P 148, RR 36, bp 111/64, SpO2: 91-93% on RA
• “Medical evaluation” called, evaluated by MD
• PE
  - Tachy MM, LLL crackles, perioral cyanosis, “ill appearing”
Hospital Course

• ED interventions
  - Normal saline bolus 10mL/kg
  - IV vancomycin: arrived from pharmacy 1 hour after ordered
  - IV cefotaxime: begun 2 hours after ordered
  - Maintenance IV fluids ordered

• Transfer to pulmonary inpatient unit:
  - P 150 • R 34 • BP 88/48 • SpO₂ 97% 2L
  - 3 ½ hours after assessment of vital signs, RRT called for dyspnea, grunting, decreased responsiveness
Hospital Course

• PICU
  • Blood pressure was not obtainable by cuff
  • Additional IVF bolus resuscitation
  • Pressors titrated
  • ECMO started

• Johnny died 18 hours after presentation
Jenny Jones

7 yo with fever and respiratory symptoms.

- 1344 T 100.1 97/62 HR 186 RR 42
- 1415 Seen by resident
- 1440 1st Bolus 20cc/kg over 1 hour
- 1500 Vitals 110/60 HR 192
- EC Attending: Pneumonia, Sepsis, needs PICU
- 1522 7.18/40/36 Lactate 7.1
- 1530 Vitals 105/52 HR 182

Lack of timely intervention

- 1550 2nd Bolus 20cc/kg over 1 hour
- 1600 Call to PICU fellow - "OK with"
- 1650 3rd Bolus 20cc/kg over 1 hour
- 1700 O2 sats > 96% on 5L face mask
- 1705 Intubated
- 1830 Physically from EC to PICU
- 1830 HFOV, Inotropes

- Died within 24 hours
Goals

• Review the impact of sepsis on patient outcomes

• Define the sepsis disease spectrum

• Discuss early recognition challenges

• Review the evidenced based guidelines for the management of severe sepsis/septic shock
Impact of Sepsis on Patient Outcomes
Epidemiology

• Over 20-30 million cases worldwide each year
• The annual incidence in the US of severe sepsis is approximately 3.0 cases per 1,000
• Incidence of sepsis is projected to increase by 1.5%/yr
  - Mainly due to the growing use of interventional procedures and increasing numbers of vulnerable individuals

Sepsis kills 50 people EVERY HOUR EVERYDAY
Pediatric Epidemiology

- Worldwide accounts for 60-80% deaths per year in childhood
- 6 million neonatal and childhood deaths per year
- Leading cause of illness and death among U.S. children, with severe sepsis effecting >42,000 children annually

- Mortality
  - Children do better than adults
  - 97% in the 1960’s → 60% in the 1980’s
  - Now 5-10%
  - Highest in infants and children with chronic medical conditions

Epidemiology of Pediatric Sepsis

• Highest risk are children with indwelling vascular catheters, short gut, hematogenous malignancies, and solid organ malignancies

• Most common organisms vary by comorbidity:
  - Previously healthy children: *Staph aureus*, pneumococcus, meningococcus
  - Children with comorbidities: Gram-negative enterics, coagulase-negative staphylococci, *S. aureus*
The Burden of Sepsis in the US

• Most expensive condition treated in US hospitals
  -$20 billion/year
  - Increasing by 11.9% annually
• Most hospitalized condition

**HOSPITALIZATION** rates for sepsis have overtaken the incidence of myocardial infarction

Surviving Sepsis Campaign
Agency for Healthcare Research and Quality
Quality Improvement

• Early identification and treatment is estimated to have significant results
  - 92,000 fewer deaths annually
  - 1.25 million fewer hospital days annually
  - Decrease in costs of over $1.5 billion
Sepsis Defined
Sound Familiar?

• “I know septic shock when I see it”
• “That child doesn’t appear septic”
• “He looked so good I didn’t think he was septic”
• “I thought her abnormal vital signs were just from fever”
• “I don’t need anyone to tell me what a child with septic shock looks like; they always look sick”
• “His blood culture was negative, he wasn’t septic”
Sepsis and septic shock are diagnosed *clinically* from physical exam, vital signs and pertinent history.

Sepsis is life-threatening organ dysfunction caused by a dysregulated host response to an infection. (Third International Consensus Sepsis-3)

Singer, et al. JAMA 2016: 315(8)
Sepsis is a Spectrum...

Non-Severe Sepsis (NS Sepsis):
Infection + Abnl Vital Signs (temp, HR, RR)/WBC

Severe Sepsis:
NS Sepsis + Resp OR ≥ 2 organ systems

Septic Shock:
Severe Sepsis + CV compromise

Huh...
Non-Severe Sepsis vs Severe Sepsis vs Septic Shock?

• Is pathophysiology different?
  - Yes...but can’t tell clinically

• Is treatment different?
  - Nope

• So....what is the difference?
  - MORTALITY: Further along the spectrum the higher the mortality risk

• Septic shock is subset of sepsis in which profound circulatory, cellular and metabolic abnormalities are associated with a greater risk of mortality than sepsis alone.
Non-Severe Sepsis

Infection

Severe Sepsis

2+ Organ Dysfunction:
Neuro  Resp
Cards  Renal
Hem    Liver

Septic Shock

Singer, et al. JAMA 2016: 315(8)
Practically Speaking…

**Infection**

**Sepsis**

2+ Organ Dysfunction:
- Neuro
- Resp
- Cards
- Renal
- Hem
- Liver

**Septic Shock**

**“Bad Infection”**
- “Badness”
- “Really Sick”

**“OMG SICK!!!”**
UTI

Pyelonephritis

+ Tachycardia, Tachypnea, Dehydration

Hypotension

“Shocky”

Altered
A Few Words re Pediatric Septic Shock

- **Compensated septic shock**: Normal systolic BP
- **Decompensated shock**: Systolic hypotension
- Most often children present in compensated shock

- Kids are different:
  - Compared to adults, children maintain higher vascular tone and compensate perfusion with tachycardia alone
  - The “shocky” state can occur long before hypotension
  - Hypotension is a late sign of shock in children
A Brief Word about Tachycardia….

- Tachycardia in the EC is common in children
- Persistent excessive tachycardia is often only early sign of sepsis
- We recognize that there are many causes
  - Fever
  - Hypoxemia
  - Dehydration
  - Medication effects (beta-agonists)
  - Bacterial toxins
  - Pain
  - Anemia
  - Agitation—crying, fussiness
- However, presence of other causes does not exclude possible sepsis
Sepsis is a Spectrum...

Infection  Sepsis  Septic Shock

Goal is to recognize, treat early in the continuum, continued reassessments
ACCM Guidelines:

**Figure 1: Stepwise management of hemodynamic support in infants and children**

- **0 min**: Recognize decreased mental status and perfusion. Begin high flow O₂. Establish IV/IO access.
- **5 min**: Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless toxic or hemodynamically unstable. Correct hypoglycemia & hyperkalemia. Begin antibiotics.

  - **0.5 min**: Shock not reversed?
  - **5 min**: Fluid refractory shock: Begin inotrope IV/IO. Use atropine/epinephrine IV/AIOIM to obtain central access & airway if needed. Reverse cold shock by titrating central dopaminergic or, if resistant, titrate central epinephrine. Reverse warm shock by titrating central norepinephrine.

  - **0.5 min**: Shock not reversed?

- **15 min**: Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency.

- **60 min**: Monitor CVP in PICU, attain normal MAP, CVP & SevO₂ > 70%

- **Cold shock with normal blood pressure**:
  - 1st goal: Titrating epinephrine, SevO₂ > 70%, Hgb > 10 g/dL
  - 2nd goal: Add vasodilator (nitrovasodilators, milrinone, and others) with volume loading, consider levosimendan

- **Cold shock with low blood pressure**:
  - 1st goal: Titrating epinephrine, SevO₂ > 70%, Hgb > 10 g/dL
  - 2nd goal: Add norepinephrine. Add dobutamine if SevO₂ < 70%
  - Consider milrinone, epinephrine, or levosimendan

- **Warm shock with low blood pressure**:
  - 1st goal: Titrating norepinephrine, SevO₂ > 70%
  - 2nd goal: Consider vasopressin, thalidomide or angiotensin
  - Add dobutamine or low dose epinephrine if SevO₂ < 70%

  - **0.5 min**: Shock not reversed?

- **Persistent catecholamine resistant shock**: Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mmHg.

  - Use pulmonary artery catheter, PICCO monitor, FATD &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.

  - Goal C.I. > 3.3 & < 6.0 L/min/m²

  - **0.5 min**: Shock not reversed?

- **Refactory shock**: ECMO (110 mL/kg/min) & or CRRT (> 35 mL/Kg/hr)

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PALS Guidelines:

- **Septic Shock Algorithm**

- **1st hour**: Push repeated 20 mL/kg boluses of isotonic fluid up to 3 x, or more based on patient response

  - Additional therapies:
    - Correct hypoglycemia and hyperkalemia
    - Administer first-dose antibiotics STAT
    - Consider ordering STAT vasopressor drip and stress-dose hydrocortisone

  - **1st hour**:
    - Yes: Fluid responsive i.e., normalization of perfusion/arterial oxygen saturation?
      - Begin vasoactive drug therapy and titrate to correct hypotension/poor perfusion; consider establishing arterial and central venous access.
      - Hypotensive: Begin dopamine
      - Hypotensive vasodilated (warm) shock: Begin norepinephrine
      - Hypotensive vasocostricted (cold) shock: Begin epinephrine rather than norepinephrine
      - Consider ICU monitoring

    - No: Evaluate SevO₂ goal, SevO₂ sat > 97%?
      - Transfuse to Hgb > 10 g/dL
      - Optimize arterial oxygen saturation
      - Additional fluid boluses
      - Consider milrinone or nitroprusside
      - Consider dobutamine

- **Note**: Fluid responsive and dopamine-dependent shock defines patients at risk for adrenal insufficiency.
  - Additional fluid boluses
  - Hydrocortisone 2 mg/kg bolus IV, maximum 100 mg

- **Draw baseline cortisol; consider ACTH stimulation test if unsure of need for steroids**
Adult Mortality Reduced by 15% with Early Goal Directed Therapy (EGDT)

Hallmark Study: for every 6 adults with septic shock who are treated effectively, 1 death is prevented.
Early Goal Directed Therapy Decreases Mortality in Children

- **29% Reduction in Mortality**
- Each hour of delay associated with **50%** increased odds of mortality

% Mortality

- **38%**
- **8%**

Resuscitation followed ACCM-PALS Guidelines

Han *Pediatrics* 2003 112:793-9
Early Rapid Fluid Resuscitation in Pediatric Septic Shock is Associated with Improved Outcomes

**Fluid-sensitive**

<table>
<thead>
<tr>
<th>Volume (mL/kg)</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;40</td>
<td>33%</td>
</tr>
<tr>
<td>20–40</td>
<td>52%</td>
</tr>
<tr>
<td>&lt;20</td>
<td>73%</td>
</tr>
</tbody>
</table>

**Time-sensitive**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>40%</td>
</tr>
<tr>
<td>30–60</td>
<td>58%</td>
</tr>
<tr>
<td>&gt;60</td>
<td>73%</td>
</tr>
</tbody>
</table>

**FIGURE 1.** Patients with septic shock—mortality versus first-hour resuscitation volume. *P = 0.03 (χ² for trend).

**FIGURE 2.** Patients with septic shock—mortality versus time to volume infusion. *P = 0.015 (χ² for trend).
Early Antibiotic Administration Saves Lives

Every hour delay in receiving effective antibiotics is associated with a 7.6% decrease in survival in adults with septic shock.
Septic Shock Algorithm
0-5 min

0 - minute mark

Time of arrival or recognition

Recognize abnormal vital signs and altered mental status and perfusion

Pediatrics
These are Easy…
Which of These Kids Are Sick?
Identify as at risk for sepsis if:
1. Hypotension or
2. Meets 3/8 criteria if no risk or
3. Meets 2/8 criteria if high-risk

**High Risk Conditions**
- Malignancy
- Asplenia (including GCD)
- Bone marrow transplant
- Central or intraventricular line/catheter
- Solid organ transplant
- Severe MR/CP
- Immunodeficiency, immune compromise or infection

**Vital Signs**

<table>
<thead>
<tr>
<th>Age</th>
<th>Heart Rate</th>
<th>Resp Rate</th>
<th>Systolic BP</th>
<th>Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 - 1 m</td>
<td>&gt; 205</td>
<td>&gt; 80</td>
<td>&lt; 60</td>
<td>&lt; 65 or &gt; 58</td>
</tr>
<tr>
<td>≥ 1 m - 2 m</td>
<td>&gt; 205</td>
<td>&gt; 80</td>
<td>&lt; 70</td>
<td>&lt; 75 or &gt; 66</td>
</tr>
<tr>
<td>≥ 2 m - 1 r</td>
<td>&gt; 100</td>
<td>&gt; 80</td>
<td>&lt; 70</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>≥ 1 y - 2 y</td>
<td>&gt; 190</td>
<td>&gt; 40</td>
<td>&lt; 70</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>≥ 2 y - 4 y</td>
<td>&gt; 140</td>
<td>&gt; 40</td>
<td>&lt; 70</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>≥ 4 y - 6 y</td>
<td>&gt; 120</td>
<td>&gt; 34</td>
<td>&lt; 70</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>≥ 6 y - 10 y</td>
<td>&gt; 100</td>
<td>&gt; 20</td>
<td>&lt; 70 + (age in y x 2)</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>≥ 10 y - 13 y</td>
<td>&gt; 100</td>
<td>&gt; 30</td>
<td>&lt; 80</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
<tr>
<td>&gt; 13 y</td>
<td>&gt; 100</td>
<td>&lt; 30</td>
<td>&lt; 80</td>
<td>&lt; 36 or &gt; 39.5</td>
</tr>
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</table>

**Signs of Perfusion**

- Cold Shock
  - Decreased or weak
- Warm Shock
  - Bounding
- Capillary refill (central vs. peripheral)
  - ≥ 3 sec
  - Flash (< 1 sec)
- Skin
  - Mottled, cool
  - Flushed, ruddy, erythodermia (other than face)
  - Petechiae below the nape, any purpose
- Mental status
  - Decreased, irritability, confusion, inappropriate crying or droveness, poor interaction with parents, lethargy, diminished reactability, obtunded

**Septic Shock Checklist**
- Obtain a full set of vital signs including blood pressure and temperature
- Perform a brief history and physical exam assessing mental status, skin, pulses and capillary refill/perfusion
- Is the patient a high-risk patient? (see Table 1)
Within 5 min of arrival or recognition:
- Administer supplemental oxygen and/or respiratory support to keep oxygen saturation in normal range
- Insert PIV. If IV unattainable, establish IO access.
- Place on cardiac monitor and continuous pulse oximeter
- Vital signs every 15 min.
- Neuro checks every 30 min.
- Strict I & O's

Initial Resuscitation
Within 20 min of arrival or recognition:
- Administer 1st bolus* of 20 mL/kg normal saline (NS) via push-pull, rapid infuser or pressure bag within 20 minutes
- Reassess need for additional fluid resuscitation
- Draw labs
- Begin antibiotics within 60 minutes
- Consider inserting a foley catheter

OFF algorithm
Manage as appropriate to clinical findings

Clinical improvement

Yes

No
Place on Oxygen
Consider early noninvasive ventilation or intubation for severe sepsis/shock
Rapid IV Access

Obtain IO access if IV access not successful.
Administer 1\textsuperscript{st} bolus of 20 mL/kg NS via push-pull, rapid infuser, or pressure bag
Broad spectrum antibiotics in first hour!
Hypoglycemia Treatment
D10W 5 ml/kg/dose IV/IO
D25 2 ml/kg/dose IV/IO
D25 should be administered for children > 1 year old.

Subsequent Resuscitation
- Establish second PIV (or IO if PIV cannot be established) and consider central line.
- Administer 2nd and 3rd boluses* of 20 mL/kg isotonic saline or colloid up to and over 60 mL/kg until perfusion improves or unless rales or hepatomegaly develop
- Correct hypoglycemia† and/or hypocalcemia
- Consider treatment of anemia
- If on chronic steroids, give stress dose.
- Reassess need for additional fluid resuscitation

- OFF algorithm
- Manage as appropriate to clinical findings
- Determine appropriate level of care‡

60-minute mark

Clinical improvement

20-60 min
Administer additional boluses of 20 mL/kg NS via push-pull, rapid infuser, or pressure bag. Up to 60 ml/kg. Kids can require 80-100 ml/kg.
Therapeutic Goals

• Capillary refill time ≤ 2 seconds
• Normal pulses with no differential between peripheral and central pulses
• Warm extremities
• Urine output > 1 cc/kg/hr
• Normal mental status
• Normal blood pressure for age
>60 min

60 - minute mark

- OFF algorithm
- Manage as appropriate to clinical findings
- Determine appropriate level of care

OFF algorithm
Manage as appropriate to clinical findings

Fluid Refractory Shock
- Transfer to ICU
- Evaluate for warm or cold shock
  - Reverse cold shock by titrating epinephrine (dose range: EPINEPHrine 0.05 to 1 mcg/kg/min) via IV or central access. Dopamine (dose range: DOPAmine 5 to 20 mcg/kg/min) may be used as an alternative
  - Reverse warm shock by titrating central norepinephrine (dose range: 0.05 to 2 mcg/kg/min) via central access
- Obtain central access if it does not delay admission to the ICU. Initiate venous saturation and central venous pressure monitoring

Clinical improvement

Catecholamine Resistant Shock
- Begin hydrocortisone if at risk for absolute adrenal insufficiency (Dosage: 2 mg/kg IV bolus). Obtain serum cortisol level prior to administration, if feasible.
- Consider ECMO if prior interventions are not effective

Clinical improvement

ICU Transfer Criteria
- Vital signs and/or neurological signs every hour or more frequent as ordered
- Intubation and/or acute ventilatory assistance
- Vasoactive drugs to maintain cardiovascular status
- Clinical demise for deterioration
- Arterial Cannulation
Pressors (dopamine, epi, norepi) can be started through a PIV!
Monitor CVP in PICU, attain normal MAP-CVP & ScvO\textsubscript{2} > 70%

<table>
<thead>
<tr>
<th>Cold shock with normal blood pressure:</th>
<th>Cold shock with low blood pressure:</th>
<th>Warm shock with low blood pressure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} goals: Titrate epi/nad, ScvO\textsubscript{2} 70%, CVP 18-20 mmHg</td>
<td>1\textsuperscript{st} goals: Titrate norepinephrine, ScvO\textsubscript{2} &gt; 70%, CVP &gt; 15 mmHg</td>
<td>1\textsuperscript{st} goals: titrate epinephrine, ScvO\textsubscript{2} &gt; 70%, CVP &gt; 15 mmHg</td>
</tr>
<tr>
<td>2\textsuperscript{nd} goals: Add dobutamine, dopamine or milrinone</td>
<td>2\textsuperscript{nd} goals: Add dopamine, milrinone, or levosimendan if ScvO\textsubscript{2} &lt; 70%</td>
<td>2\textsuperscript{nd} goals: Add vasopressin or vasopressin-angiotensin mimetic if ScvO\textsubscript{2} &lt; 70%</td>
</tr>
<tr>
<td>Other interventions: NPO, avoid sedation, consider using other vasoconstricators</td>
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<td>Other interventions: NPO, avoid sedation, consider using other vasoconstricators</td>
</tr>
</tbody>
</table>

**Persistent shock refractory to resuscitation:** Rule out: Direct pericardial effusion, pneumothorax, & abdominal pressure >12 mmHg.

- Pulmonary artery catheter, PICCO monitor, FATD \&/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.

**Goal C.I. > 3.3 & < 6.0 L/min/m\textsuperscript{2}**

**shock not reversed?**

**Refractory shock:** ECMO (110 mL/Kg/min) \&/or CRRT (> 35 mL/Kg/hr)
Sepsis as a Disease Continuum: Key Points

• Patients with life-threatening infection often present with fever and excessive, persistent tachycardia

• Tachycardia, tachypnea, and signs of worsening perfusion precede hypotension
  - Hypotension is a late, ominous sign in children
  - Often followed by cardiopulmonary collapse

• Halting progression to a decompensated state via early aggressive interventions improves outcomes
REALITY:
Texas Children’s Hospital
2009
2009 Reality

> 75,000 EC visits
> 2400 PICU admits
> 70 EC providers
> 20 PICU providers
Perception: Preliminary Data
Standard protocols of resuscitation for septic shock are followed

- **Strongly Agree**: 0%
- **Agree**: 52%
- **Neutral**: 14%
- **Disagree**: 15%
- **Strongly Disagree**: 2%
- **N/A**: 0%

144 respondents of EC and PICU physicians and nurses
Performance Metrics: Preliminary Data
Morbidity and Mortality Themes

• Lack of awareness of subtle signs of illness, especially excessive persistent tachycardia

• Lack of timely interventions

• Systems barriers
Culture

I hate you more!

EC

PICU

Pediatrics
Quality?

“Every system is perfectly designed to get the results it gets.”

Paul Batalden MD

“A bad system will defeat a good person every time.”

W. Edwards Deming
Aim

- Implementation of a protocol for early recognition and initiation of goal-directed therapy of patients in septic shock
  - Within one year, during “golden hour”, up to 60 cc/kg fluids and initiation of appropriate antibiotics in children with septic shock
The Team

Led by PEM Quality Director

- ED Physicians
- CCM Physicians
- Transport Team Members/Leadership
- ID Physicians
- Nursing—ED and PICU
- Pharmacy
- Sub-specialties

- “Bottom up” approach

- Administrative support
  - Quality and outcomes management
  - Nursing and patient safety leadership
  - Evidence based outcome center
  - Electronic medical record
Needs Assessment
Needs Assessment: Barriers

- Recognition
  - Delays in recognition
  - Varying experience levels
  - ED volume fluctuations
- Resource recruitment
- Nursing procedures

- Poor communication
  - Evaluation and treatment
  - Procedural
  - Disposition
Leverage Points
The ED Process

Arrival to ED → Triage → Disposition

Many things happen

Recognize Badness → Protocol → Do Something
TCH Shock Protocol
Need: Recognition Triage Best Practice Alert

• Identifies criteria
• Accept vs reassess with new vitals
Need:
Recognition
Physician Best Practice Alert

- Identifies criteria
- Past Medical History
- Last labs
- Links to order set
Need: Resource Recruitment
### Need: Minimize Variation

**Phase 2 — Required**

**Goal:** 15 minutes from initiation of protocol

**IV Fluids - Bolus 1 [Shock]**
- Sodium Chloride 0.9% (NS) Bolus Injection (20 mL/kg)
  - 20 mL/kg, Intravenous, ONCE, Push/Pull or via Rapid Infuser
- Sodium Chloride 0.9% (NS) Bolus Injection (CARDIO/IVT 10 mL/kg)
  - 10 mL/kg, Intravenous, ONCE, Push/Pull or via Rapid Infuser

**Antibiotic Therapy - High Risk Patients [Shock]**
- Piperacillin/Tazobactam (ZOSYN) Injection
  - Max: 1200 mg/dose
- Gentamicin Injection
  - Max: 120 mg/dose
- Vancomycin Injection
  - Max: 1500 mg/dose

**Antibiotic Therapy - Normal Hosts / Sickle Cell Disease / Staph Sepsis [Shock]**
- Gentamicin Injection
  - Max: 120 mg/dose, for 3 Months, Intravenous, ONCE, Administer this antibiotic first.
- Vancomycin Injection
  - Max: 1500 mg/dose, for 3 Months, Intravenous, ONCE

**Chronic Steroid Use (Stress Dose) [Shock]**
- Hydrocortisone sodium succinate injection
  - Max: 200 mg/m², Intravenous, ONCE

**Laboratory Tests [Shock]**
- For all neutropenic patients: urine cultures collect voided specimens, not catheterized.
- Nursing Blood Gas and Metabolites POD.
  - Routine, STAT First occurrence Today at 1700
- CBC With Platelet Count
  - Routine, STAT First occurrence Today at 1700
- Type and Screen (ABO/RH and Antibody Screen)
- DIC Panel
- Chemistry 10 Panel
  - Routine, STAT First occurrence Today at 1700
- Liver Panel
- C Reactive Protein
- HSV Rapid Screen
- Adeno Rapid Screen
- Flu Rapid Screen
- Urinalysis W/ Reflex Microscopic

**Blood Cultures - EC — Required**
- Blood Culture (central line present) ≤ 3 kg
- Blood Culture (no central line present) ≤ 3 kg

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**Symbols:**
- Fluids
- Abx: High Risk
- Abx: Normal host
- Labs: recs pre-checked
- Blood Cx
Need: Minimize Variation
Need: Minimize Variation
Standardized Interventions

Pre-Protocol

• Topical anesthetic and delayed access
• IVF on pump over 1 hour
• Nurse walks to pharmacy to get antibiotic
• Prolonged lab results
• Variation in disposition

Post-Protocol

• Pain Ease and rapid intravenous access
• All boluses via push pull, pressure bag, or rapid infuser
• Pharmacy delivers antibiotics to room
• Life threatening labs
• Standardized dispositions
Subsequent PDSA Cycles

• Modified the best practice alert
• Trialed any side room vs dedicated side room vs resuscitation room
• ALL boluses rapidly regardless of diagnosis
• Handoff to bedside nurse checklists
• Triage intake redesign and improved bedside documentation
Future PDSA Cycles

• Huddles to improve bedside communication between nurses and providers
• Improving Pediatric Sepsis Outcomes (IPSO): care throughout hospital (acute care, surgery floor, ICU)
• Continued modifications to best practice alert
• Education strategies
Sustainability Barriers

- Data management
- Trigger fatigue
- Complacency
- New projects/priorities
- CHANGE
How Do I Do This at My Hospital?

- Partnership between local physician and nursing leadership
- Buy-in from hospital level leadership
- Champions committed to this work predicts success
- Do not re-invent the wheel. Resources are out there through Surviving Sepsis, American Academy of Pediatrics, Children’s Hospital Association, Google.
- Breakdown into manageable interventions.
  - Early recognition: triage
  - Rapid care: standardized orders, meds, no fluid pump
  - Resource recruitment: FTEs, share with hospital, outside the box
- When things get hard, keep patient at the center.
Does it matter?
TCH: 30 Day Mortality

30 Day Mortality of EC Sepsis Patients

Best Estimate of Sepsis Mortality Pre-Protocol: 8-12%
Protocol Go-Live February 2010
TCH: Promising Trends and Observances...

- Length of stay PICU
- Central lines
- Use of pressors
- Use of dialysis amongst PICU patients with sepsis
AAP Pediatric Septic Shock Collaborative
3 Day Mortality, All Sepsis

Cases between events

Desired direction

UCL

LCL
1. Recognize a problem

2. Do Something

3. Continued Reassessments
Fluid	Refractory	shock	MAP	milrinone	dopamine	epinephrine
tvasopressin
cold
colloid
cold
hypoglycemia
hypoatropine
cold
hypocalkemia
adrenal
inotrope
saline
hepatomegaly
60cc/kg
CVP
antibiotics
catecholamine
resistant
shock
decreased
mental
status
Hgb
insufficiency
warm
Emergency
Department
bolus
resuscitation
Perfusion
ScvO2
Ketamine
IV/IO
PICU
ECMO
BPA and EMR Optimization
2016-2017
**Risk Assessment**

- **History of fever (including tactile) in the last 4 hours?**
- **History of hypothermia in the last 4 hours?**

**Underlying High Risk Condition**
- Bone marrow transplant
- C-line/PICC/Port
- Complex urogenital repair
- Malignancy
- Other immunocompromise
- Sickle-cell disease
- Significant neurologic/functional impairment or technology dependence
- Solid organ transplant

Row Information:
- Bone marrow transplant (ever in past)
- Complex urogenital repair (Examples: Mitrofanoff, cloaca, bladder extrophy, multiple GU surgeries, etc.)
- Malignancy (in the past 5 years)
- Other immunocompromise (Examples: asplenia, immune deficiencies, medications causing immune suppression, parental report of immune deficiency, neutropenia)
- Significant neurologic/functional impairment or technology dependence (Examples: severe MRDD, non-ambulatory, CPAP/BiPAP, vent, trach, etc.)
- Solid organ transplant (fever in past)

Patient has none of the above high risk conditions
- None of the above

**Circulation Assessment**

- **NORMAL Circulation:**
  - Pulses palpable, strong and equal
  - Cap refill is < 2 sec and not flash
  - Skin is warm and dry
  - Skin and nail beds are pink

- **Skin characteristics**
  - Cool
  - Pale
  - Diaphoretic
  - Dusky
  - Mottled
  - Petechiae (Below the nipple)
  - Purpura
  - Flushed
  - Erythema (Other than face)

- **Abnormal circulation skin characteristics**

- **Cap Refill**
  - > 2 Sec
  - Flash (< 1 Sec)

- **Abnormal pulse value**
  - Bounding
  - Weak
  - Absent
**Sepsis Assessment Vitals**

- **Restart Vitals Timer**: yes
- **BP**:
  - [ ] 
- **Resp**:
  - [ ]
- **Temp src**:
  - Oral, Tympanic, Rectal, Axillary, temp, Esophag...

**Shock Protocol**

- **Shock protocol initiated**: yes

[Link to document](http://connect2depts.texaschildrens.org/depts/1nursing/Evidence%20Based%20Outcomes%20Center/Documents/Septic%20Shock/Shock%20Guideline%2002.03.17.pdf)
### Shock Protocol Care Summary

- **Number of Fluid Boluses**:
  - [ ] 1
  - [ ] 2
  - [ ] 3
  - [ ] >3

- **Cultures Collected?**:
  - [ ] Blood - peripheral
  - [ ] Blood - central
  - [ ] Urine
  - [ ] Trach
  - [ ] Other
  - [ ] None

- **Antibiotics Administered?**:
  - [ ] IV
  - [ ] IM
  - [ ] None

- **Vasopressors?**:
  - [ ] Yes
  - [ ] No

- **Voided?**:
  - [ ] Yes
  - [ ] No

### Ongoing Plan of Care

- **Monitoring**:
  - [ ] Cardiac
  - [ ] Pulse Ox

- **Vital Signs Frequency**:
  - [ ] Q 15min x 4, Q 30min x 2, Q 1 hr x 2

- **Expected Disposition**:
  - [ ] Admission Requested
  - [ ] Bed Pending
  - [ ] Likely Discharge

- **Protocol Complete Per?**
  - [ ]

### Quick Note

- **Quick Note**
  - [ ]