Pediatric Sepsis: From Guidelines to Outcomes

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Reid WD Farris, MD MS
Objectives

- Brief overview of current pediatric sepsis guidelines
- Review published outcomes in pediatrics associated with historic sepsis guideline adherence
### ACCM/PALS Guidelines – 2002 - Current

#### 0 min
- Recognize decreased mental status and perfusion.
- Begin high flow O₂ and establish IO/IV access according to PALS.

#### 5 min
- If no hepatomegaly or rales/crackles then push 20 mL/kg isotonic saline boluses and reassess after each bolus up to 60 mL/kg until improved perfusion. Stop for rales, crackles or hepatomegaly. Correct hypoglycemia and hypocalcemia.
- Begin Antibiotics.

#### 15 min
- Fluid refractory shock?
- Begin PIV/IO Inotrope infusion preferably Epinephrine 0.05-0.3 μg/kg/min
  - Use Atropine/Ketamine PIV/IO/IM if needed for Central Vein or Airway Access

  - If central access available titrate central Epinephrine 0.05-0.3 μg/kg/min for Cold Shock
    - (Titrated central Dopamine 5-10 μg/kg/min if Epinephrine not available)
  - Titrate central Norepinephrine from 0.05 μg/kg/min and upward to reverse Warm Shock
    - (Titrated central Dopamine ≥ 10 μg/kg/min if Norepinephrine is not available)

#### 60 min
- Catecholamine-resistant shock?
- If at risk for Absolute Adrenal Insufficiency consider Hydrocortisone

  - Use Doppler US, PICCO, FAST, or PAC to Direct Fluid, Inotrope, Vasopressor, Vasodilators

  - Goal is normal MAP-CVP, ScvO₂ > 70%* and CI 3.3-6.0 L/min/m²

  - Normal Blood Pressure
    - Cold Shock
    - ScvO₂ < 70%* / Hgb > 10 g/dl on Epinephrine?
  - Low Blood Pressure
    - Cold Shock
    - ScvO₂ < 70%* / Hgb > 10 g/dl on Epinephrine?
  - Low Blood Pressure
    - Warm Shock
    - ScvO₂ > 70%* on Norepinephrine?

  - If euvolemic, add Vasopressin, Terlipressin or Angiotensin but if CI decreases below 3.3 add Dobutamine, Enoximone, Levosimendan or Milrinone

<table>
<thead>
<tr>
<th>Persistent Catecholamine-resistant shock?</th>
<th>Refractory Shock?</th>
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<tr>
<td>Evacuate Pericardial Effusion or Pneumothorax, Maintain IAP ≤ 12 mm/Hg.</td>
<td>ECMO</td>
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*Pediatric Critical Care 2017*
Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children

- ‘Yes, and…’
- Largely expert consensus recommendations
- Few recommendations with more than ‘low quality evidence’
- 9 Best Practice Statements
- 6 Strong recommendations
- 49 Weak recommendations
• Best Practice Statements
  • Implement protocol/guideline for management of children with septic shock or sepsis associated organ dysfunction
  • Obtain blood cultures before initiating antimicrobials where this does not substantially delay antimicrobial administration
  • Source control should be implemented as soon possible if infection is felt amenable to intervention
  • Empiric broad-spectrum therapy to cover all likely pathogens
  • Narrow empiric coverage once pathogens & sensitivities are known
  • If no pathogen identified, narrow or stop antimicrobials given clinical course and expert advice
  • Utilize antimicrobial dosing strategies based on best evidence
  • Assess daily for de-escalation of antimicrobials
  • Duration of antimicrobial therapy; based on site of infection, pathogen, response to treatment, and ability to achieve source control
Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children

- Strong Recommendations
  - For septic shock: antibiotics within 1 hour of recognition
  - Remove intravascular access felt to be source of infection
  - Against - use of starches for resuscitation in septic shock
  - Against - tight glucose control with insulin
  - Against - routine use of iNO in sepsis associated PARDS
  - In settings without ICU resources: Against - bolused fluid resuscitation in absence of hypotension
Adherence to PALS guidelines

- Han, et al. 2003
  - Referring centers prior to transport team arrival
  - Decreased mortality in those with shock reversed or resuscitation consistent with PALS

- de Oliveira, et al. 2008
  - RCT! of ‘goal directed therapy’/use of continuous SvO2 monitor
  - Intervention group had 12% vs. 39% 28d mortality in control group

  - Tertiary, Peds ED
  - Patients who received care consistent with PALS (19%) had decreased hospital LOS
Pediatric Sepsis Bundles

- Arikan, et al. 2015
  - Pre & Post implementation of a ‘Sepsis Resuscitation bundle’ in a Pediatric ED
  - AKI, mortality, ICU & Hosp LOS all improved*

  - Retrospective cohort in Peds ICU comparing those who did & did not receive ’protocolized’ sepsis care in the ED
  - Organ dysfunction on Hosp d2, ICU & Hosp LOS all improved with use of protocol
Pediatric Sepsis Bundles

  • Retrospective cohort of patients with septic shock resuscitated in Peds ED, directly admitted to ICU according to SSC guidelines vs. not
  • No substantial differences in outcomes

• Lane, et al. 2016
  • Retrospective cohort of all patients with septic shock admitted to the hospital via Peds ED (same center & time period as above)
  • Comparison of those who received ‘bundle compliant care’ vs. not
  • Those who received ‘compliant care’
    • 1.2 vs. 4.2% mortality
    • ICU & hospital LOS unaffected
Conclusions

- AHA/PALS Guidelines continue to represent global best practice in pediatric septic shock resuscitation
- New Surviving Sepsis Campaign Guidelines provide additional detail & recommendations as well as defining areas of limited evidence
- Protocolized care of pediatric sepsis & septic shock likely improves outcomes & has not been associated with harm

- Our collective agreement on definitions, a starting place for treatment and ideal outcomes will enable us to push the field forward & improve our care
Pediatric Sepsis

References