IMPLEMENTING A PEDIATRIC SEPSIS PROGRAM

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September 20, 2017
DISCLOSURES

• None!
WHAT IS SEPSIS?

SIRS
Systemic Inflammatory Response Syndrome

Infection

SEPSIS

SIRS

Infection

SEPSIS
SEPSIS: A CONTINUUM OF ILLNESS

Sepsis  Severe Sepsis  Septic Shock

Organ dysfunction
SEPSIS QUALITY INTERVENTIONS IN THE CHOP ED

2012
Pathway
Order Set
Automated
Data

2013
Candidate alert applied retrospectively

2014-15
Prospective Alert

Weiss CCM 2014, Balamuth AEM 2015, PCCM in press
Improve care of sepsis when we know we are worried

JOURNEY PHASE 1
SEPSIS BUNDLES IMPROVE CARE

• Improve timeliness
  • Time to antibiotics
  • Time to IV fluids

• Improve outcomes
  • ICU and hospital LOS
  • Organ failure
  • Mortality

• Recommended in 2017 guidelines

BUNDLE COMPONENTS

• IV access
• Rapid antibiotics
  • 60 min from recognition
• Rapid IV fluids
  • 60 ml/kg in first hour
• Vasoactive agents if needed
• Evaluate for resolution of shock
TIMELY ANTIBIOTICS

• Prompt antibiotics reduces mortality
  • Adults:
    • 7% increase in mortality for every hour delay in abx after onset of hypotension (Kumar CCM 2006)
    • Appropriate antibiotics critical (Gaieski CCM 2010)
  • Pediatrics:
    • Increased mortality with long (>3h) delays in abx (Weiss/Fitzgerald/Balamuth CCM 2014)
    • Is too quickly harmful?
      • Increased 1 year mortality in <1hr cohort (Han Shock 2017)
TIMELY FLUID RESUSCITATION

• EGDT
  • Initial Rivers study 2001 (NEJM): reduced mortality
  • Controversy NOT over prompt treatment
  • IS over how to measure successful resuscitation
  • PROCESS trial (Yealey NEJM 2014)
Operationalize bundle components

CHOP PATHWAY/ORDER SET
BUILD A TEAM!

All potential stakeholders at the table:

• Physician Lead
• Nursing Lead
• Mid-level providers
• ICU Providers
• Pharmacy
ED Pathway for Evaluation/Treatment of Infants > 28 Days of Age and Children with Severe Sepsis

Related Pathway:
Severe Sepsis/Septic Shock ICU Pathway

Goals and Metrics

Antibiotic Recommendations

Recommended Laboratory Studies

Infants and Children with Severe Sepsis

Triage
EPIC Sepsis Alert, Sepsis Huddle Indicated

Initiate Pathway

Sepsis pathway not indicated: Care/reassessment continues as clinically indicated

MD/CRN/CRNP/RN Rapid Assessment
- MS, ABCDE’s
- Monitors, VS
- Administer high flow O₂
- Immediate IV access, IV Escalation Plan
- Order labs, IVF, antibiotics

Assure 1st antibiotic given within 1st hour
Consider need for hydrocortisone

Rapid Fluid Resuscitation
- 20 ml/kg bolus
- Order Dopamine to Bedside

Correct Hypoglycemia, Hypocalcemia

Monitor MS, VS, ABCDE’s, perfusion

Rapid NS
20 mL/kg boluses
Repeat as needed

Notify PICU
Tier 1 or 2 as needed

Sedation and Intubation
Detailed H&P to Identify Source of Infection

Fluid Responsive Shock

Consider Observation in ICU

Fluid Refractory Shock

Tritate Dopamine up to 10 mcg/kg/min

Dopamine Refractory Shock

Cold Shock

Epinephrine infusion

Consider Hydrocortisone for Catecholamine Resistant Shock

Warm Shock

Norepinephrine infusion

Sedation, Intubation Recommendations

RAPID TRANSFER TO PICU WITHIN 1 HOUR

60 min
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Selection Count</th>
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<tbody>
<tr>
<td>Previously Healthy, No Central Line. Administer Ceftriaxone FIRST</td>
<td>0 of 2 selected</td>
</tr>
<tr>
<td>Difficult IV Access (no IV access within 20 minutes of pathway activation)</td>
<td>0 of 1 selected</td>
</tr>
<tr>
<td>Suspected Intra-Abdominal Source, Administer Piperacillin/Tazobactam FIRST (if Penicillin allergy, replace Piperacillin/Tazobactam with Cefepime and Metronidazole-see Penicillin allergy section below)</td>
<td>0 of 2 selected</td>
</tr>
<tr>
<td>Suspected CNS source AND intra-abdominal source-Use Cefepime in place of Piperacillin/Tazobactam and add Metronidazole to the Vancomycin; Administer Cefepime FIRST</td>
<td>0 of 3 selected</td>
</tr>
<tr>
<td>Immunocompromised, Immunosuppressed, Central Line, Chronic Medical Condition, Recent Hospitalization with Suspected Source outside the Abdomen. Administer Cefepime FIRST</td>
<td>0 of 2 selected</td>
</tr>
<tr>
<td>Oncology Patient</td>
<td>0 of 4 selected</td>
</tr>
<tr>
<td>For Penicillin Allergy Use</td>
<td>0 of 2 selected</td>
</tr>
<tr>
<td>For Cephalosporin Allergy Use</td>
<td>0 of 1 selected</td>
</tr>
<tr>
<td>For Toxin-mediated illness, consider the addition of Clindamycin</td>
<td>0 of 1 selected</td>
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ED Sepsis Pathway

ED Sepsis Pathway Order Set Started
Details

Place peripheral IV

Nursing

Please assess patient per sepsis pathway assessment recommendations: Every 15 minutes: Heart rate, Respiratory rate, Blood Pressure; Every 30 minutes: Mental status, Work of breathing, Perfusion status, Pulses; Every 60 minutes: Temperature and Intake

Please assess patient per sepsis pathway assessment recommendations: Every 15 minutes: Heart rate, Respiratory rate, Blood Pressure; Every 30 minutes: Mental status, Work of breathing, Perfusion status, Pulses; Every 60 minutes: Temperature and Intake/Output

Please remind FLOC to order antibiotics as soon as possible. Goal of first antibiotic given within 60 minutes of arrival.

UNTIL DISCONTINUED starting Today at 0945 Until Specified, Please remind FLOC to order antibiotics as soon as possible. Goal of first antibiotic given within 60 minutes of arrival.

Diet NPO

DIET EFFECTIVE NOW starting Today at 0945 Until Specified

☐ Discontinue sepsis pathway frequent assessments for vital signs, mental status, work of breathing, pulses and Intake/Output

Discontinue sepsis pathway frequent assessments for vital signs, mental status, work of breathing, pulses and Intake/Output

Respiratory

Oxygen Therapy Aerosol Mask

p STAT, CONTINUOUS starting Today at 0945 Until Specified
Device: Aerosol Mask
O2 Concentration (%): 100
Laboratory

- **Blood**
  - **POC Glucose**
    - Point of Care, Routine, ONE TIME starting Today at 0942 for 1 occurrence, Blood
  - **POC Glucose**
    - Point of Care, Routine, AS INSTRUCTED (SEE COMMENTS) starting Today at 0942 Until Specified, Blood, Every Hour
  - **CBC, Platelet With Differential**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **Basic Metabolic Panel**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **C-Reactive Protein**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **Procalcitonin**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **Culture, Blood**
    - P Clinician to Collect, Routine, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **Hepatic Function Panel**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **PT/INR**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
  - **PTT Profile**
    - P Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found
Fibrinogen
Clinician to Collect, STAT, ONE TIME for 1 occurrence

D-Dimer
Clinician to Collect, STAT, ONE TIME for 1 occurrence

Type & Screen
Clinician to Collect, STAT, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found

Super Gas W/ Lactate Venous
Clinician to Collect, Routine, ONE TIME starting Today at 0942 for 1 occurrence, Blood, @Contact Team for critical results (use patient Service if none): @No providers found

Super Gas with Lactate (Arterial)
Clinician to Collect, Routine, ONE TIME for 1 occurrence

POC ISTAT BGP 7
Point of Care, ONE TIME for 1 occurrence

Co-Oximetry
Clinician to Collect, STAT, ONE TIME for 1 occurrence

Cortisol Series
Clinician to Collect, STAT, ONE TIME for 1 occurrence

Lipase
Clinician to Collect, STAT, ONE TIME for 1 occurrence

Amylase
Clinician to Collect, STAT, ONE TIME for 1 occurrence

Pregnancy, Serum
Clinician to Collect, STAT, ONE TIME

Research Study IMPRESS Study
Name of Research Study: IMPRESS Study
Study Coordinator: Katie Hayes; Pager 75004
1. Collect sample ONLY if patient is between 57 days and 17 years (inclusive) of age. 2. 7A-MN: please contact academic associate who will provide tubes and take care of sample storage/processing 3. 12A-7A (overnight): tubes can be found in IMPRESS marked packets in trauma bay with instructions attached. Please place RNA sample in dirty utility room in marked box and send red top tube to lab as per attached instructions 4. Collection instructions: For patients 57 days- < 1 y o: 2ml in syringe, 1 ml Tempus tube for RNA and 1 ml in red top for serum; For patients 1 y o- 17 y o: 3ml in Tempus tube for RNA and 2ml in red top for serum
Urine
- POC 10 SG Urine Dipstick
  Point of Care, Routine, ONE TIME starting Today at 0942 for 1 occurrence, Urine

- Culture, Urine
  Clinician to Collect, STAT, ONE TIME

OASIS Research Study

Pharmacy

- IV Fluid and Electrolytes
  - sodium chloride 0.9% (BOLUS) inj
    Intravenous, ONCE, 1 dose Today at 0945
  - lactated ringers (BOLUS) injection
    Intravenous
  - dextrose 5% and 0.9% NaCl infusion
    Intravenous
  - dextrose 10% (BOLUS) injection
    2.5 mL/kg/DOSE, Intravenous, ONCE
  - dextrose 25% injection bolus
    1 mL/kg/DOSE, Intravenous, ONCE
  - calcium gluconate injection (Dose 50-100 mg/kg/DOSE)
    Intravenous, ONCE
### Stress Dose Steroids
- [ ] hydrocortisone critical stress dose panel

### Vasopressors
- [ ] DOPamine infusion (peripheral line)  
  5 mcg/kg/min, Intravenous, CONTINUOUS
- [ ] DOPamine infusion (central line)  
  5 mcg/kg/min, Intravenous, CONTINUOUS
- [ ] EPINEPHrine infusion (peripheral line)  
  0.1 mcg/kg/min, Intravenous, CONTINUOUS
- [ ] EPINEPHrine infusion (central line)  
  0.1 mcg/kg/min, Intravenous, CONTINUOUS
- [ ] norepinephrine infusion (peripheral line)  
  0.1 mcg/kg/min, Intravenous, CONTINUOUS
- [ ] norepinephrine infusion (central line)  
  0.1 mcg/kg/min, Intravenous, CONTINUOUS

### Sedation/ Intubation/ Other
- [ ] hydroCORTISone SS inj  
  2 mg/kg/DOSE, Intravenous, ONCE
- [ ] ketAMINE 10 mg/ml Injection  
  1.5 mcg/kg/DOSE, Intravenous, ONCE
- [ ] aTRopine injection  
  Intravenous, ONCE
- [ ] vecuronium injection  
  Intravenous, ONCE
- [ ] fentaNYL injection  
  0.2 mg/kg/DOSE, Intravenous, ONCE
SEPSIS CARE BAG
1. Attending or fellow pushes bedside sepsis activate button
2. Triggers call cascade
3. FLOC opens sepsis order set and initiates pathway/order set
4. Reminders for timely Abx sent to nurse phone automatically
ADDITIONAL CHALLENGES IN THE PEDIATRIC EMERGENCY SETTING

3 yo patient in triage with the following vital signs:

- Temp: 39.8
- HR: 187
- RR: 38
- BP: 100/67
- Pox: 97% RA

[Image of a child with a popsicle]
HOW DO WE FIND THE RIGHT PATIENTS?
Time to tackle sepsis recognition

JOURNEY PHASE 2
WOULD AN ELECTRONIC ALERT HELP?

Electronic Alert
- Sensitive
- Not specific

Clinical Judgment
- Less sensitive
- More specific

Retrospective alert applied first...
RETROSPECTIVE ALERT

• Algorithmic Alert
  • 2 or more abnormal vital signs
  • High risk condition
  • Altered perfusion
  • Altered mental status

• Clinical Judgement
  • MD determined risk for sepsis
  • Patient placed on institutional sepsis protocol
**“IN SILICO” ALERT IMPLEMENTATION**

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<td>68.2 (67.5, 68.8)</td>
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<td>83.4 (82.91, 83.95)</td>
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<td>Positive Predictive Value</td>
<td>2.5 (2.24, 2.67)</td>
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<td>Likelihood Ratio Positive</td>
<td>5.6 (5.18, 5.95)</td>
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INTERVENTION: 2 STAGE ALERT

- Electronic Alert
  - Vital signs
  - Mental Status
  - Perfusion
  - High Risk Condition
- Clinical Judgement
  - “Sepsis Huddle”
  - Attending/Fellow MD
  - Bedside RN
INTERVENTION: INITIAL ALERT

Your patient has tachycardia and/or hypotension documented.

Filed Sepsis-Related Vitals:
03/24/15 12:21
Pulse: 200

Additional assessments are needed to determine further interventions.

Is there a fever (home or ED >= 38), hypothermia or signs/symptoms of infection for this patient?

Do one of the following:

If No, click the no concern for infection button below.

If Yes, click the hyperlink below to document additional assessments.

Acknowledge reason: No concern for infection

 CLICK HERE TO DOCUMENT ADDITIONAL ASSESSMENTS

Tachycardia: 1x/patient
Hypotension: unlimited
INTERVENTION: ADDITIONAL SCREENING

[Screenshot of Sepsis Screen - Sepsis Screen]

- **UE Cap Refill**
  - < 2 seconds
  - 2-3 seconds
  - > 3 seconds

- **Existing High Risk Condition**
  - < 56 Days Old
  - Asplenia
  - Bone Marrow or Solid Organ Transplant
  - Central Line
  - Malignancy
  - Significant CNS/Functional Tech Dependence
  - Other Immunodeficiency/Immunocompromise
  - None
INTERVENTION: 2ND STAGE OF ALERT

“This patient meets criteria for a sepsis huddle due to tachycardia and a risk factor (high-risk condition, altered mental status, or delayed cap refill).

Please take the following actions based on triage ESI level:

ESI 1: Move to Resuscitation Bay
ESI 2: Available Room (Team 1-3) - Move to room and notify team attending for huddle. No Available Room - Call Team 1 Attending to triage for sepsis huddle.

*** Document the sepsis huddle outcome by clicking the hyperlink below or via the nursing narrator.

- [ ] Open Order Set: ED Sepsis Pathway preview
- [ ] Click Here to Document the Outcome of the Sepsis Huddle

Accept | Cancel
**Could also activate sepsis huddle based on concern even if alert did not fire**

***Plan to add “maybe” option***
MONTHLY FREQUENCY OF ALERTS/HUDDLES

- ED Census: 96,427 visits
- 1st Stage Alerts: 16% of census
- Huddles: 7% of alerts (1% of census)
RESULTS: HUDDLE OUTCOMES

1112 SEPSIS HUDDLES

- Sepsis Pathway Activated: 24%
- Other Pathway Activated: 36%
- No Pathway Activated: 40%
## Test Characteristics of Alert

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<td><strong>Positive Predictive Value</strong></td>
<td>25.4 (22.8, 28.0)</td>
<td>28.1 (25.6, 30.8)</td>
</tr>
<tr>
<td><strong>Negative Predictive Value</strong></td>
<td>99.7 (99.6, 99.8)</td>
<td>99.9 (99.9, 100)</td>
</tr>
<tr>
<td><strong>Likelihood Ratio Positive</strong></td>
<td>15.6 (14.4, 16.9)</td>
<td>18.0 (16.8, 19.2)</td>
</tr>
<tr>
<td><strong>Likelihood Ratio Negative</strong></td>
<td>0.15 (0.12, 0.20)</td>
<td>0.01 (0.00, 0.03)</td>
</tr>
</tbody>
</table>

Denominator: 1st stage alert positive (fever + abnormal vitals)
MISSED PATIENTS: 2013-2017

2017 Goal: <5% missed
Hitting the mark

JOURNEY PHASE 3
ENSURING QUALITY

• Multidisciplinary ongoing QI team
• Monitor pathway adherence and response
  • Use of Sepsis Alert/Huddle
  • Timeliness of antibiotics
  • Timeliness of fluids
  • Appropriate antibiotics
• Provide feedback and re-education
• Update ED on current progress
DATA MONITORING: QLIKVIEW

Pathway Order to Antibiotic Administration

- Administration Time: 180 Min
- % within 60 min
- Median

Pathway to Abx Admin
- Screen to Abx Admin
- Triage to Abx Admin

Median Pathway Activation to Antibiotic Administration (excluding where abx ordered before pathway)

- Abx ordered to admin
- Pathway to abx order

Cohort:
Patient encounters that have the ED Sepsis Pathway Order set (S00PATH16) activated (excluding those where the order set is discontinued within 15 minutes of order).

Timestamp Definitions:
MD Eval: Minimum of attending assignment time and resident/NP assignment time
Minimum antibiotic administration: The earliest antibiotic administration time while the patient is in the ED. If no antibiotics are administered in the ED, this field is null.

Last Updated: 9/24/2017 8:14:29 AM Data Source: E/O
ANTIBIOTIC ADMINISTRATION

Pathway Order to Antibiotic Administration

% <= 60 minutes
Baseline Mean
Goal = 80% within 60 minutes
LCL
UCL
FLUID ADMINISTRATION

Pathway Order to 1st Fluid Bolus

% within 30 Minutes

Median

% <= 30 minutes

Baseline Mean

LCL

UCL

Goal = 75% in <30 min

Episode Week, Year

Children's Hospital of Philadelphia™
BPA ALERT TRACKING
TEAM FEEDBACK

• Weekly chart review of outliers & “missed” patients
• Outreach to identify
  • Barriers
  • Best practices
  • Systems issues
  • Areas for improvement
• Monitor for common themes → widespread re-education
COMMON BARRIERS

• Recognition/Cognitive Bias
• IV Access
• Antibiotic preparation
• Appropriate fluid administration technique
• Competing priorities
HOSPITAL WIDE ACTIVITIES

• Governance Committee
  • Multi-unit/disciplinary team
  • FY 2017 Aim: Reduce rate of new organ dysfunction related to hospital-wide suspected sepsis episodes

• Participation in CHA Sepsis Collaborative
NEXT STEPS

• Continuing QI work
• Individual “score cards”
• Consideration of additional middle tier of response
Questions?

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