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# Pediatric Sepsis

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# Pediatric Sepsis

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## Goals

- To explain pediatric and neonatal considerations
- To explain purpose and benefit of Children's Hospital Early Warning Score
- To explain rapid recognition sepsis bundle
- To explain early goal-directed therapy
- To review pediatric sepsis algorithm
- To discuss case studies

# History of Guidelines

- Surviving Sepsis Campaign (SSC)
  - Started in 2002
  - Updated every four years
  - Pediatric guidelines are in a separate document
    - SSC: Special Considerations in Pediatrics
    - American College of Critical Care Medicine (ACCM) guidelines
    - Pediatric Advanced Life Support (PALS) 2016

# Sepsis

- Life-threatening organ dysfunction cause by a dysregulated host response to infection
- Major healthcare problem
  - Affecting millions per year
  - Killing as many as one in four
- 12 children die everyday from sepsis

# Pediatric and Neonatal Considerations

"Except on few occasions,
the patient appears to die from the body's response to infection rather than from it.“

Sir William Osler – 1904
The Evolution of Modern Medicine

## Sepsis in Pediatrics

- Infants and children are able to maintain BP despite the presence of septic shock through an increase in HR, systemic vascular resistance, and venous tone, but have limited capacity to augment stroke volume
- Pediatric patients are more likely to exhibit cold shock than warm shock in adults
- Associated with severe hypovolemia
- Reduction in oxygen delivery, not defect in oxygen extraction like adults
- Low cardiac output, not low systemic vascular resistance (SVR) like adults, increases mortality

# Sepsis in Neonates

- Complicated by immature organ systems and transitional physiology
- Hemodynamic info only from echocardiogram (echo)
- Deficiencies in thyroid and parathyroid
- Immature thermogenesis

# Sepsis in Neonates

- Reduced glycogen stores and muscle mass for gluconeogenesis

# High-Risk Patient Population

- Ages less than one year and greater than 85 years
- Immunocompromised (HIV, asplenia, cancer, bone marrow transplant, and malnutrition)
  - Prescribed steroid users
  - Chronic illnesses
  - Intra-abdominal surgery
  - Invasive devices
  - Trauma
  - Burns

# Pediatric Age Group Definitions

- Newborn = 0 to 7 days
- Neonate = 7 to 30 days
- Infant = 1 to 12 months
- Toddler = 2 to 5 years
- School-age child = 6 to 12 years
- Adolescent and young adult = 13 to 18 years

| Age | Tachycardia Beats/Min | Bradycardia Beats/Min | Respiratory Rate Breaths/Min | Leukocyte Count Leukocytes x $10^3$ /mm | Systolic BP Pressure, mm Hg (millimeter of mercury) |
|---|---|---|---|---|---|
| 0 days - 1 week | >180 | <100 | >50 | >34 | <59 |
| 1 week - 1 month | >180 | <100 | >40 | >19.5 or <5 | <79 |
| 1 month - 1 year | >180 | <90 | >34 | >17.5 or <5 | <75 |
| 2 - 5 years | >140 | <60 | >22 | >15.5 or <6 | <74 |
| 6 - 12 years | >130 | <60 | >18 | >13.5 or <4.5 | <83 |
| 13 - 18 years | >110 | <55 | >14 | >11 or < 4.5 | <90 |


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# Age-Specific Vital Signs and Lab Values

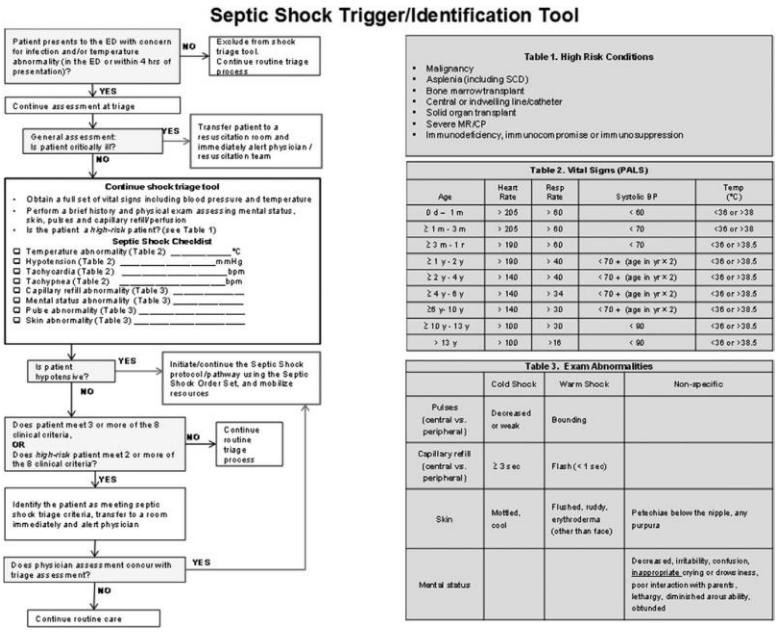
- PALS definition of systolic hypotension
  - Neonates – <60
  - Infants – <70
  - 1-10 years – <70 + age x2
  - >10 years – <90

# Rapid Recognition

## 2017 Sepsis Recognition Bundle

- Identification of sepsis
- Rapid clinical assessment for identified patients
  - Clinical assessment with 15 minutes by a physician
- Rapid initiation of resuscitation
  - Within 15 minutes of confirming

# American Academy of Pediatrics Trigger Tool for Early Sepsis Recognition

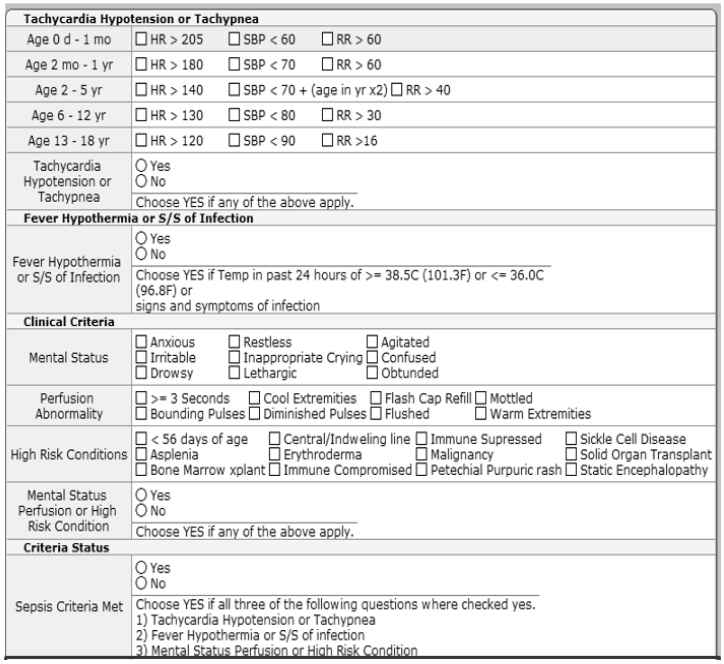



Courtesy of the Pediatric Septic Shock Collaborative of the American Academy of Pediatrics

# Age-Specific Vital Signs and High-Risk Conditions Exam Abnormalities

| Age | Tachycardia Beats per minute | Respiratory rate Breaths per minute | Systolic blood Pressure, mm hg | Leukocyte count Leukocytes x $10^3$ /mm | Temp (◦C) |
|---|---|---|---|---|---|
| 0 days-1 month | >205 | >60 | <60 | X | <36◦ or >38.5◦ |
| 1 months-3 months | >205 | >60 | <70 | | |
| 3 months-1 year | >190 | >60 | <70 | | |
| 1-2 years | >190 | >40 | <70 + (age in years x 2) | | |
| 2-4 years | >140 | >40 | <70 + (age in years x 2) | | |
| 4-6 years | >140 | >34 | <70 + (age in years x 2) | | |
| 6-10 years | >140 | >30 | <70 + (age in years x 2) | | |
| 10-13 years | >100 | >30 | <90 | | |
| >13 years | >100 | >30 | <90 | | |

# Covenant Children's Hospital Sepsis Screening Tool



| Tachycardia Hypotension or Tachypnea | |
|---|---|
| Age 0 d - 1 mo | ☐ HR > 205 ☐ SBP < 60 ☐ RR > 60 |
| Age 2 mo - 1 yr | ☐ HR > 180 ☐ SBP < 70 ☐ RR > 60 |
| Age 2 - 5 yr | ☐ HR > 140 ☐ SBP < 70 + (age in yr x2) ☐ RR > 40 |
| Age 6 - 12 yr | ☐ HR > 130 ☐ SBP < 80 ☐ RR > 30 |
| Age 13 - 18 yr | ☐ HR > 120 ☐ SBP < 90 ☐ RR >16 |
| Tachycardia Hypotension or Tachypnea | ○ Yes ○ No<br>Choose YES if any of the above apply. |
| **Fever Hypothermia or S/S of Infection** | |
| Fever Hypothermia or S/S of Infection | ○ Yes ○ No<br>Choose YES if Temp in past 24 hours of >= 38.5C (101.3F) or <= 36.0C (96.8F) or<br>signs and symptoms of infection |
| **Clinical Criteria** | |
| Mental Status | ☐ Anxious ☐ Restless ☐ Agitated<br>☐ Irritable ☐ Inappropriate Crying ☐ Confused<br>☐ Drowsy ☐ Lethargic ☐ Obtunded |
| Perfusion Abnormality | ☐ >= 3 Seconds ☐ Cool Extremities ☐ Flash Cap Refill ☐ Mottled<br>☐ Bounding Pulses ☐ Diminished Pulses ☐ Flushed ☐ Warm Extremities |
| High Risk Conditions | ☐ < 56 days of age ☐ Central/Indweling line ☐ Immune Supressed ☐ Sickle Cell Disease<br>☐ Asplenia ☐ Erythroderma ☐ Malignancy ☐ Solid Organ Transplant<br>☐ Bone Marrow xplant ☐ Immune Compromised ☐ Petechial Purpuric rash ☐ Static Encephalopathy |
| Mental Status Perfusion or High Risk Condition | ○ Yes ○ No<br>Choose YES if any of the above apply. |
| **Criteria Status** | |
| Sepsis Criteria Met | ○ Yes ○ No<br>Choose YES if all three of the following questions where checked yes.<br>1) Tachycardia Hypotension or Tachypnea<br>2) Fever Hypothermia or S/S of infection<br>3) Mental Status Perfusion or High Risk Condition |

# Pediatric Red Flags

- Presence of Fever
  - For infants 3 months of age or older – core temp >38.3° C (101° F)
  - Less than 3 months of age – core temp <38° C (100.4° F)
- Hypothermia
  - Core temp <36° C (96.8° F)
- Tachycardia*
  - Tachycardia should resolve when temperature returns to normal
  - Persistent tachycardia is a sensitive indicator of circulatory dysfunction and SHOULD NOT be overlooked
- Tachycardia and tachypnea are common, nonspecific findings in pediatric patients and may be due to fever, anxiety, dehydration, pain, anemia, or agitation*

# Pediatric Red Flags

- Tachypnea*
- Abnormal pulses
  - Diminished, weak, bounding
- Abnormal capillary refill
  - Central refill three seconds or greater or flash refill (<one second)
- Abnormal mental status
  - Irritability
  - Inappropriate crying
  - Inappropriate drowsiness
  - Not interacting with caregiver
  - Difficult to arouse
  - Confused

# Pediatric Red Flags

- Purpura
- Petechiae below the nipple line
- Macular erythema
  - Mucosal changes (strawberry tongue and conjunctival injection)
- Signs of poor perfusion

# Signs and Symptoms of Infection

## Signs and Symptoms of Infection

- Toxic or ill appearance
- Signs of dehydration
- Rigors
- Decrease tone
- Seizures
- Meningismus (meningeal irritation)
- Respiratory depression or failure
- Pulmonary rales or decreased breath sounds caused by bronchopneumonia
- Distended, tender abdomen
- Costovertebral angle tenderness
- Macular erythema
- Skin cellulitis, lymphangitis, or abscess
- Warmth, swelling, erythema of an extremity
- Peripheral edema caused by capillary leak
- Multiple nodules
- Ecthyma

# Children's Hospital Early Warning Scoring Tool (CHEWS)

- Standardizes patient assessment to prevent deterioration in pediatric patients
- Scoring includes:
  - Behavioral/ neurological
  - Cardiovascular
  - Respiratory
  - Staff/family concerns
- It takes less than ten seconds to score
- It helps to identify critical deterioration earlier for the CHEWS (3.8 h) compared to the Brighton PEWS (35 min)
- This objective tool could help communication between departments

**CHEWS Scoring and Escalation Algorithm**

| | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| **Behavior/Neuro** | – Playing/sleeping appropriately OR<br>– Alert, at patient's baseline | – Sleepy, somnolent when not disturbed | – Irritable, difficult to console OR<br>– Increase in patient's baseline seizure activity | – Lethargic, confused, floppy OR<br>– Reduced response to pain OR<br>– Prolonged or frequent seizures OR<br>– Pupils asymmetrical or sluggish |
| **Cardiovascular** | – Skin tone appropriate for patient<br>– Capillary refill ≤ 2 seconds | – Pale OR<br>– Capillary refill 3-4 seconds OR<br>– Mild tachycardia OR<br>– Intermittent ectopy or irregular HR (not new) | – Grey OR<br>– Capillary refill 4-5 seconds OR<br>– Moderate tachycardia | – Grey and mottled OR<br>– Capillary refill > 5 seconds OR<br>– Severe tachycardia OR<br>– New onset bradycardia OR<br>– New onset/increase in ectopy, irregular HR or heart block |
| **Respiratory** | – Within normal parameters<br>– No retractions | – Mild tachypnea/ increased WOB (flaring, retracting) OR<br>– Up to 40% supplemental oxygen OR<br>– Up to 1L NC > patient's baseline need OR<br>– Mild desaturations < patient's baseline OR<br>– Intermittent apnea self-resolving | – Moderate tachypnea/ increased WOB (i.e. flaring, retracting, grunting, use of accessory muscles) OR<br>– 40-60% oxygen via mask OR<br>– 1-2 L NC > patient's baseline need OR<br>– Nebs Q 1-2 hour OR<br>– Moderate desaturations < patient's baseline OR<br>– Apnea requiring repositioning or stimulation | – Severe tachypnea OR<br>– RR < normal for age OR<br>– Severe increased WOB (i.e. head bobbing, paradoxical breathing) OR<br>– > 60% oxygen via mask OR<br>– > 2 L NC more than patient's baseline need OR<br>– Nebs Q 30 minutes – 1 hour OR<br>– Severe desaturations < patient's baseline OR<br>– Apnea requiring interventions other than repositioning or stimulation |
| **Staff Concern** | | – Concerned | | |
| **Family Concern** | | – Concerned or absent | | |

| Green = Score 0-2 | Yellow = Score 3-4 | Red = Score 5-11 |
|---|---|---|
| – Continue Routine Assessments | – Notify charge nurse or LIP<br>– Discuss treatment plan with team<br>– Consider higher level of care<br>– Increase frequency of vital signs / CHEWS / assessments<br>– Document interventions and notifications | – Activate Rapid Response Team or appropriate personnel per unit standard for bedside evaluation<br>– Notify attending physician<br>– Discuss treatment plan with team<br>– Increase frequency of vital signs / CHEWS / assessments<br>– Document interventions and notifications |

**A PEDIATRIC CODE CAN BE ACTIVATED AT ANYTIME BY ANYONE**
**Use SBAR communication**

Reference: McLellan, M.C., et al., Validation of the Children's Hospital Early Warning System for Critical Deterioration Recognition, Journal of Pediatric Nursing (2016), http://dx.doi.org/10.1016/j.pedn.2016.10.005

# Scenario 1:

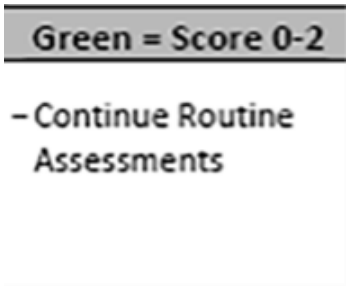
- A three-year-old with asthma comes to the ER (emergency room)
- Somnolent
  - → Behavior/neurological = 1
- Moderate tachycardia
  - → Cardiovascular score = 2
- Mild desaturation $SpO_2$ = 95%, mild tachypnea
  - → Respiratory score = 2
- Mother of child and nurse are concerned = 2
- Total CHEWS = 6
- Red Zone

**Red = Score 5-11**

- Activate Rapid Response Team or appropriate personnel per unit standard for bedside evaluation
- Notify attending physician
- Discuss treatment plan with team
- Increase frequency of vital signs / CHEWS / assessments
- Document interventions and notifications

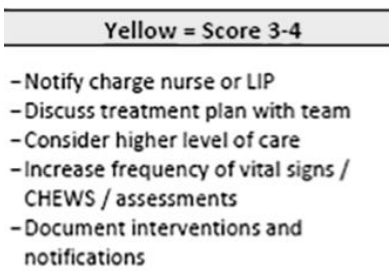
# Scenario 2:

- A 10-month-old, on day 2 of postoperative admission, planned discharge today
- Playing appropriately
  - → Behavior/neurological = 0
- Capillary refill ≤ 2 seconds
  - → Cardiovascular = 0
- Respirations normal
  - → Respiratory = 0
- Family and staff not concerned = 0
- Total CHEWS = 0
- Green Zone




# Scenario 3:

- A four-year-old with asthma admitted to pediatrics
- Alert at baseline
  - → Behavior/neurological = 0
- Moderate tachycardia
  - → Cardiovascular score = 2
- Moderate tachypnea, nebs every two hours
  - → Respiratory score = 2
- Family and nurse not concerned = 0
- Total CHEWS = 4
- Yellow Zone



# Early Goal-Directed Therapy

## 2017 Sepsis Resuscitation Bundle


- Maintain and support airway, breathing, and circulation (ABCs)
- Obtain vascular access within ***five*** minutes
- Start appropriate fluid resuscitation within ***30*** minutes
- Begin broad-spectrum antibiotics within ***60*** minutes
- For fluid-refractory shock, initiate inotropic infusion within ***60*** minutes
- Every hour that went by without restoration of normal blood pressure for age and capillary refill less than three seconds was associated with a two-fold increase in mortality
- Timers set to time going from 0-60 minutes rather than from 60-0 reduced hospital mortality
- In the first hour of resuscitation, the goals are to restore or maintain: airway, oxygenation, ventilation, circulation, threshold heart rate

# Airway and Breathing During Septic Shock

- Initially receive 100% supplemental oxygen
- Wean $FiO_2$ once adequate perfusion has been restored
  - Avoid $SpO_2$ greater than 97%
- Endotracheal intubation is frequently necessary
  - The decision to intubate and ventilate is based on clinical assessment of increased WOB, hypoventilation, or impaired mental status

# Rapid Sequence Intubation

- When performing rapid sequence intubation (RSI) in a child with septic shock, it is important to choose agents that do not worsen cardiovascular status
- Atropine – used for pretreatment of unstable bradycardia
- Ketamine – recommended for sedation. The use of ketamine with atropine pretreatment is considered to be the sedative/induction regimen which best promotes cardiovascular integrity
  - Use fentanyl for patients <three months of age
- Etomidate – inhibits cortisol formation and is not recommended. Etomidate was a common choice because it typically did not compromise hemodynamic stability. Studies show that there is an increase in mortality if used
  - Fentanyl 1-2mcg/kg should be used instead morphine
- Short-acting barbiturates and propofol should be avoided
  - Pentobarbital and other barbiturates are direct myocardial depressants and decrease systemic vascular resistance (SVR), commonly causing hemodynamic instability

# Rapid Sequence Intubation

Hemodynamic instability should receive appropriate support prior to intubation**

- Intubation for controlled ventilation plays an important role in the management of neonates and children with septic shock, and timing should be thoughtfully considered
- Sedation, analgesia, and positive-pressure ventilation prior to adequate volume resuscitation may cause profound drops in preload and precipitate severe hemodynamic instability during intubation

# Circulation During Septic Shock

- Rapid fluid resuscitation
  - Two IV/IO sites rapidly
  - Fluid resuscitation
    - 20mL/Kg NS/LR over 5 minutes
    - Cardiac-10mL/kg over 15 minutes
  - Fluid-refractory shock
    - Inotropes – peripherally
    - Other Fluids – 5% albumin and RBC
    - Other Fluids – 5% albumin and RBC
      - 5% albumin is a reasonable options for children who have NOT improved following >60mL/kg of crystalloid fluid, have hypoalbuminemia (<3), or who develop hyperchloremic metabolic acidosis

# Circulation During Septic Shock

- Resource-limited settings that cannot provide advanced airway and circulatory support
  - Use caution with both volume and speed of fluid boluses if access to mechanical ventilation is limited and life-threating shock is not present. Administer fluid 10-20mL/kg over 30-60 minutes

# Laboratory Studies

- Blood glucose
- Blood gas
- CBCd
- Lactate
- CMP
- PT, PTT, INR
- Fibrinogen and D-Dimer
- Blood culture
- Urinalysis and culture
- CRP
- Procalcitonin

# Broad Spectrum IV Antibiotics

- Administer within one hour
- Administer antibiotics which can be given rapid IV bolus first followed by antibiotics that must be delivered more slowly
  - Cephalosporins versus vancomycin
- Blood cultures should be obtained prior but should not delay administration

# Fluid-Refractory Hypotension Shock

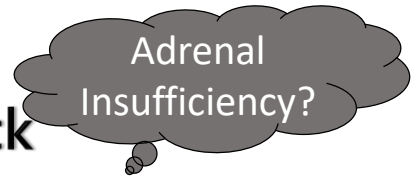
## Warm Shock

- Bounding pulses, pink extremities, "flash" CR
- Decrease SVR and increase blood flow to skin → warm extremities, bounding pulses, brisk cap refill
- Norepinephrine infusion
  - 0.03-0.05mcg/kg/min

## Cold Shock

- Weak peripheral pulses, cold distal extremities, and prolonged CR time
- Increase SVR and decrease blood flow to skin → weak pulses, cold extremities, pale, mottled skin
- Epinephrine infusion
  - 0.05-0.3mcg/kg/min
    - Epi-up to 1.5 mcg/kg/min, low dose 0.03-0.05mcg/kg/min

# Fluid-Refractory Hypotension Shock

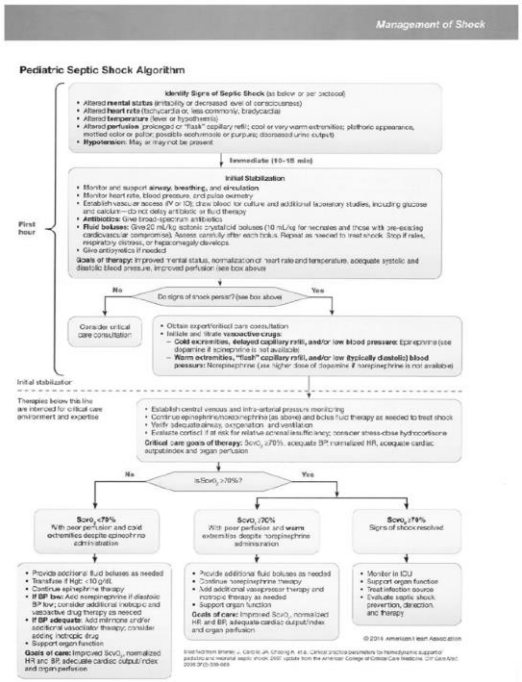



- Identify within one hour of fluid resuscitation
- Recommends inotropes be started through peripheral infusion in children until central access is attained
- Catecholamine-resistant shock-treat with stress dose hydrocortisone

# Reversal of Shock and Restoration of Tissue Perfusion

- Quality of central and peripheral pulses
- Skin perfusion
- Mental status
- Urine output
- Blood pressure
- Normal serum lactate
- Central venous oxygen saturations

# PALS Septic Shock Algorithm




# Case Study

- Four-year-old
- Seen in Midland ER one week ago with abdominal pain, fever, and vomiting (gastroenteritis)
- Admitted after being sent home from ER
- Sent home after four-day admission
- Continued with fever, abdominal pain, and vomiting
- Presented to ER again two days later with ↑ abdominal distention, pallor, and lethargy
- Past medical history – none
- Past surgical history – none
- Meds – none
- Allergies – none
- Immunizations – unable to determine (UTD)
- Social history – lives with mom, dad, and ten-month-old brother – no sick contacts identified

# Pediatric Assessment Triangle

## Appearance

- Alertness
- Distractibility
- Consolability
- Eye contact
- Quality of cry
- Spontaneous movement


## Circulation to Skin

- Pale
- Mottled
- Grey
- Blue

## Work of Breathing

- Chest rise
- Rocking motions
- Retractions
- Nasal flaring
- Head bobbing, grunting
- Snoring, gurgling, stridor, hoarseness

# Case Study

- Pale
- Tachypneic
- Lethargic
- Vital Signs
  - HR: 200s
  - BP: 86/42
  - RR: 80
  - $O_2$ Sats: 94% RA
  - Temp: 99.9°

**Pediatric Septic Shock Identification Tool**

| | |
|---|---|
| **Pediatric Septic Shock Parameters** | |
| Concern for Infection and/ or Temperature Abnormality | ○ Yes ○ No<br>Patient presents to the ED with concern for infection and/or temperature abnormality (in the ED or within 4 hours of presentation) |
| **High Risk Conditions** | |
| High Risk Conditions | ○ Asplenia (including SCD) ○ Bone marrow transplant<br>○ Central or indwelling line/ catheter ○ Immunodeficiency<br>○ Severe MR/CP ○ Solid organ transplant<br>○ Malignancy ○ None |
| **Clinical Criteria:** | |
| **General Assessment – Vital Signs by Age Group** | |
| Age 0 d to 1 m | ☐ HR > 205 ☐ RR> 60 ☐ SBP <60 ☐Temp <36 or > 38 |
| Age > 1 m – 3 m | ☐ HR > 205 ☐ RR> 60 ☐ SBP <70 ☐Temp <36 or > 38 |
| Age > 3 m – 1 y | ☐ HR > 190 ☐ RR> 60 ☐ SBP <70 ☐Temp <36 or > 38.5 |
| Age ≥ 1 y-2 y | ☐ HR > 190 ☐ RR> 40 ☐ SBP <70 + (age in yr x2) ☐Temp <36 or > 38.5 |
| Age ≥ 2 y – 4 y | ☐ HR > 140 ☐ RR> 40 ☐ SBP <70 + (age in yr x2) ☐Temp <36 or > 38.5 |
| Age ≥ 4 y-6 y | ☐ HR > 140 ☐ RR> 34 ☐ SBP <70 + (age in yr x2) ☐Temp <36 or > 38.5 |
| Age ≥ 6 y-10 y | ☐ HR > 140 ☐ RR> 30 ☐ SBP <70 + (age in yr x2) ☐Temp <36 or > 38.5 |
| Age ≥ 10 y-13y | ☐ HR > 100 ☐ RR> 30 ☐ SBP <90 ☐Temp <36 or > 38.5 |
| Age > 13 y | ☐ HR > 100 ☐ RR> 16 ☐ SBP <90 ☐Temp <36 or > 38.5 |
| **Exam Abnormalities** | |
| Pulses (Central vs. Peripheral) | ○ Decreased or weak (Cold Shock) ○ Bounding (Warm Shock) ○ Nonspecific |
| Capillary Refill | ○ ≥ 3 Sec (Cold Shock) ○ Flash < 1 Sec (Warm Shock) ○ Nonspecific |
| Skin | ○ Mottled, cool (Cold Shock) ○ Flushed, ruddy, erythroderma (Warm Shock)<br>○ Petechiae below the nipple, any purpura (Nonspecific) |
| Mental Status (Nonspecific) | ☐ Confused ☐ Decreased ☐ Diminished Arousability<br>☐ Drowsiness ☐ Inappropriate Crying ☐ Irritability<br>☐ Lethargy ☐ Poor Interaction with Parents ☐ Obtunded |
| **Criteria Status** | |
| Meets Criteria | ○ Yes ○ No<br>Does patient meet 3 or more of the 8 clinical criteria?<br>OR<br>Does *high-risk* patient meet 2 or more of the 8 clinical criteria? |
| Notified Physician | ○ Yes ○ No<br>Comment _____ |
| Physician Response | ☐ Antibiotics ☐Blood Culture ☐Fluids ☐ Observation ☐ Other_____ |
| **Sepsis Tool Comment** | |
| Sepsis Screening Tool Comment | |

8/6/11 0400

| CBC | | CMP | |
|---|---|---|---|
| WBC | 8.2 | K | 3.6 |
| Hgb | 12.5 | BUN | 26 |
| Hct | 37.2 | Gluc | 45 |
| Plt | 322 | AST | 152 |
| Segs | 10% | ALT | 40 |
| Bands | 67% | Alb | 1.6 |
| Lymphs | 23% | Alk Phos | 63 |

Hemoglobin (hgb), blood urea nitrogen (BUN), hematocrit (hct), glucose (Gluc), potassium (K) Platelets (Plt), aspartate aminotransferase (AST), segmented neutrophils (Segs), alanine transaminase (ALT), alanine transaminase (Alb), alkaline phosphatase (Alk Phos)

# Case Study

- Fluid boluses given in ER
- Ampicillin, gentamicin, and Flagyl® given in ER
- Taken to OR for exploratory lap
- Intraabdominal abscess and ruptured appendix

# 8/6/11

| | 0627 |
|---|---|
| pH | 7.127 |
| $pCO_2$ | 87.9 |
| $pO_2$ | 9.3 |
| Hgb | 8.3 |

Partial pressure of carbon dioxide ($PCO_2$), partial pressure of oxygen ($pO_2$)

# 8/6/11

| | 0627 |
|---|---|
| Hct | 24 |
| K | 9.24 |
| iCa | 1.38 |
| Lactate | 11.39 |

Ionized calcium (iCa)

# 8/6/11

| | 0627 | 0807 |
|---|---|---|
| **pH** | 7.127 | 6.98 |
| **$pCO_2$** | 87.9 | 82.4 |
| **$pO_2$** | 9.3 | 32.9 |
| **Hgb** | 8.3 | 9.2 |

Partial pressure of carbon dioxide ($PCO_2$), partial pressure of oxygen ($pO_2$), Ionized calcium (iCa)

# 8/6/11

| | 0627 | 0807 |
|---|---|---|
| **Hct** | 24 | 27 |
| **K** | 9.24 | 8.79 |
| **iCa** | 1.38 | 0.51 |
| **Lactate** | 11.39 | 14.1 |

# Discharged to Rehab 10/10/11

| | |
|---|---|
| 8/6/11 | Exp lap, arrested between 4-6 in OR and 4-6 times in ICU |
| 8/10/11 | Arterial study bil LE |
| 8/15/11, 9/1/11, 9/7/11, 9/9/11, 9/12/11, 9/14/11 | Debridement bil LE |
| 8/16/11 | Removal Vac-Pak® and close abdominal wound |

Exploratory laparotomy (Exp Lap), operating room (OR), intensive care unit (ICU), Bilateral lower extremity arterial (bil LE)

# Discharged to Rehab 10/10/11

| | |
|---|---|
| 8/18/11 | MRI and EEG show anoxic injury |
| 8/27/11 | Amputation right foot |
| 9/14/11 | Nissen fundoplication and G-tube placement |
| 9/16/11 | Amputation up to right thigh |

Gastric feeding tube (G-tube), Magnetic resonance imaging (MRI), electroencephalogram (EEG)

# Discharged to Rehab 10/10/11

| | |
|---|---|
| 8/6/11 | Exp lap, arrested between 4-6 in OR and 4-6 times in ICU |
| 8/10/11 | Arterial study bil LE |
| 8/15/11, 9/1/11, 9/7/11, 9/9/11, 9/12/11, 9/14/11 | Debridement bil LE |
| 8/16/11 | Removal Vac-Pak® and close abdominal wound |
| 8/18/11 | MRI and EEG show anoxic injury |
| 8/27/11 | Amputation right foot |
| 9/14/11 | Nissen fundoplication and G-tube placement |
| 9/16/11 | Amputation up to right thigh |

**“If someone dies of an infection, that someone has died of sepsis.”**

James O'Brien, MD, an intensive care physician at The Ohio State University Medical Center and a member of Sepsis Alliance's board of directors

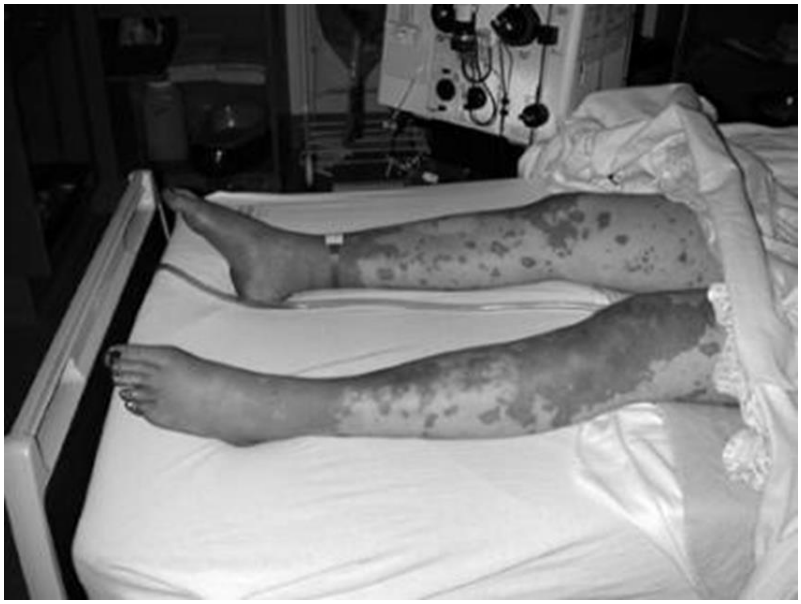


Image courtesy of Amber Cline, BSN, NPDS, CCRN Covenant Children's Hospital

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