Emergency Management of Pediatric Sepsis

Courtney Titus, MPAS, PA-C, CLSSGB

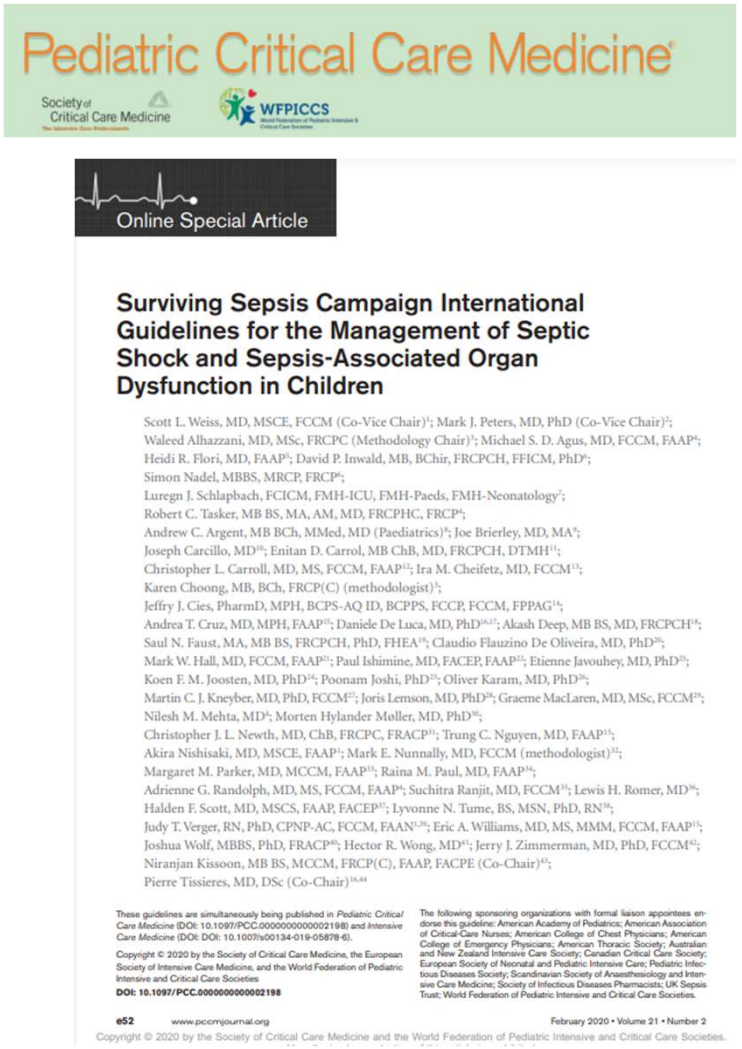
Who here?

- Works in pediatric emergency medicine?
- General emergency medicine or urgent care, pediatrics, family practice or any specialty who treats children and pediatric patients?

Why an “Update”?

In 2020, SCCM Published Surviving Sepsis Campaign Guidelines

- 77 statements made
- 6 were strong recommendations
- 9 best practice statements
- Inadequate data limited the strong recommendations for or against interventions
- Rigorous systematic review using PICO questions and GRADE criteria



Pediatric Critical Care Medicine

Society of Critical Care Medicine

WFPICCS

Online Special Article

Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children

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The following sponsoring organizations with formal liaison appointees endorse this guideline: American Academy of Pediatrics; American Association of Critical-Care Nurses; American College of Chest Physicians; American College of Emergency Physicians; American Thoracic Society; Australian and New Zealand Intensive Care Society; Canadian Critical Care Society; European Society of Neonatal and Pediatric Intensive Care; Pediatric Infectious Diseases Society; Scandinavian Society of Anaesthesiology and Intensive Care Medicine; Society of Infectious Diseases Pharmacists; UK Sepsis Trust; World Federation of Pediatric Intensive and Critical Care Societies.

Guidelines Have Been Updated

- ACCM Published Guidelines in 2017
  - For decreased mental status and perfusion, late findings
  - Early and aggressive fluids
  - Vasoactive based on physical presentation (old terms like cold/warm shock used)
  - Hydrocortisone was recommended
- 2020 SCCM published
  - Methodology was standardized using GRADE criteria and meta-analysis to support recommendations. Key action statements broke down level of evidence in to high medium and low
  - Intended to provide general guidelines that consider local factors, resources etc so hospital systems could adapt
  - Management
    - Balanced risk and benefits of fluids based on ICU resources, presence of shock
    - Epinephrine vs Norepinephrine
    - Stopped using cold and warm shock terms, multimodal imaging preferred
    - Supports Hydrocortisone vs No use of cortisone

Objectives:

- Identify patients at risk for pediatric sepsis according to evidence-based standards of practice
- Describe common causative organisms of pediatric sepsis
- Discuss treatment strategies for pediatric sepsis

Get YOU comfortable with RECOGNITION and TREATMENT of sepsis in your own settings

Case Study:

12 year old boy sent to the ER by the pediatrician for dehydration, fever, abdominal pain and leg pain

- Symptoms began at 12am that Thursday morning, woke with vomiting and thigh pain. Later in the morning he developed a fever of 104.
- PCP saw patient at 6pm that same evening
  - Parents mentioned a scrape on his elbow from a fall during gym class the day before, and that he was complaining of abdominal/leg pain, now limping due to the pain
  - Strep negative (vomited during swab), noted that his skin was blotchy/mottled
  - PCP told parents to bring him to the ER for rehydration

In the ER

- Weight 169 lbs
- Triage VS: HR 143, RR 20

- Labs drawn, 2 boluses IVF and ondansetron given.
- 2 hours later:
  - Noted “pt improved”
  - Rx for Zofran, and home supportive care. Family told likely a stomach virus that had been going around, and may take a week to recover.
  - V/S: Temp risen to 102 F, HR 131, RR 22

The Next Day: Friday

- Slept poorly through the night, fevers and chills continued
- Had some diarrhea but trouble getting off the couch to the bathroom
- He couldn’t sit up to eat and screamed with light touch
- Mom noticed blue around his nose and on the right side of his body

- 10am They called the PCP
  - Advised Tylenol and motrin, pushing fluids and crackers

Friday Evening

- Returned to the ER for a 2nd ER visit
  - Needed help walking to car and asked for a wheelchair
  - Admitted to the ICU for septic shock
  - Intubated, digits turned black, stopped urinating and stopped clotting. He coded twice before he was unable to be resuscitated.

- **4 days after the scrape the patient died from Toxic Shock Syndrome, a strep pyogenes associated septic shock secondary to the wound on his arm**

The Case of Rory Staunton

July 2012, New York Times Article:

ABOUT NEW YORK

An Infection, Unnoticed, Turns Unstoppable

- He had an elevated WBC count that resulted 12 minutes AFTER he was discharged

Photo: Rory Staunton, Society to Improve Diagnosis in Medicine

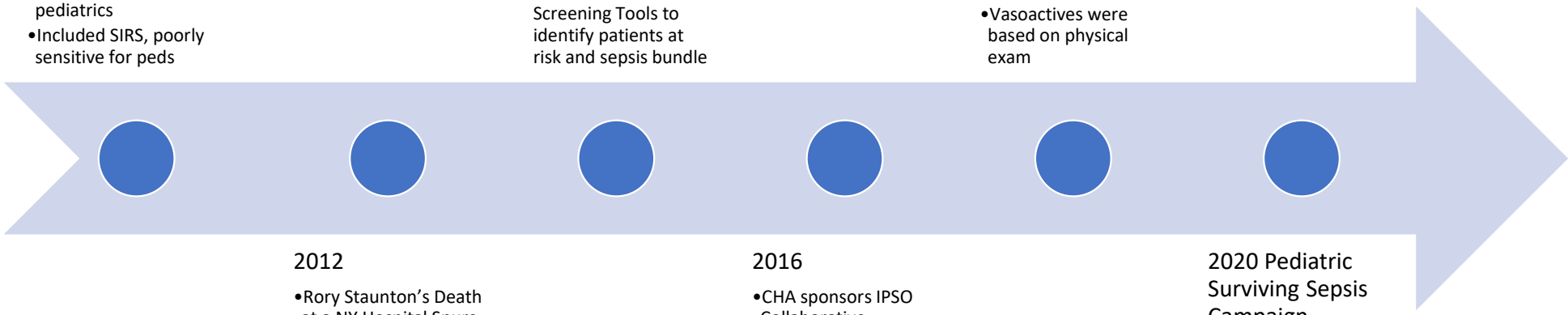
A Flurry Of Data Review

- From 2004-2012 prevalence of pediatric severe sepsis increased from 3.7% to 4.4%, with 176,000 hospitalizations and 8.2% mortality
  - When the data was reviewed, **only 25% of patients were getting 1 hour sepsis treatment bundle**
  - Definitions of time 0 (when sepsis actually started) were variable across hospitals, making it difficult to compare efforts

“Rory’s Regulations”

- 2013 A New York State regulatory initiative was developed as a result of the efforts made by the parents and caregivers of Rory Staunton
  - Evidence Based protocols
  - Screening tools to identify individuals at risk
  - Implementing guidelines through bundled care
    - **Blood culture collection before administering antibiotics**
    - **Broad spectrum antibiotics**
    - **Completion of 20-mL/kg fluid bolus**
- 2018 A Study of 1179 patients, 54 hospitals showed post “Rory’s Regulations” lower mortality among patients who completed the 1 hour bundle for sepsis

Timeline



2005 International Pediatric Sepsis Definition Consensus Conference (Sepsis-1)

- Outlined terms specific to pediatrics
- Included SIRS, poorly sensitive for peds

2012

- Rory Staunton's Death at a NY Hospital Spurs Change
- CHA studies burden of disease

2013 Rory's Regulations are Passed in NY

- Evidence Based Protocols and Screening Tools to identify patients at risk and sepsis bundle

2016

- CHA sponsors IPSO Collaborative
- AAP launches ED Focused Severe Sepsis Collaborative and found inconsistent variables
- **Sepsis-3** clarified terms for adults but not for kids

2017 ACCM Published Guidelines

- More prescriptive and time based
- Aggressive fluid management
- Vasoactives were based on physical exam

2020 Pediatric Surviving Sepsis Campaign

- Removes the adult definitions
- Considers resources & gives framework for local workflow

Sepsis Definitions

- Sepsis: from Greek “sepsin” which means “rot”
  - Life-threatening organ dysfunction caused by a dysregulated host response to infection
- Septic Shock
  - A subset of sepsis with circulatory and cellular/metabolic dysfunction that is associated with a higher risk of mortality

The Problem With Defining Sepsis in Pediatrics

- 2005 International Pediatric Sepsis Definition Consensus Conference
  - Definition of sepsis included SIRS which is poorly sensitive for critically Ill children
- 2016 Sepsis-3
  - Included SOFA score for organ dysfunction which is NOT validated for pediatrics
  - Requires hypotension to meet adult shock criteria, a late stage finding for children
- 2020 Pediatric Surviving Sepsis Campaign
  - Removes requirement of hypotension

Our goal with Sepsis is to identify COMPENSATED Shock

Epidemiology and Prevalence

- Sepsis contributes to 19% of deaths worldwide
- 0.7% of all hospital encounters
- 8% of PICU admissions

- GROSSLY under reported due to errors in diagnostic coding

Most Common Pathogens

- More than 1/3 of children do not have an identifiable pathogen
  - Viral etiology
  - Limitation of testing
- Gram positive slightly higher than Gram negative

Pathogens	Range (%)
No pathogen identified	35–57
Gram-negative bacteria	12–28
Gram-positive bacteria	16–30
Other bacteria	0.4–0.7
Fungal infections	4–13
Viral infections	11–21

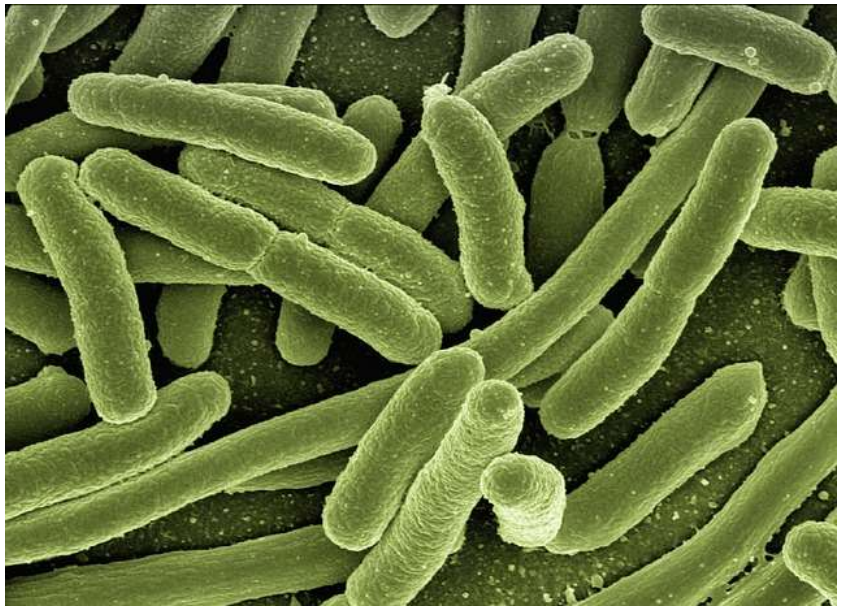
[a]Sum >100% as ranges compiled from various studies and patients may have had multiple sites of infections or polymicrobial infections.

Cruz, et al.

Which Organisms to Blame?

One study US multicenter study (Prout et al):

- Previously healthy
  - Staph aureus (9.4%)
  - Streptococcal species (7.9%)
  - E. Coli (7.1%)
- Chronic illnesses
  - S. aureus (11%)
  - Candida (9.8%)
  - Pseudomonas (8.1%)



Most Common Sites of Infection

- **Respiratory** and **Bacteremia** (blood) is most common
- Ranges vary: CNS/GU sites can be as high as 22-23%

TABLE 2 Most common sites of infection and pathogens in sepsis[a]

Site	Prevalence range (%)
Respiratory	19–57
Bacteremia (primary)	19–68
Abdominal	8
Central nervous system	4–23
Genitourinary	4–22
Skin	4–3

Cruz, et al.

TABLE 3 Most common pathogens by site of infection in children with sepsis

Organism	Bacteremia (%)	CNS (%)	UTI (%)	SSTI (%)	Pneumonia (%)	Osteomyelitis (%)
S. aureus	19	12	6	30	15	51
S. pneumoniae	2	9	1	0.2	4	1
Other Gram-positives	28	25	9	11	6	16
K. pneumoniae	8	2	5	1	3	2
E. coli	11	2	23	2	5	3
H. influenzae	1	3	0.3	0.4	4	1
Pseudomonas	7	2	5	4	13	3
Other Gram-negatives	13	9	6	3	10	2
Candida	9	9	5	7	7	5
Aspergillus	0.4	1	0.2	0.5	0.3	0
No identifiable pathogen	N/A	21	36	37	31	15

Note. Adapted from Prout et al.[9,12]

Abbreviations: CNS, central nervous system; N/A, not applicable; SSTI, skin/soft tissue infection; UTI, urinary tract infection.

Who is at Risk: Most Common Comorbidities

Top 3:

- Central Lines
- Congenital Heart Disease
- Neurologic illness

TABLE 1 Most common comorbidities in children with sepsis in non-resource-limited settings

Condition	Prevalence range (%)[a]
Central venous catheter	31
Congenital heart disease	7–27
Neurologic	9–26
Oncologic diagnosis	11–17
Metabolic disorder	3–13
Respiratory (including ventilator dependence)	5–7
Congenital or acquired immune deficiency	4–7
Renal	2–6
Gastrointestinal	4–5
Solid organ transplant	4
Dialysis dependence	3
Bone marrow transplantation	3

[a]Sum >100% as ranges compiled from various studies and patients may have had multiple comorbidities.

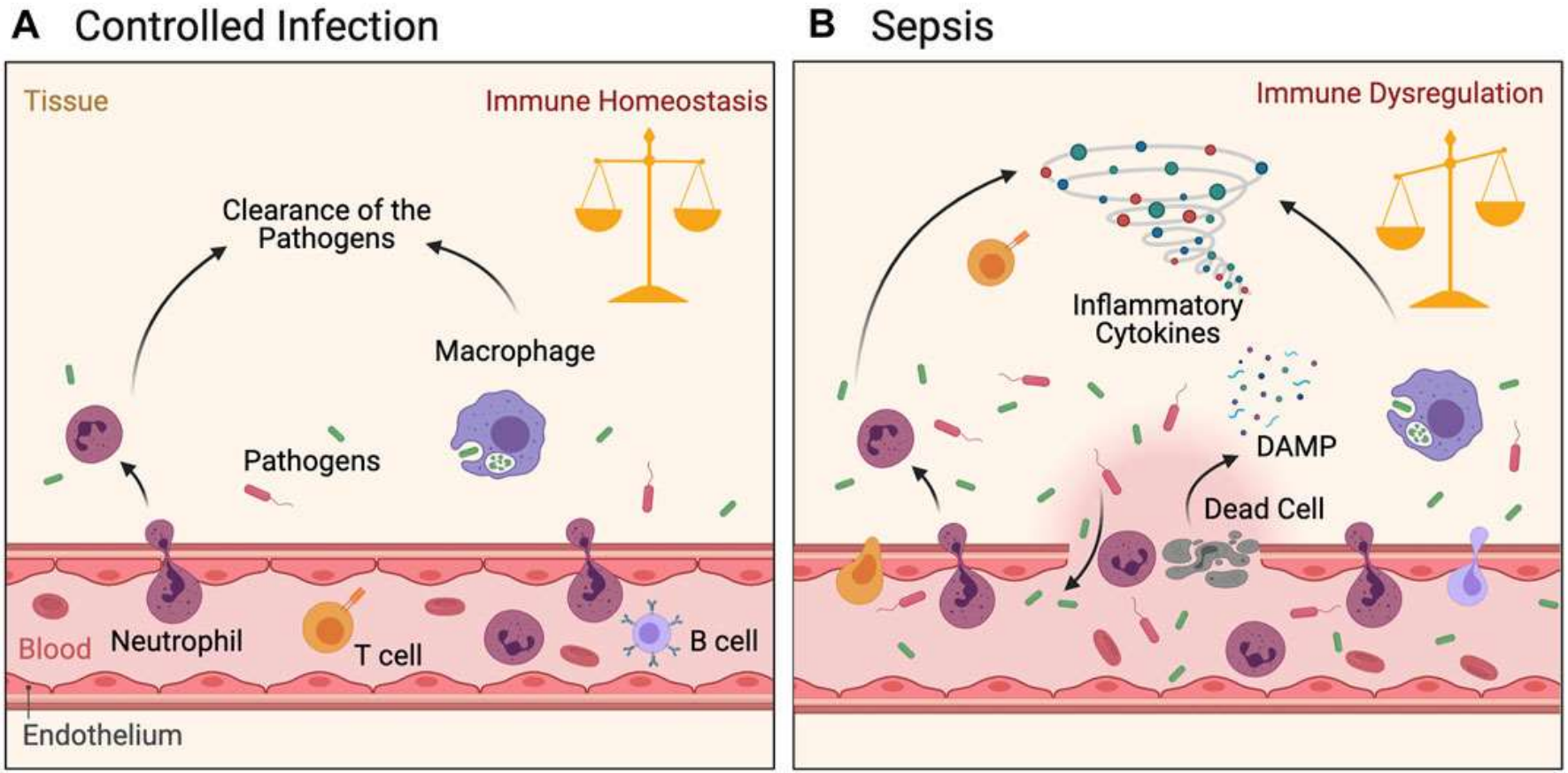
Who is at risk? Are There Inequities in Sepsis Care?

- Black or Hispanic children with severe sepsis or septic shock are approximately 25% more likely to die than non-Hispanic white children
- Black children are 30% more likely than white children to develop sepsis after surgery

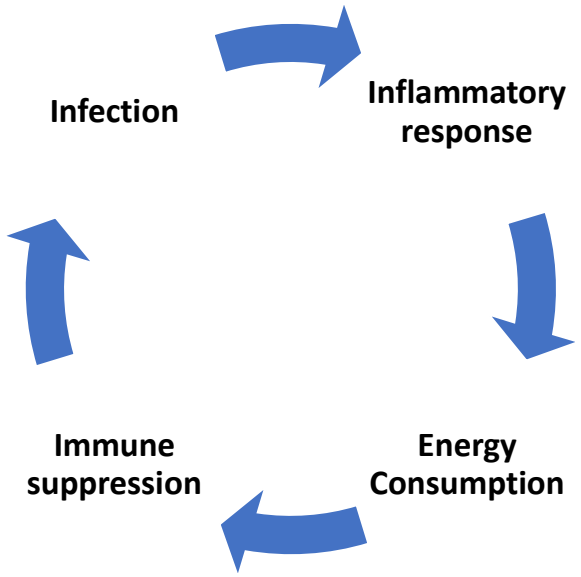
Pathophysiology of Sepsis

- Sepsis is the **host disorder** which is **induced by infection**
- Sepsis develops from an **excessive immune activation** into **extensive immunosuppression**

Pathophysiology of Sepsis



Pathophysiology: Immune Dysregulation



- Persistent inflammation & immunosuppression
  - Some are able to recover into homeostasis and clinically improve
  - Others do not and develop an immunosuppression, inducing a secondary infection

Pathophysiology: Control Burn vs Wildfire

Initial Presentation

Fever or hypothermia

- Especially in neonates or patients with baseline hypothalamic dysfunction

PLUS

- Symptoms suggestive of sepsis (the more there are the higher suspicion)
  - Chills, shivering
  - Clammy, pale, cyanotic or mottled skin
  - Shortness of breath, fast breathing, grunting, labored breathing
  - Chest pain, fast heartbeat
  - Dizziness, confusion, decreased responsiveness, altered level of consciousness, limp or sleepy
  - Generalized weakness, difficulty walking
  - Complaining of body pain, young kids may be irritable and inconsolable
  - Decreased fluid intake, poor feeding
  - Decreased urine output, decreased wet diapers
  - Worsening symptoms, instead of improving

How Do Pediatric Presentations Differ from Adults in early sepsis?

Neonates & Infants

- History includes maternal risk factors, delivery risk factors, vaccination status
- Poor tone
- Poor suck/feeding
- Delayed cap refill/cyanosis
- Bradycardia or tachycardia
- Hypothermia or fever
- Tachypnea, grunting, retractions
- Fewer wet diapers from baseline
- Hypotension is late finding

Children

- History includes vaccination status
- Delay cap refill/cyanosis
- Bradycardia or tachycardia
- Hypothermia or fever
- Tachypnea, grunting, retractions
- Decreased urine output
- Hypotension is late finding

Adults

- Altered mental status
- Respiratory distress
- Tachycardia
- Hypotension

Pediatric Physiology

- Hemodynamic Differences
- Airway and Pulmonary differences
- Demand differences

Proportion of body weight in water is larger, more in extracellular spaces. Daily water exchange rate is much higher

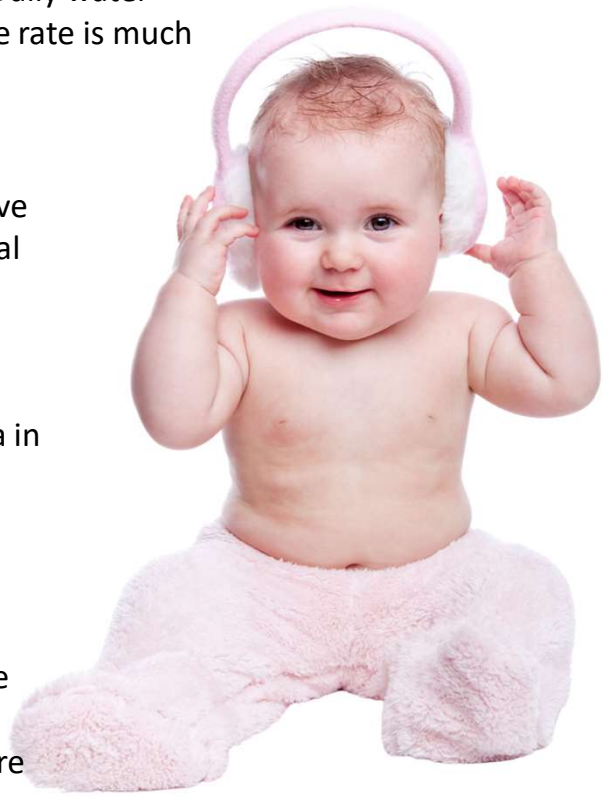
Body surface area is large for weight, making infants susceptible to hypothermia

Higher metabolic rate, higher oxygen needs, higher caloric needs

Tongue is large relative to small nasal and oral airway passages

Short narrow trachea in children under 5

Faster respiratory rate, fewer and smaller alveoli, less lung volume until age 10



Cardiac output is rate dependent NOT stroke volume dependent, making heart rate more rapid until adolescence

Blood volume is weight dependent (80mL/kg)

Diaphragm is primary breathing muscle, Co2 is not effectively expired in distress making higher susceptible to metabolic? Acidosis until age 4-5

Hemodynamic Differences

	Neonates	Infants/Children	Big Kids & Adults
Physiology in Shock	Transition of fetal to natal physiology is a unique challenge. Increase pulmonary vascular resistance and lead to a patent ductus arteriosus pulmonary hypertension, persistent fetal circulation	Limited cardiac reserve, cannot tolerate a two fold increase in HR like adults as not enough time for diastolic filling, **predominant response to decreased cardiac output is vasoconstriction**, which further impairs CO and leads to death	Hyperdynamic Shock: low SVR, hypotension**, increased cardiac output**, tachycardia, elevated O2 in pulmonary artery blood Myocardial depression, ventricular dilation nd flattening of frank starling curve
How they present clinically in Shock	decreased right ventricular afterload, cardiac failure, tricuspid regurgitation and hepatomegaly PDA, PPHN, PFC	Severe Hypovolemia, 50% will have clamped down extremities, **low CO** and **ELEVATED SVR**	Tachycardia, **reduced SVR**. Those who's SVR does not respond to vasopressors have high risk of death
Treatment Differences	Oxygen, inhaled nitric oxide, Milrinone (phosphodiesterase III inhibitors)	Frequently respond well to volume resuscitation and commonly require inotropes, vasodilators, and ECMO	

Younger Children Have Limited Cardiac Reserve

Adult/Adolescent
Resting HR- 60-80 BPM

↓ Develops low cardiac output (CO) shock

DOUBLES HR= 120-160

Neonate/Infant
Resting HR= 120-140 BPM

↓ Develops low cardiac output (CO) shock

CANNOT DOUBLE HR to 240-280
Heavily relies on increased SVR (vasoconstriction)

Not possible or sustainable,
Heavily relies on increased SVR (vasoconstriction)

Systemic Vascular Resistance (SVR)

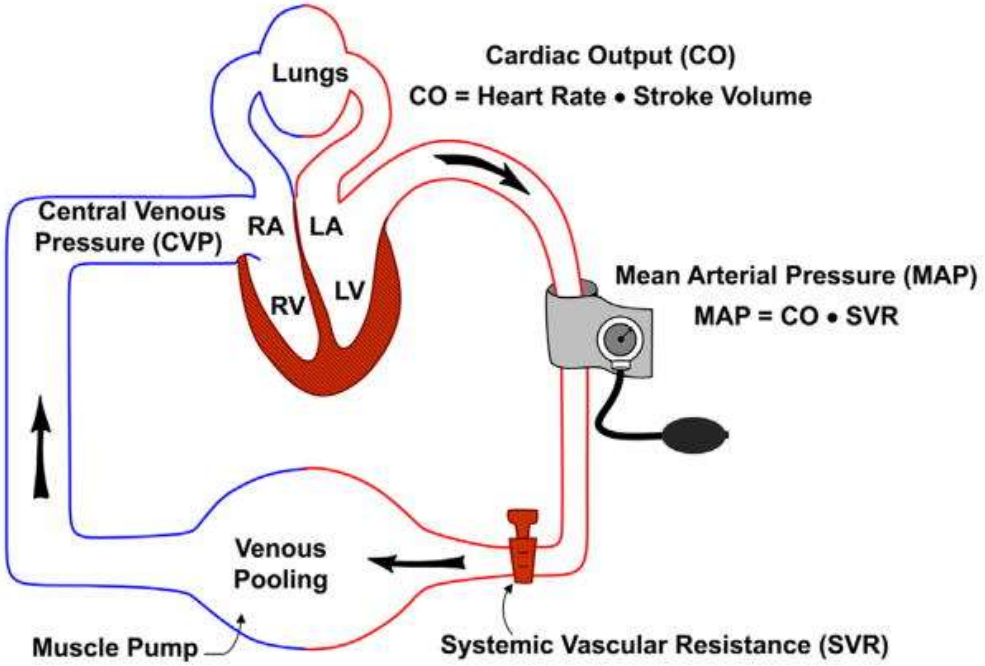


Image: Weiling et al Europe PMC

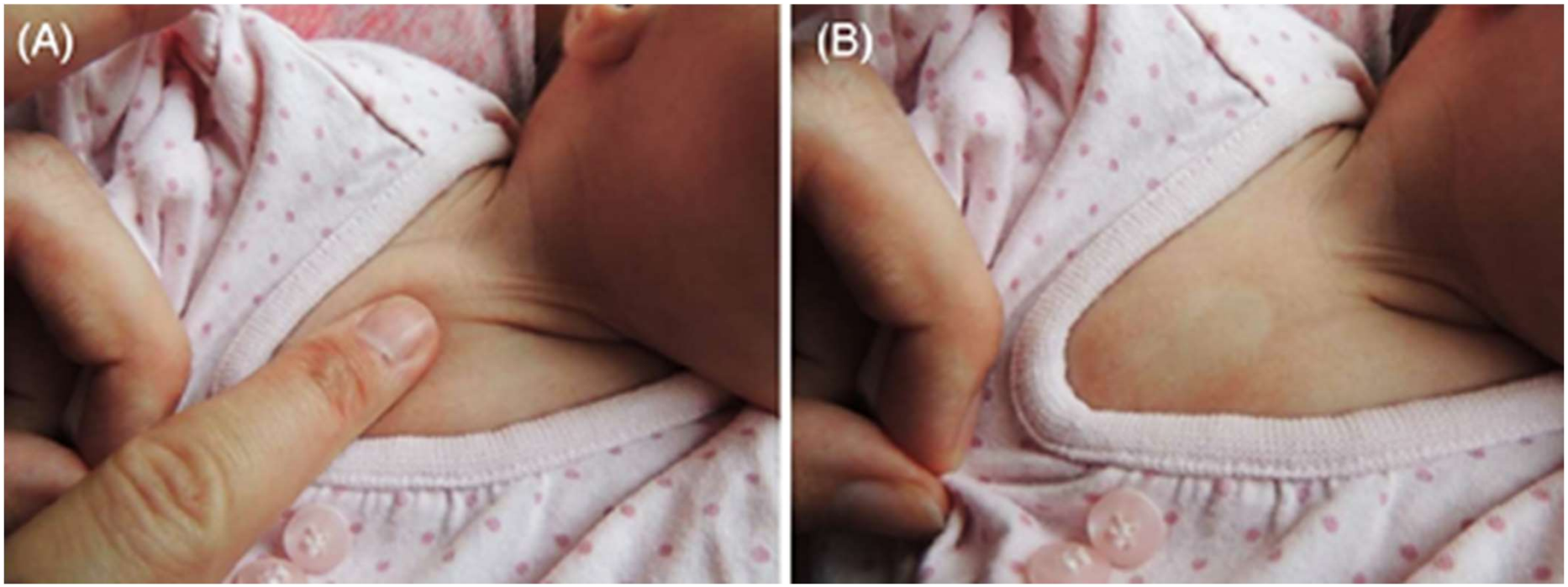
Poor Perfusion

- Delayed Central Capillary Refill
  - Normal is ≤2 seconds
  - 3-4 is delayed
  - >5 seconds is significantly delayed

Image: e-safe-anaesthesia.org

Central Capillary Refill

Image: Medcast.com



- Press one finger on sternum or forehead, hold for 5 seconds
- Count how many seconds it takes for color to return to blanched area

A Note on Mottling

- **Cutis Marmorata Telangiectasia Congenita -** characterized by discolored patches of skin called **Livedo Reticularis.**
- These are bluish-purple in color, mottled & netlike.
- Cold makes it worse and <u>does NOT usually resolve when warmed</u>
- 50% resolve by 6-12 months age
- Can be on extremities or trunk
- Females>Males

Image: Cutis Marmorata Consultant360

Image: Cutis Marmorata with Telangiectasia cincinattichildrens.org

Respiratory Distress

- Tachypnea which doesn't resolve with fever reduction
- Grunting
- Retractions

Source: Shah BR, Lucchesi M, Amodio J, Silverberg M: *Atlas of Pediatric Emergency Medicine*: www.accessemergencymedicine.com

Retractions

- Mild: Subcostal, Substernal
- Severe: Suprasternal, Sternal
- Moderate: Intercostal, Supraclavicular
- Mild: subcostal, substernal

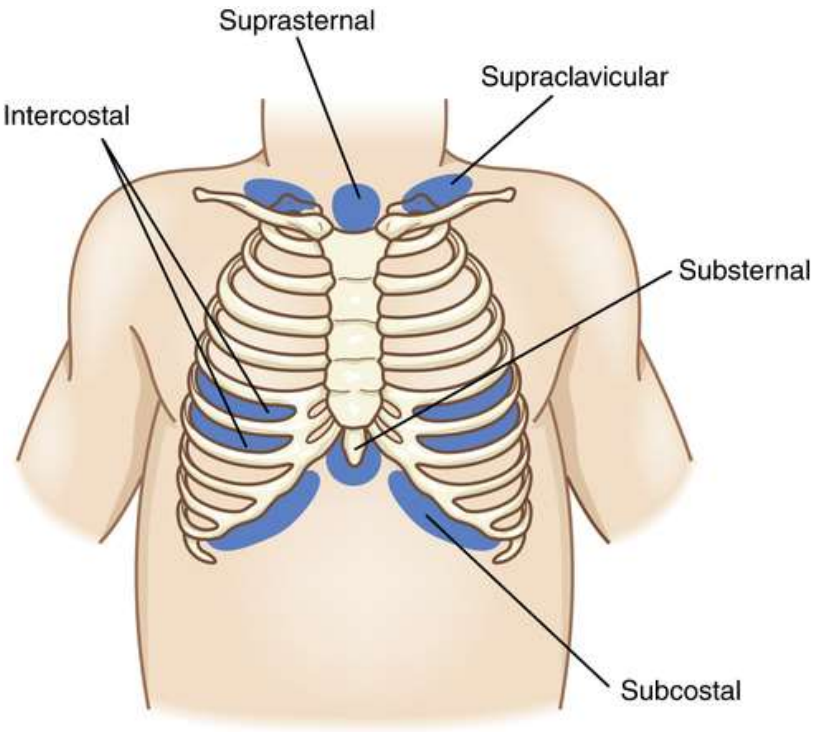
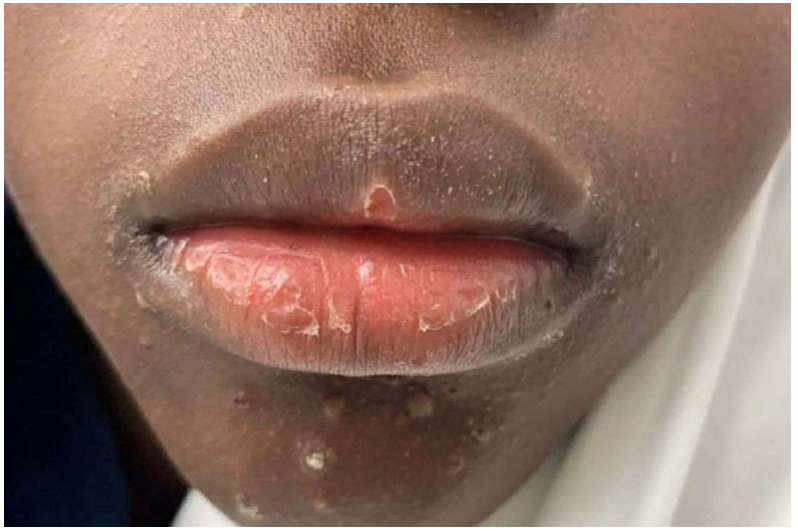


Image: basicmedicalkey.com

Dehydration

- Dry chapped lips
- Tacky mucous membranes
- No tears with crying
- Sunken Fontanel
- Decreased wet diapers from baseline (usually 4-6 a day)
- Decreased urination



Diagnosis

- Diagnosis is CLINICAL and based off many considerations:
  - History of illness and how the patient is coping with the infection
  - Risk factors (medications, comorbidities etc)
  - Initial vital signs and physical exam, including presence of organ dysfunction
  - Reassessment of physical exam and vital signs after treatment fever control & fluids

  - Early recognition is key
  - Goal in pediatrics is to identify early compensated shock

Diagnostic Barriers

- Fever is a common presentation
- Age related variation in vital signs makes it difficult to recognize “abnormal”
- Hypotension is a late manifestation
- Relatively low prevalence in the US

Triage Based Recognition

Recommendation #1	Strength & Quality of Evidence
In children who present as acutely unwell, we ***suggest implementing*** systematic screening for timely recognition of septic shock and other sepsis-associated organ dysfunction. **Remarks:** Systematic screening needs to be tailored to the type of patients, resources, and procedures within each institution. Evaluation for the effectiveness and sustainability of screening should be incorporated as part of this process.	• Weak • Very Low-Quality of Evidence

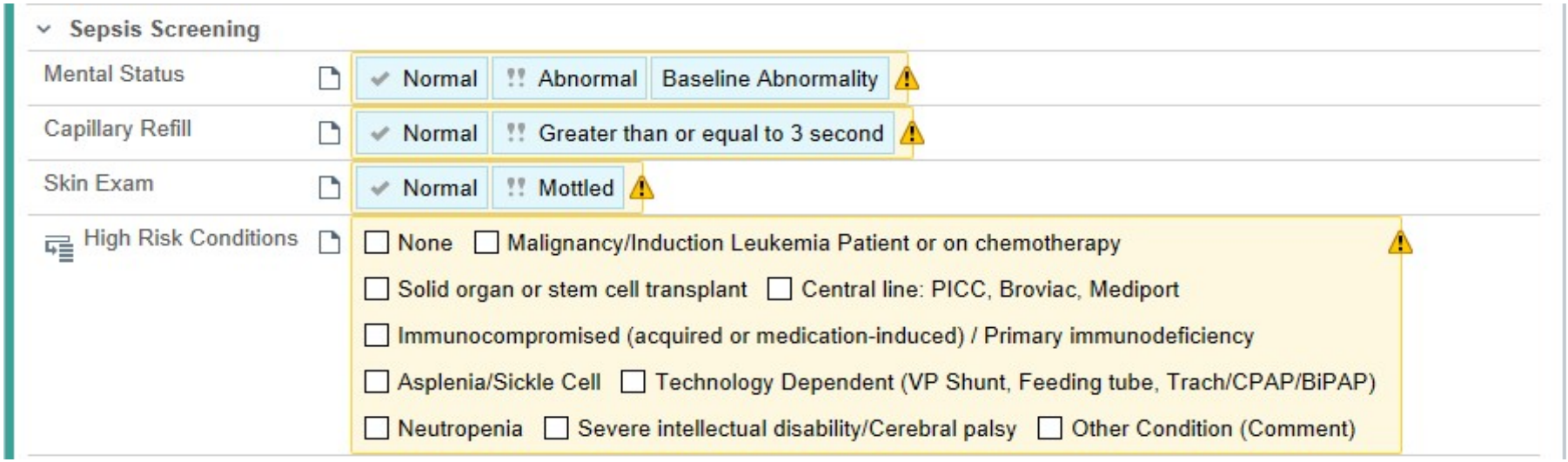
- Multiple studies support the use of rapid, systemic processes to identify patients at risk for sepsis.
- Screening is essential to early recognition
- Ideal Sepsis Screening tool should be in at least 2 steps:
  - Nurse driven screening assessment tool
  - If positive screen, then Bedside care team huddling

Triage Screening Tools

Can include a point system for each of the following:

- Suspected infection
- Fever or hypothermia
- Perfusion abnormalities
- Altered mental status
- Tachycardia
- Hypotension
- Presence of high risk conditions

Screening Tool Example



Triage Screening Tools

- Success will require a large QI effort with a dedicated work group
- Should be efficient, incorporate reassessment throughout the visit, & utilize EHR tools
- Individualized to
  - unique needs of department
  - patient populations (rural vs urban)
- Adjustments to prevent alert fatigue
  - Temperature corrected heart and/or respiratory rates
  - Age based vital sign adjustments

Screening Vital Signs

- IPSO uses Goldstein's Sepsis Criteria

- What NOT to use
  - Systemic Inflammatory Response Syndrome (SIRS) vital sign criteria
    - Poorly sensitive in identifying critically ill children
  - qSOFA
    - Not validated in pediatrics
    - pSOFA (from Sepsis-3) is used to DEFINE organ dysfunction, it is not a sensitive screening tool. It is a great predictor of severity of sepsis and in-hospital mortality

GOLDSTEIN'S AGE SPECIFIC VITAL SIGNS & LABORATORY VARIABLES
(1 Green + 1 Blue)

	1 abnormal measure from these columns PLUS				1 abnormal measure from these columns	
Age Group	**Tachycardia (High HR)**	**Bradycardia (Low HR)**	**Respiratory Rate**	**Systolic Blood Pressure (SBP)**	**WBC/ Leukocyte count**	**Temperature**
0 days – 1 week	>180	<100	>50	<65	>34	>38° C Or <36° C
1 week - 1 month	>180	<100	>40	<75	>19.5 Or <5	>38° C Or <36° C
1 month – 1 year	>180	<90	>34	<100	>17.5 Or <5	>38.5° C Or <36° C
2 - 5 years	>140	NA	>22	<94	>15.5 Or <6	>38.5° C Or <36° C
6 - 12 years	>130	NA	>18	<105	>13.5 Or <4.5	>38.5° C Or <36° C
13 to <18 years	>110	NA	>14	<117	>11 Or <4.5	>38.5° C Or <36° C

**Less than 3 months old >38 qualifies as a fever*

Pediatric Hypotension

70 + (2 x patient age)

Age Group	Systolic Blood Pressure (SBP)
0-1	<70
1-2	<72
2-10	< 70 + (2 x patient's age)
>10	<90

**If 28 days old or younger, gestational age plays a factor in determining hypotension – typically less than 55 is counted as hypotension.*

“Organ Dysfunction”

- Goldstein

Table 4. Organ dysfunction criteria

Cardiovascular dysfunction

Despite administration of isotonic intravenous fluid bolus ≥40 mL/kg in 1 hr

- Decrease in BP (hypotension) <5th percentile for age or systolic BP <2 SD below normal for age[a]

OR

- Need for vasoactive drug to maintain BP in normal range (dopamine >5 μg/kg/min or dobutamine, epinephrine, or norepinephrine at any dose)

OR

- Two of the following

  Unexplained metabolic acidosis: base deficit >5.0 mEq/L

  Increased arterial lactate >2 times upper limit of normal

  Oliguria: urine output <0.5 mL/kg/hr

  Prolonged capillary refill: >5 secs

  Core to peripheral temperature gap >3°C

Respiratory[b]

- Pao_2/Fio_2 <300 in absence of cyanotic heart disease or preexisting lung disease

OR

- $Paco_2$ >65 torr or 20 mm Hg over baseline $Paco_2$

OR

- Proven need[c] or >50% Fio_2 to maintain saturation ≥92%

OR

- Need for nonelective invasive or noninvasive mechanical ventilation[d]

Neurologic

- Glasgow Coma Score ≤11 (57)

OR

- Acute change in mental status with a decrease in Glasgow Coma Score ≥3 points from abnormal baseline

Hematologic

- Platelet count <80,000/mm^3 or a decline of 50% in platelet count from highest value recorded over the past 3 days (for chronic hematology/oncology patients)

OR

- International normalized ratio >2

Renal

- Serum creatinine ≥2 times upper limit of normal for age or 2-fold increase in baseline creatinine

Hepatic

- Total bilirubin ≥4 mg/dL (not applicable for newborn)

OR

- ALT 2 times upper limit of normal for age

Labs – Initial

- Only 2 formal recommendations:
  - Blood cultures are the only formal recommendation
    - Prior to antibiotic if possible
  - Lactate
    - ≥2 can be suggestive but are NOT predicative of sepsis

Decision to treat should be based on clinical evaluation and not only on lab results!

Recommendation #4	Strength & Quality of Evidence
We ***recommend obtaining*** blood cultures before initiating antimicrobial therapy in situations where this does not substantially delay antimicrobial administration.	Best Practice Statement

Recommendation #2	Strength & Quality of Evidence
We were unable to issue a recommendation about using blood lactate values to stratify children with suspected septic shock or other sepsis-associated organ dysfunction into low- versus high-risk of having septic shock or sepsis. However, ***in our practice***, if lactate levels can be rapidly obtained, we often measure blood lactate in children when evaluating for septic shock and other sepsis-associated organ dysfunction.	Insufficient

Labs – CBC

- WBC is poorly sensitive to bacterial infections across age groups
  - Absolute band count >1500 cells/uL is highly specific (>90%) but poorly sensitive (<30%) for bacterial infections
  - Absolute Neutrophil Count (ANC) >10,000 cells/uL moderate specificity (78%-88%) but poor specificity (<50%)
    - ANC is used as a risk stratifier for the AAP Well Appearing Febrile Infant guidelines AND Step by step AND PECARN prediction rule for infants <60 days at low risk of bacterial infections.
      - ANC >4000uL is considered PCARN
      - ANC>10,000mm3

Labs- CRP

- Low positive predictive value for predicting sepsis
- Integrated in some guidelines but some studies show lower diagnostic utility for children with sepsis
- A cut off of 2mg/dL has moderate sensitivity (88%) and specificity (60%) for identification of bacterial infections, higher levels (>8%) having higher specificity

Labs- Procalcitonin

- Most favorable test, especially in combination with other findings and labs to identify infants with SBI ≤60 days old.
- For febrile older children
  - >0.5mg/mL low sensitivity and moderate specificity for bacterial infections.
  - >2mg/mL specificity is higher (94%)
  - Best for use in higher risk children
  - Adult studies have mixed results
  - Limitation to studies- serious bacterial infection was measured outcome, NOT Sepsis or organ dysfunction

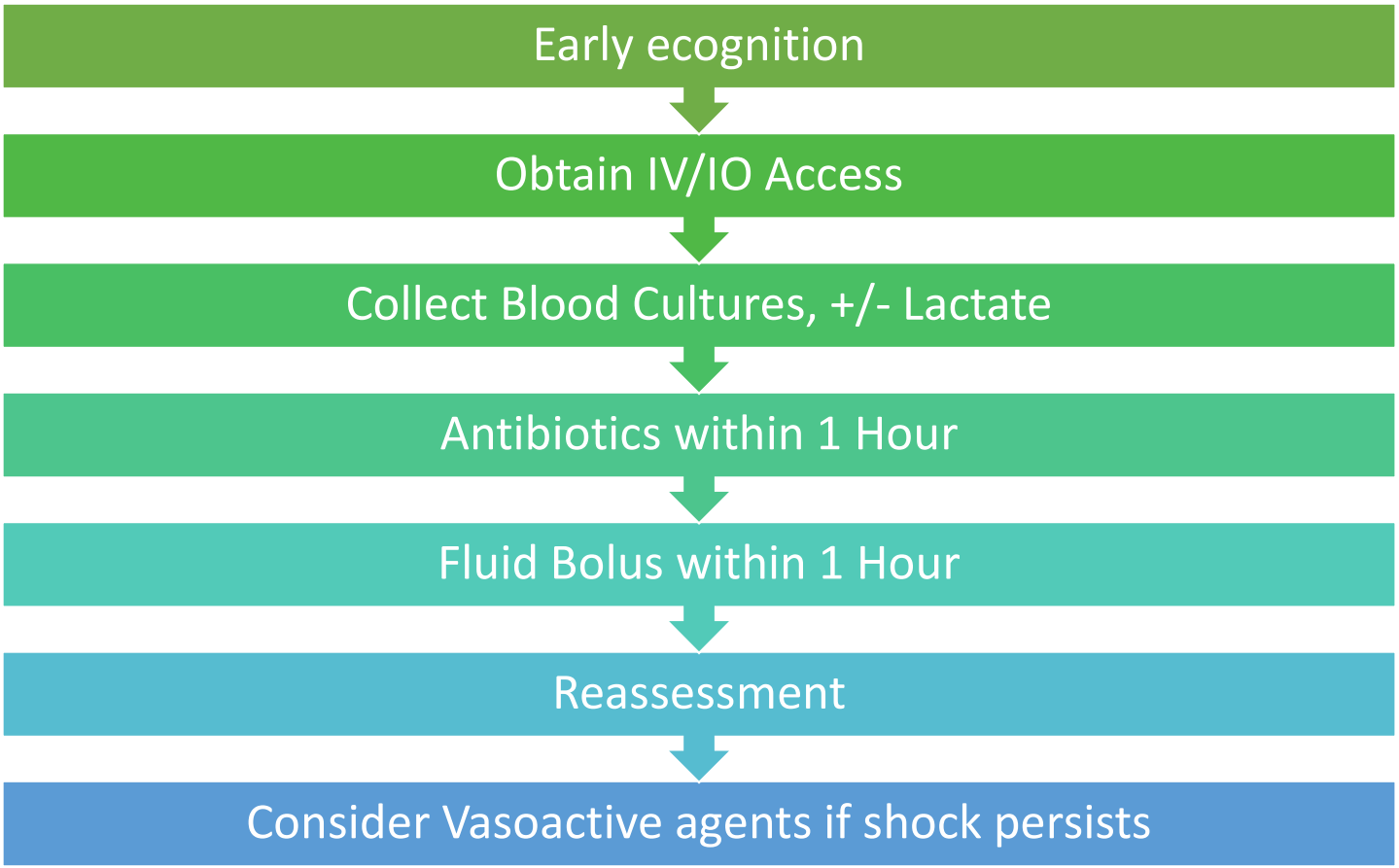
Other labs to consider

- CMP- Elevated LFTs
- Workup of source of fevers
  - Urine/Urine Culture
  - Respiratory Pathogen Panel
  - Chest XRay
  - CSF Studies
  - Troponin/EKG
  - CSF Studies

When to Consider a Lumbar Puncture

- Altered Mental Status
- Clear signs of meningitis
  - Nuchal rigidity, neck stiffness, especially with flexion
  - +kernig or brudinski's sign
  - Not reliable in neonates/young infants
- Encephalitis
- Complex febrile seizure

Sepsis Bundles



Pediatric IV Access

Scalp Veins

Image: IV House

Transillumination

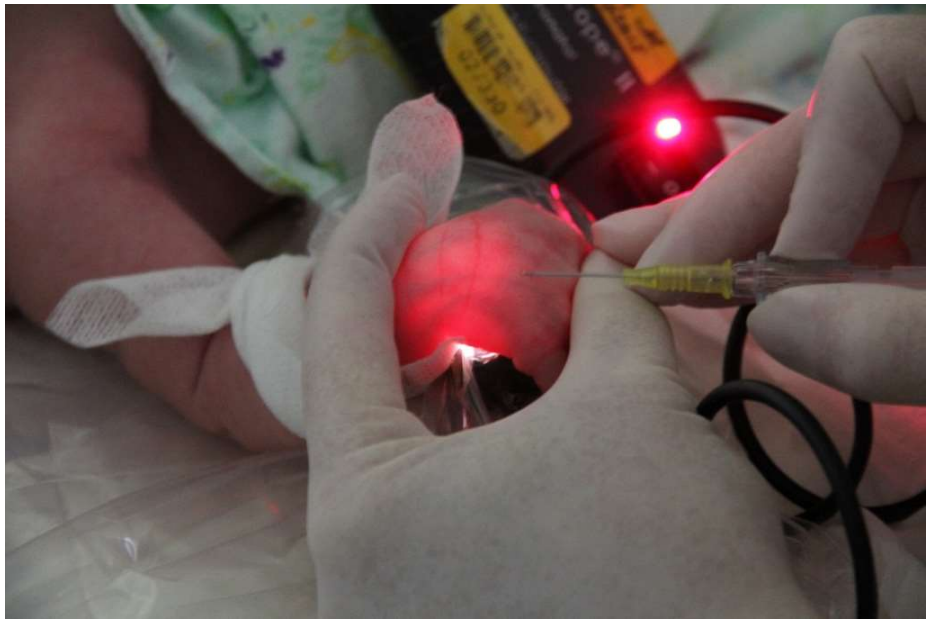


Image: Safer Care Victoria

Intraosseous (IO) Access

Indications

- >3kg <40kg

Contraindications:

- Inability to locate tibial landmarks
- Fracture or recent surgery in the tibia to be used
- Infection over the insertion site

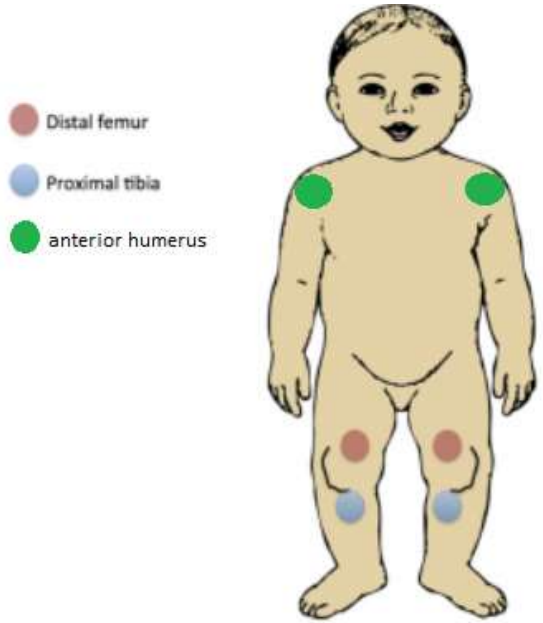


Image: Springerlink

Possible IO Complications

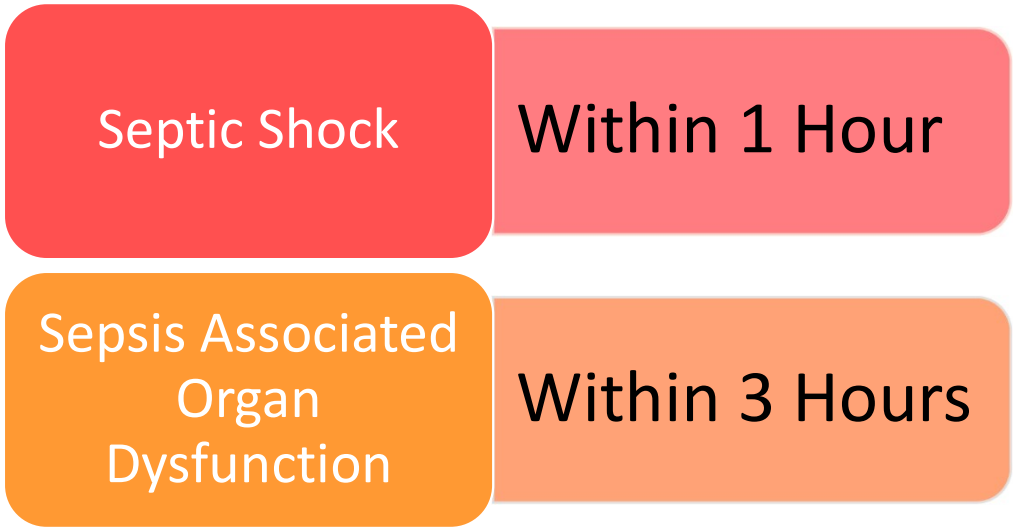
- Compartment syndrome
- Failed infusion
- Growth plate injury
- Bone infection
- Skin infection
- Bony fracture

Antipyretics- Early on

- Why it matters
  - Tachycardia, tachypnea and perfusion may improve
- Medication Options:
  - Oral:
    - acetaminophen 15mg/kg to max of 1000mg
    - Ibuprofen 10mg/kg to max of 800mg
  - Rectal: acetaminophen

Antimicrobial Therapy Timeliness

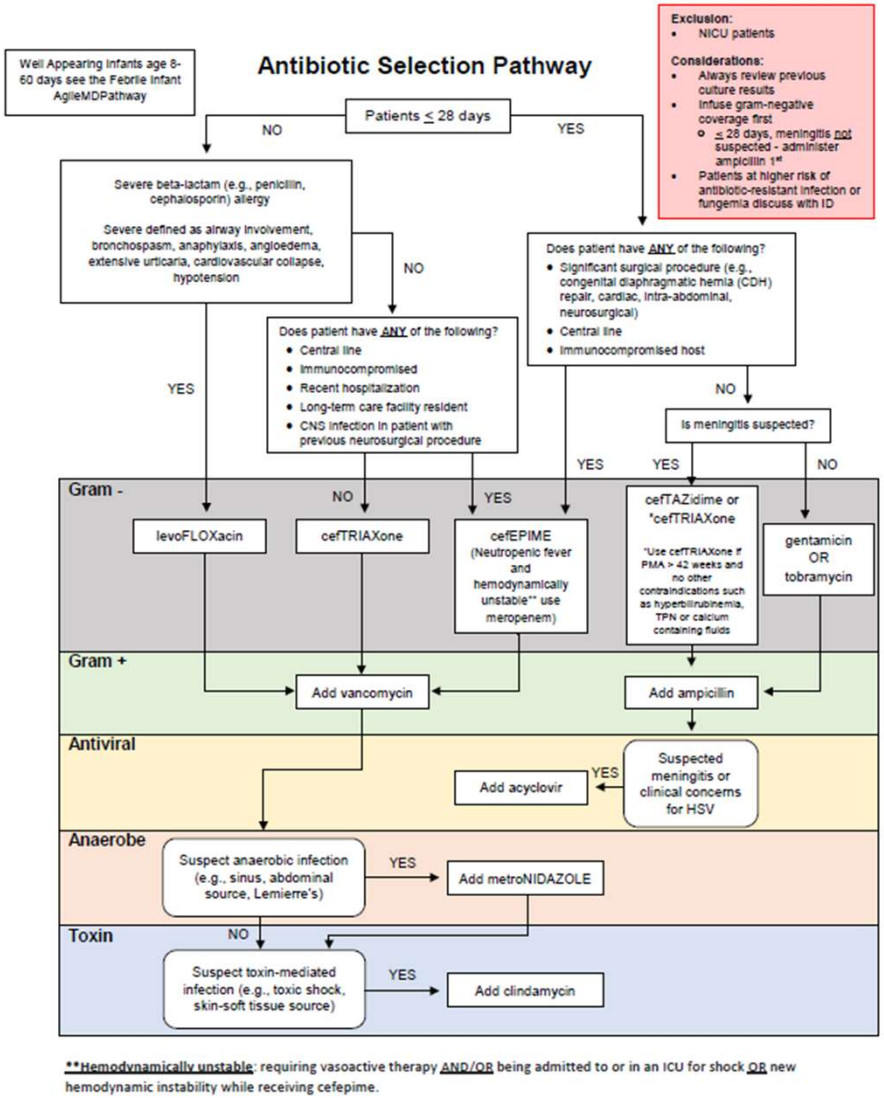
- Broad Spectrum empiric antibiotic therapy should be initiated as quickly as possible
- Choice should be based on:
  - Age
  - Presenting features/focus of infection
  - Comorbidities
  - Local epidemiology



Antibiotics: Which One?

- Choice should be based on:
  - Age
  - Presenting features/focus of infection
  - Comorbidities
  - Local epidemiology
  - Community vs Hospital acquired

- Ceftriaxone is recommended for community-acquired sepsis
  - 50mg/kg, max 2 grams
  - (Not for infants 14 days or less)



**Hemodynamically unstable: requiring vasoactive therapy AND/OR being admitted to or in an ICU for shock OR new hemodynamic instability while receiving cefepime.

Johns Hopkins All Children's Pediatric Sepsis Clinical Pathway

Antibiotics

- 2 retrospective observational studies
  - 1st: 130 children, 79% with septic shock
  - 2nd: 1179 children 69% septic shock completed bundle within 1 hour of sepsis recognition was associated with decreased mortality
- Initiation of antimicrobials ALONE was not significant
- Other secondary endpoints
  - Reduced LOS
  - Shorter duration of organ dysfunction
  - Reduced development of multiple organ dysfunction syndrome

Fluids (Weak, Low Quality of Evidence)

- Effective fluid resuscitation in septic shock can correct hypovolemia
- Considerations of systems with and without intensive care capabilities
- Monitoring cardiac output & signs of fluid overload
- They looked at 3 RCTs

10-20mL/kg bolus (max 1L)

Reassess monitor for signs of CO (HR, BP, cap refill time, LOC, Urine output)

Can repeat bolus based on reassessment to a max of 40-60 ml/kg

FEAST Study

- Higher mortality in east Africa with infection and organ dysfunction receiving fluid boluses
- SSC recommends taking healthcare setting into account
- Most US setting s have interventions such as ventilation and inotropes

Fluid Responsiveness Determines Catecholamine Use

- Fluid Refractory Shock
  - Persistent shock despite at least 40–60 ml/kg of fluid resuscitation in the first hour (Martin, et al)
- Catecholamine Refractory Shock
  - Shock that persists despite 60 ml/kg of fluid and escalating doses of vasoactive infusions (Martin, et al)

Improving Pediatric Sepsis Outcomes (IPSO) Collaborative

- Initiated in 2016 by CHA
- So far a 19% Decrease in sepsis related mortality, 30% increase in sepsis recognition
- 5 key processes identified:
  - Sepsis screening
  - Sepsis huddle
  - Order set utilization
  - Time to first fluid bolus
  - Time to first IV antibiotic

Corticosteroids, Endocrine & Metabolic Management

- Hydrocortisone, insulin, calcium and levothyroxine

Vasoactive Medications

- No formal recommendations but Epinephrine or norepinephrine is preferred as 1st line to dopamine
- No formal recommendations about giving through a peripheral line but CAN consider dilution if a central line is delayed (SCCM)

Airway Management: Intubation and Ventilation

- Follow PALS recommendations
- Suggest trial of noninvasive first
- No formal recommendation to intubate septic shock but CAN do so
- Do NOT use etomidate

Revisiting Rory's Case

What are some clues this patient was septic?

- Tachycardia
- Elevated WBC

What are the red flag symptoms the ER provider could have educated the family on?

Case Review

- 4 month old female presents to the ER with fever
- History of prematurity at xx weeks, and history of SVT, controlled well on XXX
- Was admitted and Recently discharged for Salmonella Bacteremia and UTI. Discharged on 10 days of Keflex, on day 11 fevers returned this morning.
- Went to an outside ER where they obtained labs and blood culture and sent home.
- Patient arrived to ER febrile and tachycardic

Case Review

- What labs do we get?
- Do we hold off antibiotics for testing?
- What other diagnoses should we consider?

Case Review

- She was intubated in the ER due to respiratory arrest and admitted to the PICU for Salmonella Meningitis
- Patient had continued seizures secondary encephalopathy, is blind and deaf

How Do You Implement This in Your Practice?

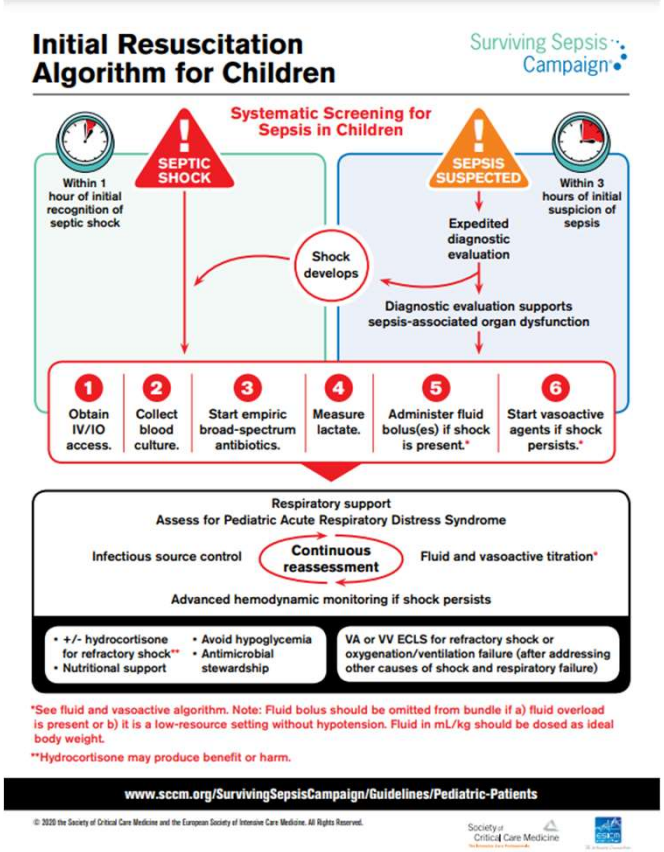
- Clinic setting
  - Early recognition is key
  - Know and educate on signs and symptoms of sepsis
- ER
  - Clinical Pathways!
  - QI metrics

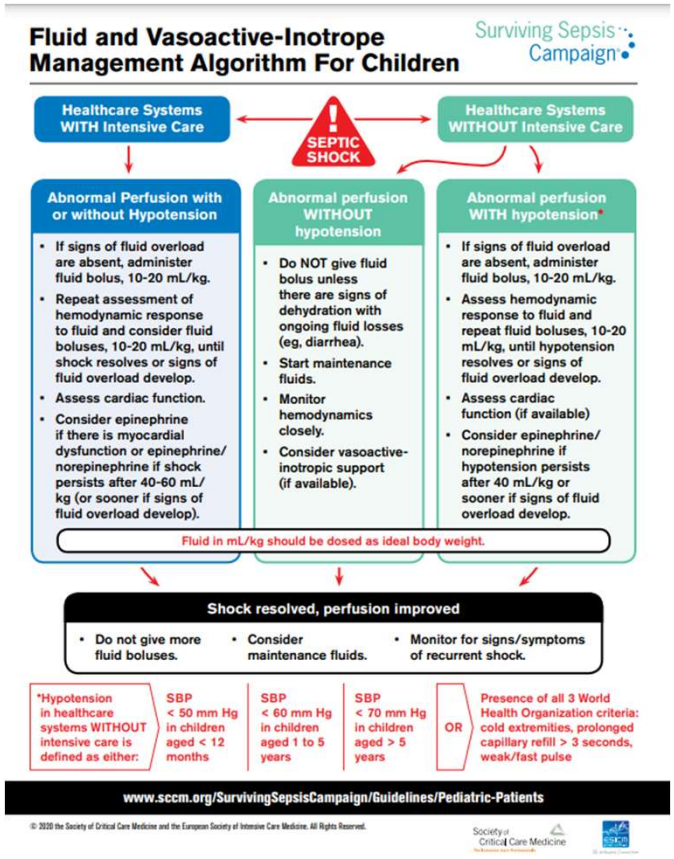
Pediatric Sepsis Clinical Pathways

- Johns Hopkins All Children's
- CHOP
- Cincinnati Children’s

Recommendation #3	Strength & Quality of Evidence
We ***recommend implementing*** a protocol/guideline for management of children with septic shock or other sepsis-associated organ dysfunction.	Best Practice Statement

Surviving Sepsis Campaign





Surviving Sepsis Campaign

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Questions?

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Reference Slides

Sep-1 Bundle

- In 2015, the Centers for Medicare and Medicaid Services (CMS) instituted an all-or-none sepsis performance measure bundle (SEP-1) to promote high-quality, cost-effective care.
- Systematic reviews demonstrated low-quality evidence supporting most of SEP-1's interventions.
- SEP-1 includes:
  - lactate level, blood cultures
  - broad-spectrum antibiotics
  - if hypotensive, a fixed 30 mL/kg fluid infusion within 3 hours
  - repeat lactate if initially elevated within 6 hours

Adults vs Peds Showdown

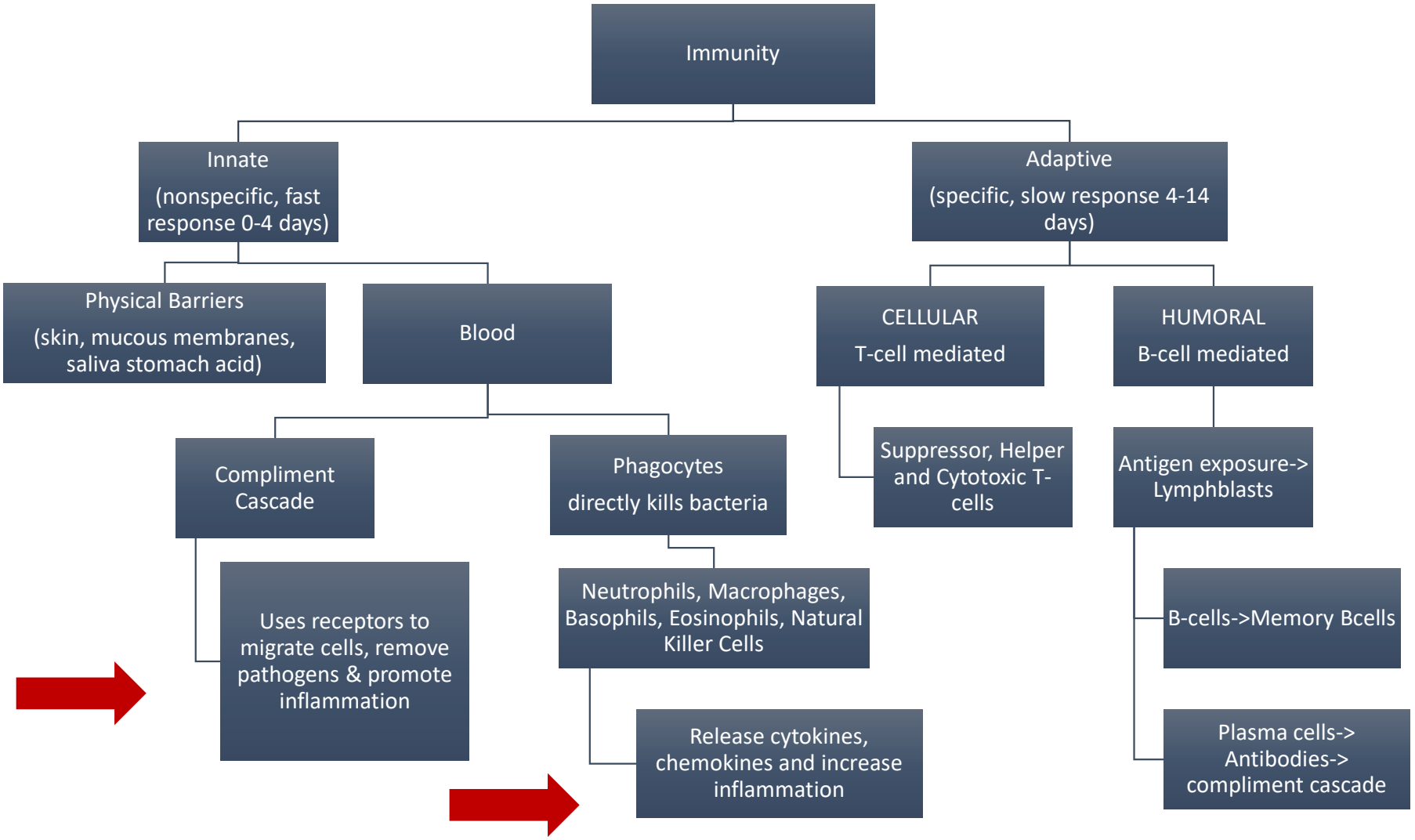
	ADULT	PEDIATRIC
MAP targets		No official recommendations, but CAN use 5th-50th percentile for age
How to assess fluid response	Dynamic testing	Dynamic testing
Septic Shock Fluids	30cc/kg over 3 hours	ICU access: Total 40-60mL/kg bolus No ICU:
Lactate	Yes (low)	Not enough data, get them if you want
Septic Shock Vasoactive 1st line:	Norepi, Dopamine	No formal recommendation but CAN use Norepi, Epi

Adults vs Kid Tx Similarities

- Screening
- Abx Source Control
- Dynamic Monitoring over static
- Adequate Nutrition
- Vent Management similar to adults

Adults vs Kids Treatment Differences

- Shock in kids includes sepsis without shock
  - If present with shock, abx in 1 hour
  - If no shock, abx within 3 hours


Immunity
Innate
(nonspecific, fast response 0-4 days)
Adaptive
(specific, slow response 4-14 days)
Physical Barriers
(skin, mucous membranes, saliva stomach acid)
Blood
CELLULAR
T-cell mediated
HUMORAL
B-cell mediated
Compliment Cascade
Phagocytes
directly kills bacteria
Suppressor, Helper and Cytotoxic T-cells
Antigen exposure-> Lymphblasts
Uses receptors to migrate cells, remove pathogens & promote inflammation
Neutrophils, Macrophages, Basophils, Eosinophils, Natural Killer Cells
B-cells->Memory Bcells
Release cytokines, chemokines and increase inflammation
Plasma cells-> Antibodies-> compliment cascade

- Recognition of sepsis in children can be difficult in the emergency setting yet studies continue to show that early recognition contributes to improved clinical outcomes, reducing morbidity and mortality. This presentation will review the 2020 pediatric guideline updates and pediatric sepsis collaborative recommendations contextualized for PAs working in emergency medicine or in a setting where pediatric specialists may not be readily available.