Pediatric Septic Shock: See It. Say It. Act on it.

Children's Hospital Colorado Virtual Pediatric Care Symposium

Michael Wittkamp, MD

Associate Professor, Pediatric Critical Care Medicine

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Disclosures

I have no relevant financial disclosures

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Other Disclaimers

- I'm a failed rural, primary care pediatrician
- I don't perform primary research in pediatric sepsis
- *I* didn't make this the last topic of the day!

Objectives

- Define pediatric sepsis and septic shock by current criteria
- State the worldwide impact of pediatric sepsis and need for early recognition and intervention
- Review priorities of intervention to ensure best outcomes

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Case Review 1: An origin story

12yo male presents with fever, vomiting and stomach upset and muscle aches

History: fully immunized, no chronic conditions, no past hospitalizations/surgery

Exam:

Tachycardia to 100s, BP 100/70, RR 20, SpO2 99% in RA

Alert, mildly ill appearing

Tachycardia, RR, no murmur; CR 2-3s; peripheral pulse 2+

Lungs CTAB

Abdomen Soft, NT, ND

Skin: small laceration and abrasions to left forearm (proudly reports he dove for ball in gym a few day ago); mild erythema, no purulence, non-tender

Case Review #1

Further history: fever and vomiting started this morning, NBNB

Actions:

Labs are drawn (BMP, CBC)

Receives NS 20ml/kg and acetaminophen

Patient feels better, HR improves

Treating team feels that he likely has a stomach virus and patient is discharged

Labs return after discharge notable for WBC 15K with 15% bands

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Case Review #1

About 20hrs later patient presents to ED. He is lethargic with a high fever and hypotension.

Patient is intubated, given antibiotics and transported to the PICU. His hypotension does not respond well to fluids, pressors and steroids and he has worsening multi-organ failure. Blood cultures grow out Group A Streptococcus

The patient dies 2 days later from septic shock with related multi-organ dysfunction syndrome

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Rory Staunton

- This was a real case that occurred in New York City in 2012
- The patient's parents happened to be good friends with a NYT reporter so the story went viral
- As opposed to seeking a personal settlement from the treating facility, the parents wanted better awareness of sepsis/septic shock so other children might be saved
- This incident sparked a national campaign that led to improved screening for and treatment of pediatric sepsis

Photo courtesy of the Rory Staunton Foundation

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

It is still a challenge . . .

- Sam Terblanche was a 19yo college student in NYC
- In 2023 he made two visits to a large, well-established hospital ED complaining of headache, myalgias, fatigue and vomiting
- Both times he was told he had a viral syndrome and was discharged
- He was found dead in his dormitory a 2 days after his last visit. Autopsy findings were consistent with sepsis.
- Case was complicated by high-volume ED traffic, multiple providers, complicated EHR order sets, and "note bloat" superimposed on a difficult diagnosis

Miller, Lisa. (2025, Oct 9) It's Just a Virus, the ER Told Him. Days Later, He Was Dead. NYT https://www.nytimes.com/2025/10/05/well/sam-terblanche-virus-death-columbia.html

5000 years of sepsis; you'd think we'd have it down by now

- Papyrus from 3000 BCE discusses sepsis from battle wounds
- Noted redness at wound led to fever on to extension of inflammation and then systemic signs
- Apparently if the wound smelled of ram's urine it was a bad prognosis

https://www.amazon.com/Happy-Silly-Jolly-Animal-Cartoon/dp/B06Y1MCY4X

Hernandez Botero, J. S., & Florian Perez, M. C. (2012). The History of Sepsis from Ancient Egypt to the XIX Century. InTech. doi: 10.5772/51484

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

The Greeks new it about it, too

- The Greeks also noted the progression of sepsis from injuries in battle
- The Egyptians and Greeks had pretty good ideas on treatment:
  - Incision and drainage
  - Clean bandages
  - Honey (antiseptic)
  - Wine/vinegar (antiseptic)
  - Green copper ore powder (antimicrobial)
  - Spiderwebs (astringent, clotting matrix)

Achilles bandaging Patroclus, c500BC.
(Photo: Public Domain/WikiCommons)

So, you're gonna' bring up Homer's "The Odyssey"

- Sepo – "I rot"
- Appears in Homeric poems from 750 BCE
- Achilles corpse is uncorrupted after a week though the dead around him have begun to rot

Groening M, writer. The Simpsons: Treehouse of Horror III [television series episode]. In: Groening M, producer. The Simpsons. Fox Broadcasting Company; 1992.

The modern age: preventable sepsis

Ignaz Semmelweis

- Physician in Vienna in 1800s
- In one hospital, 20% of women died in the post-partum period from “childbed fever”
- Semmelweis noted that most of the physicians called to delivery came directly from the morgue
- Handwashing wasn’t a big thing then, but he asked everyone to try it out
- Mortality dropped to 2%

Bettmann. Semmelweis Washing Hands [photograph]. Bettmann Archive. Accessed October 9, 2025.

Unhappy ending

- Semmelweis’s colleagues didn’t believe in germ theory
- He becomes so persecuted that he has a nervous breakdown and his colleagues commit him to an asylum (or it was syphilis)
- During one his beatings by the asylum guards he incurs a cut on his hand
- He dies 2 weeks later from . . . SEPSIS

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children’s Hospital Colorado

Davis, R. 12Jan2015. *The Doctor Who Championed Handwashing and Briefly Saved Lives* [Radio Broadcast]. NPR. https://www.npr.org/sections/health-shots/2015/01/12/375663920/the-doctor-who-championed-hand-washing-and-saved-women-s-lives

The Burden of Sepsis Worldwide

https://www.worldsepsisday.org/sepsisfacts

epartment of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Sepsis FACTS

Sepsis arises when the body's response to an infection injures its own tissues and organs. It may lead to shock, multi-organ failure, and death – especially if not recognized early and treated promptly. Sepsis is the final common pathway to death from most infectious diseases worldwide, including viruses such as SARS-CoV-2.

47 - 50 million cases per year[1]

At least **11 million** deaths per year[2]

1 in 5 deaths worldwide is associated with **sepsis**[3]

Sepsis is the number 1
- Cause of death in hospitals[4]
- Cause for hospital readmissions[5]
- Healthcare cost[6]

(e.g. $62 billion is spent on sepsis healthcare costs in the US alone)

Up to **50%** of sepsis survivors suffer from long-term physical and/or psychological effects[7]

40% of cases are children **under 5**[8]

80% of sepsis cases occur **outside** of a hospital[9]

SEPSIS is always caused by an **infection** like pneumonia or diarrheal illness[10]

SEPSIS is a medical **emergency** - if you or someone you know shows signs of sepsis, seek medical care immediately. Every hour counts.[11]

These signs may indicate sepsis:

Slurred Speech or Confusion

Extreme Shivering or Muscle Pain /Fever

Passing No Urine All Day

Severe Breathlessness

It Feels Like You're Going to Die

Skin Mottled or Discolored

September 13

You can help #StopSepsis and #SaveLives

Get involved at worldsepsisday.org

References

1, 2, 3, 8, 10 Rudd et al, https://doi.org/10.1016/S0140-6736(19)32989-7.

4 Rhee et al, https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2724768

5 Torio et al, https://www.hcup-us.ahrq.gov/reports/statbriefs/sb204-Most-Expensive-Hospital-Conditions.pdf

6 Buchman et al, https://journals.lww.com/ccmjournal/Fulltext/2020/03000/Sepsis_Among_Medicare_Beneficiaries__3__The.4.aspx

7 Prescott et al, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5839473/

9 Rhee et al, https://jamanetwork.com/journals/jama/fullarticle/2654187

11 Seymour et al, https://www.nejm.org/doi/10.1056/NEJMoa1703058

Last updated: November 2020

Pediatric Sepsis in the US

- About 75,000 hospitalizations annually
- About 6500 deaths annually
- Case fatality rate 3-25%, depending of comorbidities and access to care
- $7B+ annually in direct and indirect costs

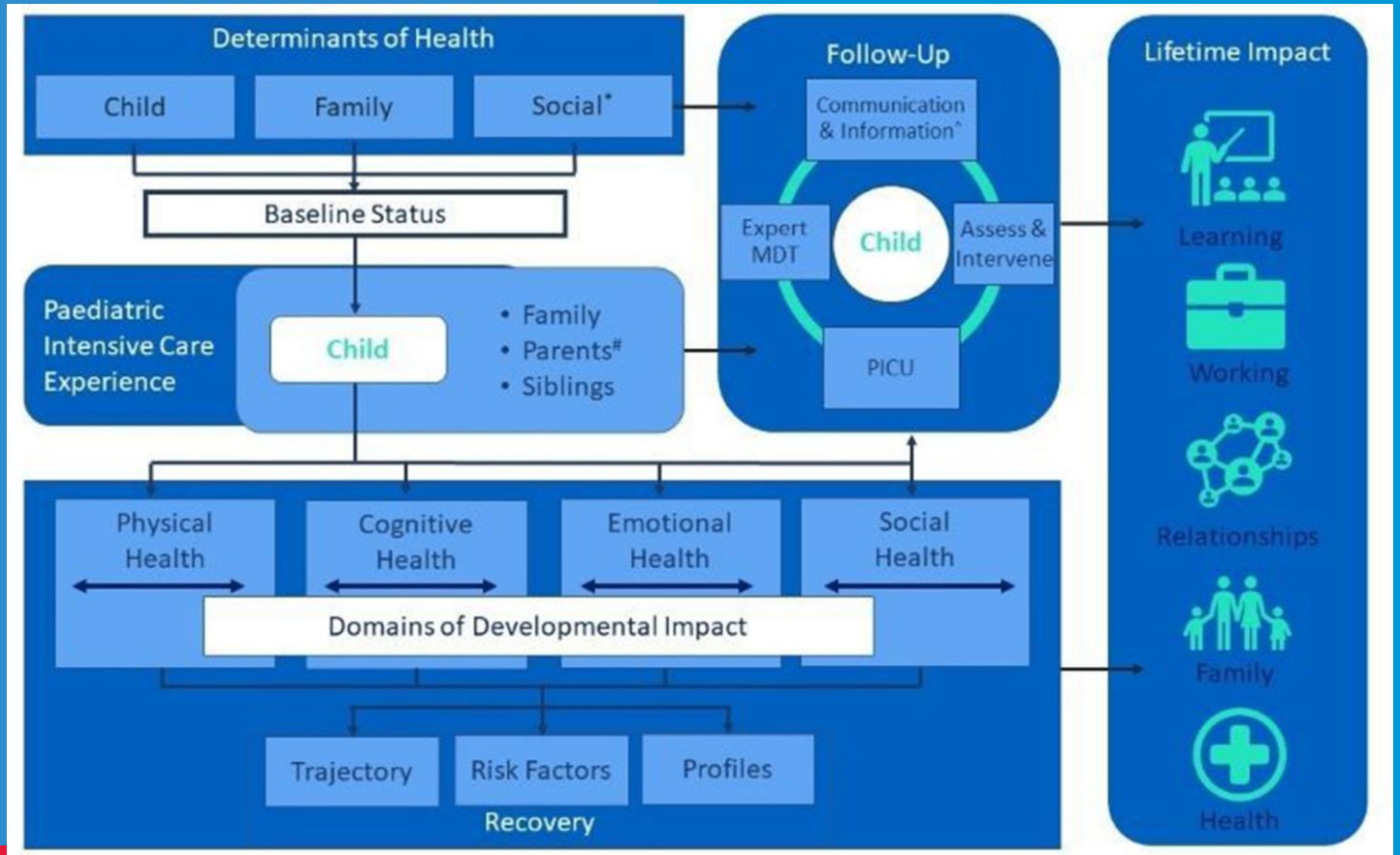
Scott L. Weiss, Julie C. Fitzgerald; Pediatric Sepsis Diagnosis, Management, and Sub-phenotypes. *Pediatrics* January 2024; 153 (1): e2023062967. 10.1542/peds.2023-062967

Carlton EF, Barbaro RP, Iwashyna TJ, Prescott HC. Cost of Pediatric Severe Sepsis Hospitalizations. JAMA Pediatr. 2019 Oct 1;173(10):986-987. doi: 10.1001/jamapediatrics.2019.2570. PMID: 31403673; PMCID: PMC6692673.

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

What about long term impact on survivors?



Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Jessicah Minogue, Samantha Keogh, Luregn J. Schlapbach, Debbie Long, Long-term outcomes after paediatric sepsis: A narrative review, Australian Critical Care,Volume 37, Issue 3,2024,Pages 499-507. https://doi.org/10.1016/j.aucc.2023.04.002.

Incidence of and Risk Factors For Increased Healthcare Utilization After Pediatric Sepsis Hospitalization

Erin F. Carlton, MD MSc[1,2], Moshiur Rahman, PhD[2], Aline B. Maddux, MD, MSCS[3], Scott L. Weiss, MD MSCE[4,5], Hallie C. Prescott, MD MSc[6,7]

- Retrospective observational cohort study
- 2801 patients, </= 18yo admitted for sepsis using insurance billing code data (commercial and Medicaid), 2016-19
- Looked at increase in ED visit or hospitalizations following sepsis admission within 90days of discharge
- 865 (30.9%) of patients met this definition for increased use
- If admission longer than 30 days, aOR 4.53
- Increased aOR (1.37-1.96) if chronic, complex issues prior to admission

Carlton EF, Rahman M, Maddux AB, Weiss SL, Prescott HC. Frequency of and Risk Factors for Increased Healthcare Utilization After Pediatric Sepsis Hospitalization. Crit Care Med. 2024 Nov 1;52(11):1700-1709. doi: 10.1097/CCM.0000000000006406. Epub 2024 Sep 19. PMID: 39297738; PMCID: PMC12344780.

To fight it, we have to define it

- Evolving definition
- Initially, emphasis on inflammatory aspects
  - Systemic Inflammatory Response Syndrome (SIRS)
- As of 2016, a move to emphasize immune dysregulation and organ dysfunction in adults
- Pediatric definitions lagged behind, using old criteria from early 2005

Definition and adherence have always been an issue

Study from 2003 looked at treatment of pediatric sepsis in community EDs

Used the AHA PALS definition and guidelines for treatment goal

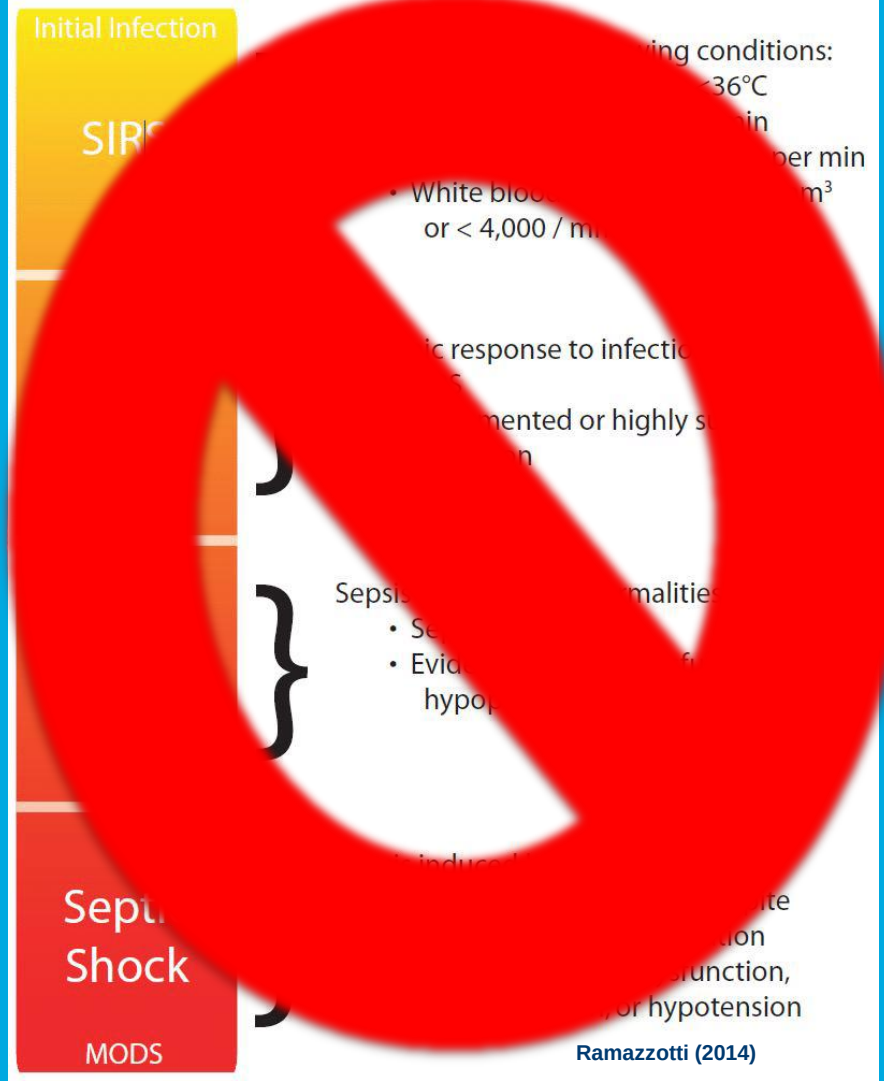
Found:

- 29% mortality (!)
- 26% of shock was reversed prior to transport
- Only 30% adherence to guidelines
- Adherence to guideline resulted in 6x increased odds of survival (!)
- Each hour of hypotension increased odds of mortality by 2x

Yong Y. Han, Joseph A. Carcillo, Michelle A. Dragotta, Debra M. Bills, R. Scott Watson, Mark E. Westerman, Richard A. Orr; Early Reversal of Pediatric-Neonatal Septic Shock by Community Physicians Is Associated With Improved Outcome. *Pediatrics* October 2003; 112 (4): 793–799. 10.1542/peds.112.4.793

What was wrong with the old 2005 International Pediatric Sepsis Consensus Conference Criteria?

- Heavily emphasized inflammation
- Poor sensitivity AND specificity
- Poor application in resource-poor/low-income countries
- Very poor correlation with outcomes



Ramazzotti (2014)

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Phoenix Scoring Criteria for Pediatric Sepsis

- Replacement for IPSCC 2005 criteria
- Data-driven, outcomes-based
- based on more than 3.5 million electronic health record encounters from 10 sites on 4 continents
- Combined several existing illness severity scores (SOFA-3, PELOD-2, etc.)
- Applicable in all environments
- Oriented toward ED presentations

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Schlapbach LJ, Watson RS, Sorce LR, et al. International Consensus Criteria for Pediatric Sepsis and Septic Shock. JAMA. 2024;331(8):665–674. doi:10.1001/jama.2024.0179

What drove the move to Phoenix Sepsis Criteria?

- Nearly 3000 physicians who care for critically ill children were surveyed across 6 continents
- Most indicated that they approached pediatric sepsis (officially based on SIRS foundation) as infectious process with related organ dysfunction (more in-line with adult 2016 Sepsis-3)
- Current definition:
  - showed a lack of correlation with outcomes
  - had poor applicability in low-resource countries
  - made study of pediatric sepsis and septic shock very difficult

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Schlapbach LJ, Watson RS, Sorce LR, et al. International Consensus Criteria for Pediatric Sepsis and Septic Shock. JAMA. 2024;331(8):665–674. doi:10.1001/jama.2024.0179

Phoenix Scoring System

- >37wks EGA newborn to 18yo
- Data from within 24hrs of presentation
- Maximum Score is 13
- Score >/=2 defines sepsis
- One or more points in CV is septic shock
- Primary outcome was early mortality (72hrs)
- Secondary outcome was ECMO

Schlapbach LJ, Watson RS, Sorce LR, et al. International Consensus Criteria for Pediatric Sepsis and Septic Shock. JAMA. 2024;331(8):665–674. doi:10.1001/jama.2024.0179

Table. The Phoenix Sepsis Score[a]

Variables	0 Points	1 Point	2 Points	3 Points
Respiratory (0-3 points)				
	Pao_2:FIo_2 ≥400 or Spo_2:FIo_2 ≥292[b]	Pao_2:FIo_2 <400 on any respiratory support or Spo_2:FIo_2 <292 on any respiratory support[b,c]	Pao_2:FIo_2 100-200 and IMV or Spo_2:FIo_2 148-220 and IMV[b]	Pao_2:FIo_2<100 and IMV or Spo_2:FIo_2 <148 and IMV[b]
Cardiovascular (0-6 points)				
		1 Point each (up to 3) for:	2 Points each (up to 3) for:	
	No vasoactive medications[d]	1 Vasoactive medication[d]	≥2 Vasoactive medications[d]	
	Lactate <5 mmol/L[e]	Lactate 5-10.9 mmol/L[e]	Lactate ≥11 mmol/L[e]	
Mean arterial pressure by age, mm Hg[f,g]				
<1 mo	>30	17-30	<17	
1 to 11 mo	>38	25-38	<25	
[illegible] <2 y	>43	31-43	<31	
2 to <5 y	>44	32-44	<32	
5 to <12 y	[illegible]	36-48	<36	
12 to 17 y	>51	[illegible]	<38	
Coagulation (0-2 points)[h]				
		1 Point each (maximum of 2 points) for:		
	Platelets ≥100 × 10^3/μL	Platelets <100 × 10^3/μL		
	International normalized ratio ≤1.3	International normalized ratio >1.3		
	D-dimer ≤2 mg/L FEU	D-dimer >2 mg/L FEU		
	Fibrinogen ≥100 mg/dL	Fibrinogen <100 mg/dL		
Neurological (0-2 points)[i]				
	Glasgow Coma Scale score >10; pupils reactive[i]	Glasgow Coma Scale score ≤10[i]	Fixed pupils bilaterally	
Phoenix sepsis criteria				
Sepsis	Suspected infection and Phoenix Sepsis Score ≥2 points			
Septic shock	Sepsis with ≥1 cardiovascular point(s)			

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

How much better is Phoenix compared to the old criteria?

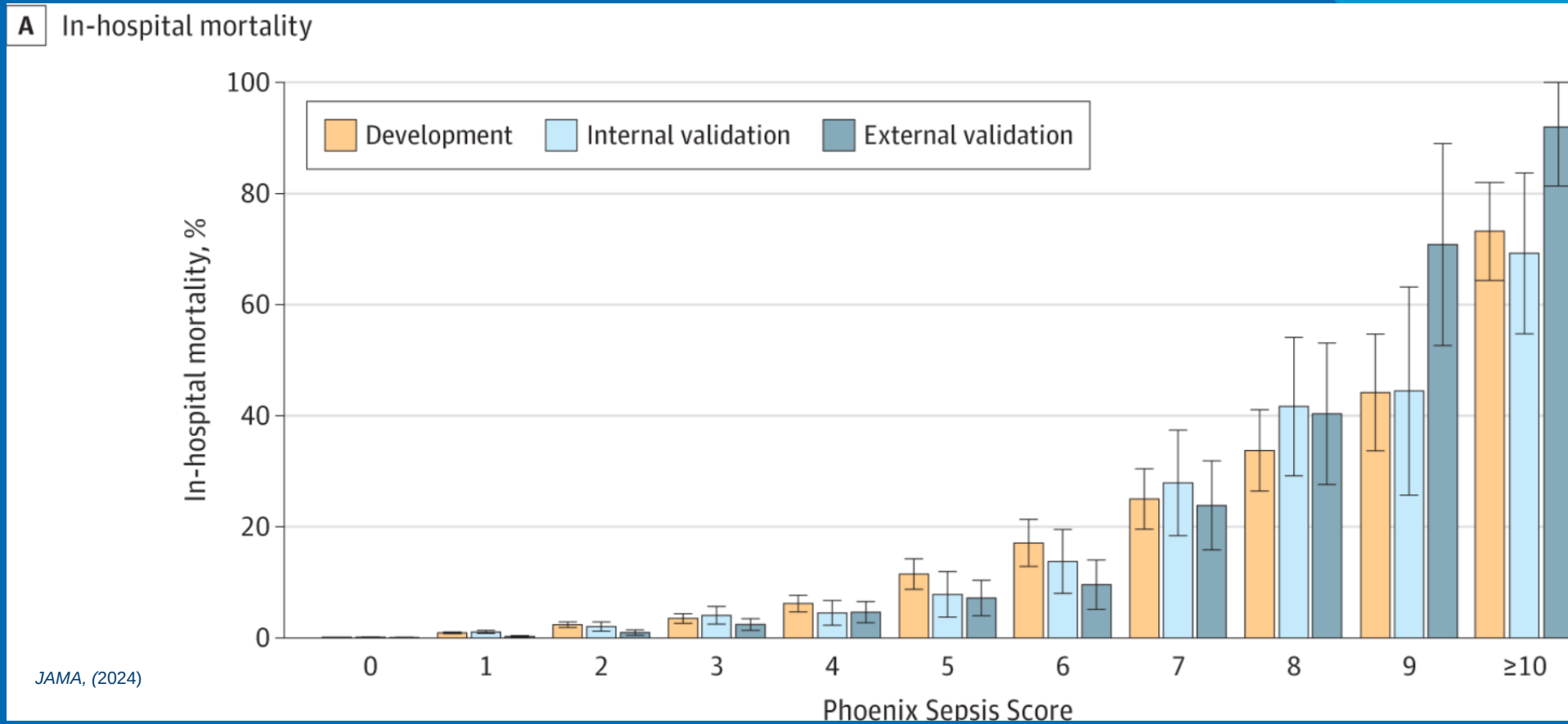
Death in First 24hrs at High Resource Facility		
Criteria	**PPV**	**SN**
IPSCC – Severe Sepsis	3.6-4.8%	58.7-70.7%
Phx SS - Sepsis	5.3-7.1%	69.2-84.4%

Death in First 24hrs at Low Resource Facility		
Criteria	**PPV**	**SN**
IPSCC – Severe Sepsis	12.7%	49.2%
Phx SS - Sepsis	22.2%	81.8%

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

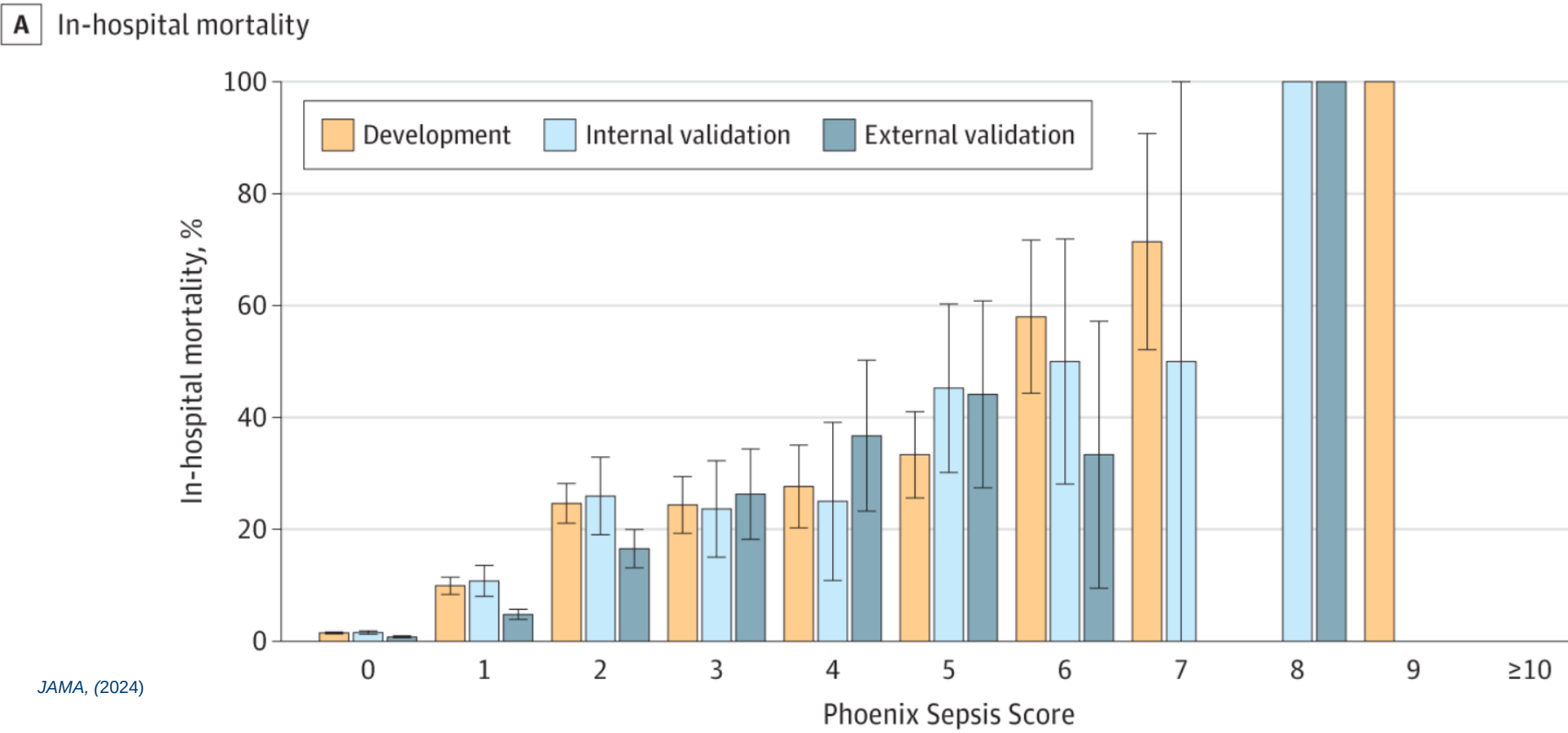
Children's Hospital Colorado

In-Hospital Mortality Associated With the Phoenix Sepsis Score in Patients in Higher-Resource Settings With Suspected Infection in the First 24 Hours



JAMA, (2024)

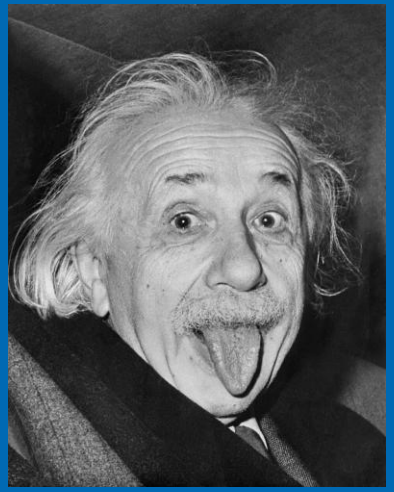
In-Hospital Mortality Associated With the Phoenix Sepsis Score in Patients in Lower-Resource Settings With Suspected Infection in the First 24 Hours



JAMA, (2024)

In depth explanation of how the Phoenix Score was derived

Big Data



Super Smart People

High-tech Computer Stuff

https://unsplash.com/s/photos/license=free

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

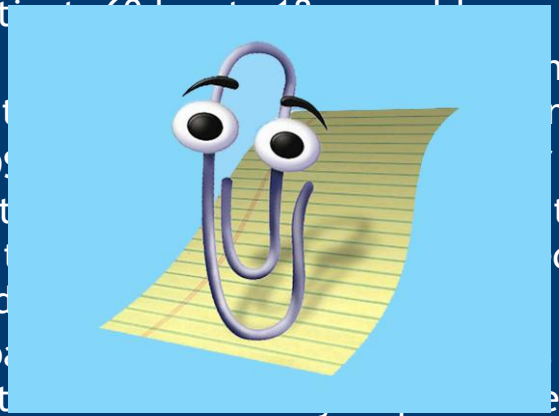
Children's Hospital Colorado

The future with Phoenix

- Integration with EHR alert systems
- Integration with clinical decision-making tools
- Risk stratification to avoid missed cases (improved signal to noise)
- Risk stratification to marshal appropriate resources/response
- Integration with evolving point-of-care sepsis profile testing
- Better identification of at-risk patient populations
- Better analysis of efficacy of interventions
- Improved comparison between studies

Can your EHR be a friend?

- Clinical decision support alert system
- Single center system with 4 sites, 1 year
- Pat
- Of net crit rol)
- CDS tside pat of d ord
- Go epsis wit (this is the usual standard for septic shock)
- No difference between two arms in primary goal (38% completion) or progression to septic shock
- But it was rated as unobtrusive!



Halden F. Scott, Carter J. Sevick, Kathryn L. Colborn, Sara J. Deakyne Davies, Christopher H. Greer, Ashley Dafoe, Brooke Dorsey Holliman, Lalit Bajaj, Sarah K. Schmidt, Allison Kempe; Clinical Decision Support for Septic Shock in the Emergency Department: A Cluster Randomized Trial. *Pediatrics* July 2025; 156 (1): e2024069478. 10.1542/peds.2024-069478

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

A moment for local recognition

Tell Bennett, MD
Critical Care

Halden Scott, MD
Emergency Medicine

Aline Maddux, MD
Critical Care

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Initial Resuscitation Algorithm for Children

Surviving Sepsis Campaign

Systematic Screening for Sepsis in Children

SEPTIC SHOCK

Within 1 hour of initial recognition of septic shock

SEPSIS SUSPECTED

Within 3 hours of initial suspicion of sepsis

Expedited diagnostic evaluation

Shock develops

Diagnostic evaluation supports sepsis-associated organ dysfunction

1. Obtain IV/IO access.
2. Collect blood culture.
3. Start empiric broad-spectrum antibiotics.
4. Measure lactate.
5. Administer fluid bolus(es) if shock is present.*
6. Start vasoactive agents if shock persists.*

Respiratory support

Assess for Pediatric Acute Respiratory Distress Syndrome

Infectious source control — **Continuous reassessment** — Fluid and vasoactive titration*

Advanced hemodynamic monitoring if shock persists

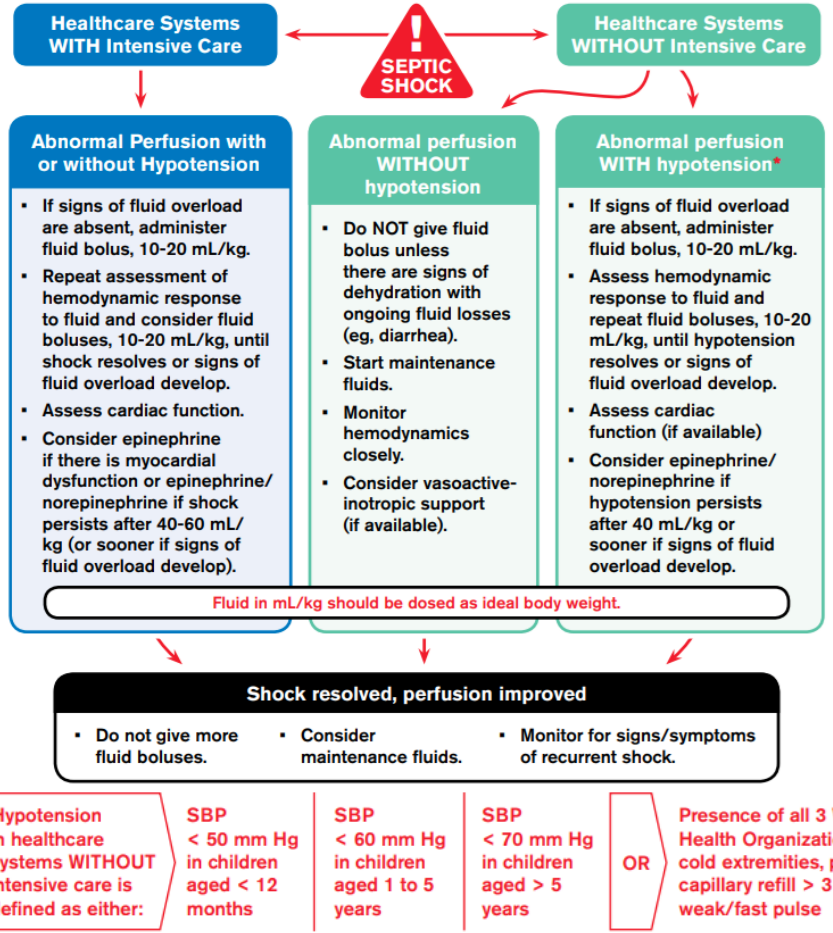
- +/- hydrocortisone for refractory shock**
- Nutritional support
- Avoid hypoglycemia
- Antimicrobial stewardship

VA or VV ECLS for refractory shock or oxygenation/ventilation failure (after addressing other causes of shock and respiratory failure)

Surviving Sepsis Campaign. Surviving Sepsis Campaign Pediatric Guidelines. *Society of Critical Care Medicine*. Accessed October 10, 2023.

Fluid and Vasoactive-Inotrope Management Algorithm For Children

Surviving Sepsis Campaign



Surviving Sepsis Campaign. Surviving Sepsis Campaign Pediatric Guidelines. *Society of Critical Care Medicine*. Accessed October 10, 2023.

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Well, that's it! Just follow the guide!

- Execution is the problem
- Adherence is variable, even at pediatric specialty centers
- Despite recommendations for targeted sepsis treatment protocols only abut 73% of US hospitals have them (only 53% of hospitals with 25 beds or less)
- Limitations:
  - Delayed recognition
  - Undertrained staff
  - No oversight (no funding)
  - Inconsistent resource availability
  - Opt-in systems

Dantes RB, Kaur H, Bouwkamp BA, et al. Sepsis Program Activities in Acute Care Hospitals — National Healthcare Safety Network, United States, 2022. MMWR Morb Mortal Wkly Rep 2023;72:907–911. DOI: http://dx.doi.org/10.15585/mmwr.mm7234a2.

But what about the bedside?

The goals at bedside remain:

- Rapid identification
- Activation of resources (Sepsis Alert)
- ABCDE assessment
- Early IV access
- Early fluid resuscitation/pressors
- Avoidance/reversal of hypotension
- Support of end-organ function
- Early antibiotic administration
- Appropriate diagnostics
- Early disposition to appropriate level of care

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Government of Western Australia
Child and Adolescent Health Service

Perth Children's Hospital

Could it be sepsis?

If your child has any one of these symptoms, it could mean they are very unwell and may have sepsis.

Breathing fast, struggling to breathe or long pauses in breathing

Skin is cold to touch or mottled, pale, bright red or discoloured

A rash that doesn't fade when pressed or looks like many small bruises

Drowsiness, confusion, irritability or is difficult to wake

Restless or floppy limbs

Unable or unwilling to walk

Fits or seizures

Severe pain – headache, neck, muscle, chest, limb or joint

Unable to drink or keep fluids down, passing less urine or reduced wet nappies

If you suspect your child has sepsis:

- visit your GP or Urgent Care Clinic
- go to the nearest hospital Emergency Department
- call 000

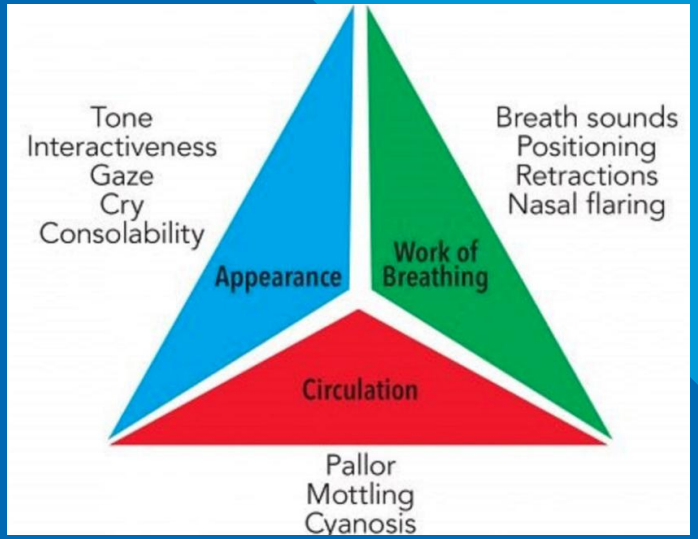
We will listen to you

You know your child best. If you're in hospital and you feel your child is getting worse, speak up and ask a doctor or nurse '**Could it be sepsis?**'

https://pch.health.wa.gov.au/For-patients-and-visitors/Sepsis

How do I SEE sepsis?

- Clinical judgement is still part of the process in identifying patients
- Using tools like the pediatric assessment triangle can be a help
- While new criteria have deemphasized tachycardia and tachypnea, they are still signs of illness that prompt further assessment, including for sepsis
- While common illnesses may cause vital signs abnormalities, remember to reassess your patient for progression of illness or inadequate response to simple interventions



Dieckmann RA, Brownstein D, Gausche-Hill M. The pediatric assessment triangle: a novel approach for the rapid evaluation of children. Pediatr Emerg Care. 2010 Apr;26(4):312-5. doi: 10.1097/PEC.0b013e3181d6db37. PMID: 20386420.

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Signs and symptoms can be confusing

- Fever or hypothermia
- Agitated or lethargic
- Tachycardic or bradycardic
- Bounding or diminished pulses
- Flushed or pale
- Hypotensive, normotensive or hypertensive

Sepsis and septic shock are highly dynamic. A high index suspicion is essential.

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Don’t let the babies fool you!

Other conditions in newborns/young infants may compound or mimic sepsis

- Congenital heart disease
- Inborn-errors of metabolism
- Immune disorders
- Non-accidental trauma

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

SAY sepsis!

Saying sepsis or septic shock is the next step in caring for your patient

In saying the words, NOT the symptoms, you signal to your team:

- The severity of the situation
- The need for timely and well-defined action
- The need for additional resources
- Accountability in completion of the necessary tasks

You say code blue, why wouldn't you say code sepsis?

Airway

Issues with airway can be related to:

- Primary infection
- Decreased consciousness

If airway is a concern, support with repositioning and adjuncts while preparing for intubation and performing other resuscitation interventions

Intubation is a high-risk procedure in a patient in septic shock and may lead to destabilization and/or arrest

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Breathing

Even if SpO2 is normal, assume tissue hypoxia apply NRB or HFNC at FiO2 100% to increase PaO2 and support tissues

If hypoxia is present, may be related to:

- Primary infection
- Cardiac dysfunction
- Capillary leak with pulmonary edema

If hypoxia does not improve with NRB or HFNC, consider NiPPV, if appropriate

Consider intubation if patient is rapidly worsening or is a poor NiPPV candidate

Positive pressure ventilation can cause decreased venous return and worsen hypotension

These items save lives

www.life-assist.com/

www.desertcart.in

www.hullanesthesia.com

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Circulation

- Heart rate, capillary refill, pulse, color, urine output and blood pressure can all be used as relative indicators
- Avoid hypotension
- Correct hypotension with fluid resuscitation and/or vasopressors (goal is within one hour)
- Serial lactates
- Blood pressure has an inconsistent relationship to end-organ perfusion
- End-organ function is a better indicator of improving perfusion than blood pressure
- Check ionized calcium in patients with poor response to vasopressors, especially neonates/infants or those who have received blood products

Blood pressure and perfusion

- Simplistic model that arterial blood pressure in large vessels correlates to capillary perfusion at end-organs
- While arterial pressure is the driving pressure for the system it may not conduct through the system depending on vascular patency and tone
- Assessment of end-organ pressure is a better indicator of adequate perfusion
- Reassess fluid and vasopressor support based on end-organ function, not just on blood pressure goals

Meng L. Heterogeneous impact of hypotension on organ perfusion and outcomes: a narrative review. Br J Anaesth. 2021 Dec;127(6):845-861. doi: 10.1016/j.bja.2021.06.048. Epub 2021 Aug 12.

Serum lactate

- Sign of tissue hypoperfusion
- Included in Phoenix Scoring
- Initial correlates to severity of shock
- Serial values may help in assessing adequacy of resuscitation
- Can see “washout” effect in early resuscitation
- Decrease in level at 6hrs with greater than 30% clearance correlates with improved survival in small studies
- MANY things can affect lactate evolution and clearance

Abdelaziz, T.A., Karam, N.A., Ismail, W.I. *et al.* Lactate dynamics in paediatric patients with severe sepsis: insights from a prospective cohort study. *BMC Pediatr* **24**, 345 (2024). https://doi.org/10.1186/s12887-024-04809-9

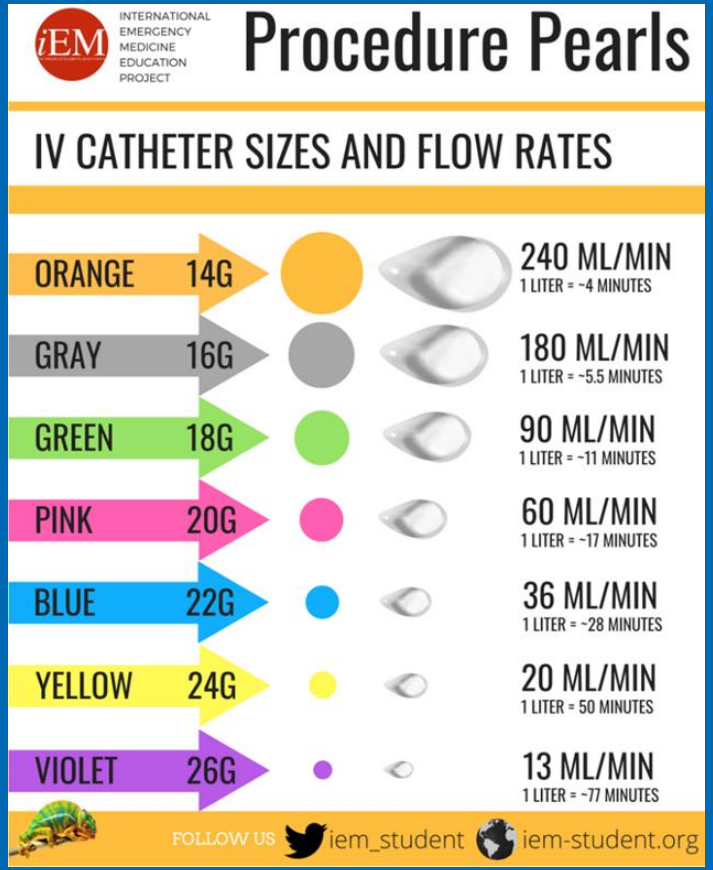
Access – short and squat!

- Large bore IVs in large veins
- Intraosseous access
- No role for CVCs*
- The goal is low resistance, rapid flow

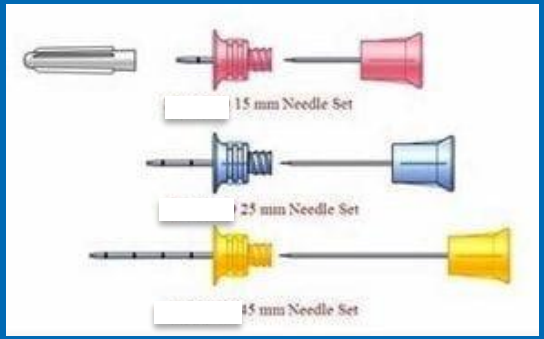
*May use existing central access such as ports, durable lines or PICCs, within parameters

Size and speed

- Largest and shortest is the goal
- ALL EZ-IO needles are 15G (infant needle 15mm, adult 45mm)
- Cook is 14G, 50-70mm
- Jamshidi is 15G, 55-75mm
- Flow limitation for an IO is limited by length and pressure of the marrow compartment



International Emergency Medicine Education Project. Procedure Pearls: IV catheter sizes and flow rates. *IEM Student Project*. Accessed October 10, 2025. https://iem-student.org



Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Fluids - Crystalloids

Balanced crystalloids preferred, such as lactated Ringer's solution

- Reduces hyperchloremia and related acidosis
- Provides pH buffering

Bolus delivery

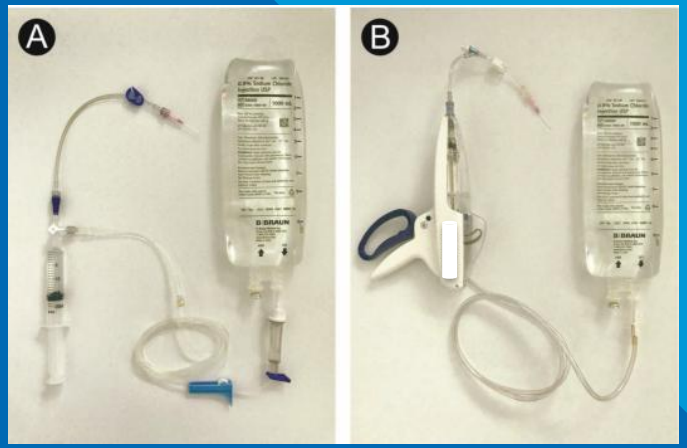
Three components to any fluid order:

- What?
- How much?
- How long?

A resuscitation bolus is usually given somewhere between AFAP and 15-20 minutes

Use rapid infusion techniques

Do not let anybody “999” it on the pump!



Push-Pull

Push Gun

Pressure Bag

Courtesy of 410 Medical, Durham, NC

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Fluid Refractory Shock

No improvement in condition after clinically appropriate fluid delivery

- HR remains high
- BP unchanged
- Perfusion/pulse/color not improved
- No improvement in organ fxn (UOP)

How much is enough?

Depending on presence of cardiac dysfunction/fluid overload, 10-60ml/kg

In shock state, fluid resuscitation should be completed in 15-30min

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Vasopressors

- Septic Shock with hypotension
- ~~Cold shock vs Warm Shock~~
- If concerns for cardiac dysfunction, start epinephrine drip at 0.1mcg/kg/min and titrate to BP, perfusion and end-organ function targets
- Norepinephrine drip may provide increased systemic vascular resistance if patient has vasodilation (start at 0.05mcg/kg/min
- Dopamine is not preferred, but if it is what you have you can use it (start 3-5mcg/kg/min)

But I don't have a central line . . .

Peripheral vasopressor safety

- Multiple small studies have shown efficacy and safety
- Practically, we do it all the time in our PICU
- PIV inserted in a larger arm vessel without difficult/leaking
- Monitor site frequently
- Risk of extravasation is low and not related to dose of vasopressor
- If you're worried, put in an IO

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Abrar S, Abbas Q, Inam M, Khan I, Khalid F, Raza S. Safety of Vasopressor Medications through Peripheral Line in Pediatric Patients in PICU in a Resource-Limited Setting. Crit Care Res Pract. 2022 Mar 31;2022:6160563. doi: 10.1155/2022/6160563. PMID: 35402044; PMCID: PMC8991380.

Where are we on corticosteroids for vasopressor refractory shock?

- A swinging pedulum
- 15 years ago, most patients got them
- No mortality advantage
- Reduced time in hypotension/on pressors
- Some patients likely have secondary adrenal insufficiency (levels/stim-testing don't correlate)
- Some studies showed increase mortality (up to aOR of 4 in "high risk" groups!)
- Future sepsis marker panels may indicate best candidates
- Verdict: sometimes/maybe

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Rulli I, Carcione AM, D'Amico F, Quartarone G, Chimenz R, Gitto E. Corticosteroids in Pediatric Septic Shock: A Narrative Review. J Pers Med. 2024 Dec 17;14(12):1155. doi: 10.3390/jpm14121155. PMID: 39728068; PMCID: PMC11676778.

ECMO

- For severe refractory shock
- Venous-arterial cannulation
- Survival 55-60%
- Outcomes correlate with age of patient and peripheral vs. central cannulation

CHCO Anschutz (Aurora) is the only Colorado location with pediatric non-cardiac ECMO capability. We will take this into account when considering an external referral disposition.

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Totapally A, Stark R, Danko M, Chen H, Altheimer A, Hardison D, Malone MP, Zivick E, Bridges B. Central or Peripheral Venoarterial Extracorporeal Membrane Oxygenation for Pediatric Sepsis: Outcomes Comparison in the Extracorporeal Life Support Organization Dataset, 2000-2021. Pediatr Crit Care Med. 2025 Apr 1;26(4):e463-e472. doi: 10.1097/PCC.0000000000003692. Epub 2025 Jan 23. PMID: 39846796.

Disability - Neurostatus

- Signs of cerebral hypoperfusion
- Somnolence and lethargy are concerning
- In infants and toddlers, look for fussiness and agitation
- Older children may display confusion and anxiety
- May also be signs of primary infection if meningeal signs present
- May require intubation

Exposure

- Fever control is important to decrease metabolic demand
- Look for rashes such as petechiae or purpura may be related to disseminated meningococcemia or other infections or simply a sign of severe disseminated intravascular coagulation

Diagnostics

- Point of care glucose
- Blood cultures
- Urine culture
- Culture of any apparent soft tissue lesion
- CBC with differential
- CMP with magnesium
- PT/INR, PTT, fibrinogen
- Lactate (free-flowing), +/- blood gas
- C-reactive protein and/or procalcitonin
- Imaging as exam indicates and is safe

A lumbar puncture in an unstable patient is not indicated!

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

History

Allergies	
Medications	Don’t forget immunization history!!! Immunosuppressants?
Past medical/surgical history	Don’t forget the birth history!!! Immunocompromised host? Surgical appliances?
Last meal/oral intake	
Events/Exposures	Don’t forget travel history!!! Pets – exotic or diseased!!!

Empiric antibiotics

- Goal: antibiotics within 1hr of presentation for septic shock and 3hrs for sepsis
- Delayed administration has been linked to increased organ dysfunction and mortality
- Ceftriaxone is a good start for most presentations, +/- vancomycin
- Neonates will require ampicillin
- Oncology patients will require cefepime
- If Group A Strep is possible, consider adding linezolid (decreased exotoxin formation)
- If patient with complex underlying issues, call their children's hospital for guidance

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital Colorado

Lane RD, Richardson T, Scott HF, et al. Delays to Antibiotics in the Emergency Department and Risk of Mortality in Children With Sepsis. JAMA Netw Open. 2024;7(6):e2413955. doi:10.1001/jamanetworkopen.2024.13955

Early disposition

If you are not the pediatric specialty center then the patient needs to leave

Call the referral center early as this:

- Allows the transport arrangements to begin
- Gives you access to expert consultation
- Ensures better continuity in care
- Allows support staff to acquire necessary information/materials (improving with related EHRs)

Review of Key Points

- Improving understanding of pediatric sepsis/septic shock as a continuum defined by organ dysfunction
- Application of information systems/technology may help in improved management
- Early recognition is the key to success
- Organized, rapid activation of resources is essential
- Adopting policies and practices that follow the surviving sepsis campaign goals is helpful
- Time-targeted actions to achieve:
  - Judicious, rapid fluid resuscitation
  - Antibiotics within an hour
- ABCDEs always apply
- A standardized history can help identify patients with unique risks
- Early disposition is part of improving outcomes (no delays to definitive care)
- Call for help!
  - Locally to activate your team
  - Expertly to gain input from consultants

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

Thank you

Department of Pediatrics
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Children's Hospital
Colorado

References

- Abdelaziz, T.A., Karam, N.A., Ismail, W.I. et al. Lactate dynamics in paediatric patients with severe sepsis: insights from a prospective cohort study. BMC Pediatr 24, 345 (2024). https://doi.org/10.1186/s12887-024-04809-9
- Abrar S, Abbas Q, Inam M, Khan I, Khalid F, Raza S. Safety of Vasopressor Medications through Peripheral Line in Pediatric Patients in PICU in a Resource-Limited Setting. Crit Care Res Pract. 2022 Mar 31;2022:6160563. Bettmann. Semmelweis Washing Hands [photograph]. Bettmann Archive. Accessed October 9, 2025.
- **Carlton EF, Barbaro RP, Iwashyna TJ, Prescott HC.** Cost of pediatric severe sepsis hospitalizations. *JAMA Pediatr*. 2019;173(10):986–987. doi:10.1001/jamapediatrics.2019.2570
- **Carlton EF, Rahman M, Maddux AB, Weiss SL, Prescott HC.** Frequency of and risk factors for increased healthcare utilization after pediatric sepsis hospitalization. *Crit Care Med*. 2024;52(11):1700–1709. doi:10.1097/CCM.0000000000006406
- **Dantes RB, Kaur H, Bouwkamp BA, et al. Sepsis Program Activities in Acute Care Hospitals — National Healthcare Safety Network, United States, 2022. MMWR Morb Mortal Wkly Rep 2023;72:907–911. DOI: http://dx.doi.org/10.15585/mmwr.mm7234a2.**
- **Davis R.** The doctor who championed handwashing and briefly saved lives [radio broadcast]. *NPR*. January 12, 2015. https://www.npr.org/sections/health-shots/2015/01/12/375663920/the-doctor-who-championed-hand-washing-and-saved-women-s-lives. Accessed October 9, 2025.
- Dieckmann RA, Brownstein D, Gausche-Hill M. The pediatric assessment triangle: a novel approach for the rapid evaluation of children. Pediatr Emerg Care. 2010 Apr;26(4):312-5. doi: 10.1097/PEC.0b013e3181d6db37. PMID: 20386420.
- End Sepsis. Join the fight to end sepsis: Learn, prevent, and support. Rory Staunton Foundation. https://www.endsepsis.org/. Accessed October 9, 2025.
- **Global Sepsis Alliance.** Sepsis facts. *World Sepsis Day*. https://www.worldsepsisday.org/sepsisfacts. Accessed October 9, 2025.
- **Groening M, writer.** *The Simpsons: Treehouse of Horror III* [television series episode]. In: Groening M, producer. *The Simpsons*. Fox Broadcasting Company; 1992.
- Hernandez Botero JS, Florian Perez MC. The history of sepsis from Ancient Egypt to the XIX century. InTech. 2012. doi:10.5772/51484
- International Emergency Medicine Education Project. Procedure Pearls: IV catheter sizes and flow rates. IEM Student Project. Accessed October 10, 2025. https://iem-student.org
- Jessicah Minogue, Samantha Keogh, Luregn J. Schlapbach, Debbie Long, Long-term outcomes after paediatric sepsis: A narrative review, Australian Critical Care,Volume 37, Issue 3,2024,Pages 499-507. https://doi.org/10.1016/j.aucc.2023.04.002

References

- Lane RD, Richardson T, Scott HF, et al. Delays to Antibiotics in the Emergency Department and Risk of Mortality in Children With Sepsis. JAMA Netw Open. 2024;7(6):e2413955. doi:10.1001/jamanetworkopen.2024.13955
- Meng L. Heterogeneous impact of hypotension on organ perfusion and outcomes: a narrative review. Br J Anaesth. 2021 Dec;127(6):845-861. doi: 10.1016/j.bja.2021.06.048. Epub 2021 Aug 12.
- Public Domain/WikiCommons. (c. 500 BC). *Achilles bandaging Patroclus* [Photograph]. WikiCommons. https://commons.wikimedia.org
- Ramazzotti D. An observational study: The effect of diuretics administration on outcomes of mortality and mean duration of ICU stay. *Acad Med Res*. 2014;https://www.academia.edu/10653117
- Rulli I, Carcione AM, D'Amico F, Quartarone G, Chimenz R, Gitto E. Corticosteroids in Pediatric Septic Shock: A Narrative Review. J Pers Med. 2024 Dec 17;14(12):1155. doi: 10.3390/jpm14121155. PMID: 39728068; PMCID: PMC11676778.
- Sanchez-Pinto LN, Bennett TD, DeWitt PE, et al. Development and Validation of the Phoenix Criteria for Pediatric Sepsis and Septic Shock. *JAMA*. 2024;331(8):675–686. doi:10.1001/jama.2024.0196
- Schlapbach LJ, Watson RS, Sorce LR, et al. International Consensus Criteria for Pediatric Sepsis and Septic Shock. JAMA. 2024;331(8):665–674. doi:10.1001/jama.2024.0179
- Scott L. Weiss, Julie C. Fitzgerald; Pediatric Sepsis Diagnosis, Management, and Sub-phenotypes. Pediatrics January 2024; 153 (1): e2023062967. 10.1542/peds.2023-062967
- Surviving Sepsis Campaign. Surviving Sepsis Campaign Pediatric Guidelines. Society of Critical Care Medicine. Accessed October 10, 2023. https://www.sccm.org/survivingsepsiscampaign/guidelines-and-resources/surviving-sepsis-campaign-pediatric-guidelines
- Totapally A, Stark R, Danko M, Chen H, Altheimer A, Hardison D, Malone MP, Zivick E, Bridges B. Central or Peripheral Venoarterial Extracorporeal Membrane Oxygenation for Pediatric Sepsis: Outcomes Comparison in the Extracorporeal Life Support Organization Dataset, 2000-2021. Pediatr Crit Care Med. 2025 Apr 1;26(4):e463-e472.
- Western Australia Department of Health. Sepsis. Perth Children's Hospital. https://pch.health.wa.gov.au/For-patients-and-visitors/Sepsis. Accessed October 10, 2025.
- Yong Y. Han, Joseph A. Carcillo, Michelle A. Dragotta, Debra M. Bills, R. Scott Watson, Mark E. Westerman, Richard A. Orr; Early Reversal of Pediatric-Neonatal Septic Shock by Community Physicians Is Associated With Improved Outcome. *Pediatrics* October 2003; 112 (4): 793–799. 10.1542/peds.112.4.793