Pediatric Updates: Sepsis

Children's Hospital Colorado

Affiliated with University of Colorado Anschutz Medical Campus School of Medicine

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Children's Hospital Colorado

Financial Disclosures

- No relevant financial relationships with any commercial interests.

Patrick Mahar

Objectives

- Review the physiologic aspects of sepsis and shock
- Discuss the differences between treating sepsis in adults and in kids (will keep this short!!!)
- Improve recognition/diagnosis of sepsis
- Review literature concerning sepsis in pediatrics
- Review the latest sepsis guidelines
- Discuss strategies for improving sepsis treatment/outcomes

Sepsis

- Adult world:
  - Sepsis is bad.
  - Need to think about and recognize sepsis to treat sepsis
  - Recognizing sepsis early is very important
  - Avoid hypotension
  - Early antibiotics saves lives

- So, same in pediatric sepsis because they are all just little adults, correct?????

Sepsis

- YES---they are basically little adults when it comes to sepsis!!!!
- Treatment of adult sepsis:
  - Rapid IVF, early antibiotics, avoid hypotension.
- Treatment of pediatric sepsis:
  - Rapid IVF, early antibiotics, avoid hypotension.



Thank you

Any Questions?

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Pediatric Sepsis Stats

- Worldwide
  - Sepsis affects more than 25 million children every year, representing over half of all sepsis cases worldwide.
  - More than 80% of all pediatric sepsis cases occur in children <5 years of age (20.3 million cases yearly).
  - Globally, sepsis is the leading cause of death of children, taking nearly 3.4 million lives eachyear.2,3

Rudd KE, et al. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet. 2020

Pediatric Sepsis Stats

- US Sepsis stats
  - Every day >200 children are diagnosed with severe sepsis in the U.S.
    - Over 75,000 cases per year
  - Approximately 85% of pediatric sepsis deaths occur in children under age 5
  - ~6,800 pediatric sepsis deaths/year (>18/day).

Hartman *PCCM* 2013, Balamuth *PCCM* 2014

Pediatric Definitions

Systemic Inflammatory Response Syndrome

(2/4, 1 must be temp or wbc):

- Core Temp > 38.5°C or <36°C
- Tachycardia / Bradycardia
- Tachypnea
- WBC elevated or depressed

- **Sepsis**
  - SIRS in the presence of infection
- **Severe Sepsis**
  - Sepsis + CV dysfunction OR ARDS OR ≥2 other organ dysfunction
- **Septic Shock**
  - Sepsis and CV organ dysfunction (hypotension, pressors use or elevated lactate)

Goldstein *PCCM* 2005

Case #1
18 mo fever x 3 days

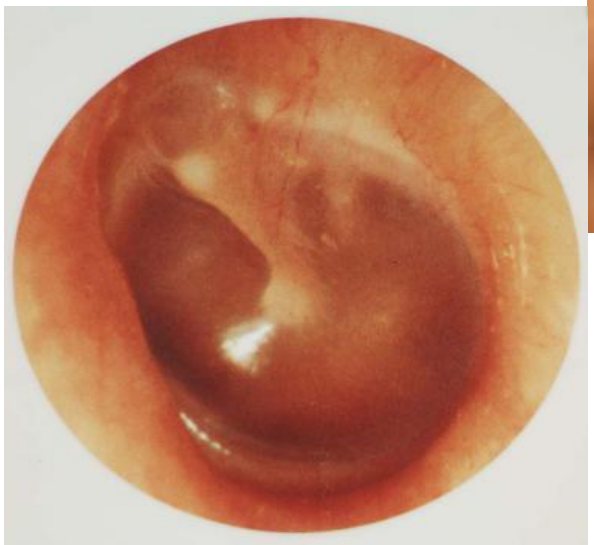
- 18 mo female; no PMHx
- Cough, congestion and runny nose for 5 days
- Fever started 3 days ago. Tmax=103.5
- Tylenol given but fever returns
- Seen by PCP 2 days ago and diagnosed with bronchitis and a double ear infection, started on Azithromycin
- Post-tussive emesis x4 over past 24 hours
- Decreased PO x1 day

- Immunizations: Has not received 18 mo shots yet
- Medications: Tylenol and azithromycin

Case #1
18 mo fever x 3 days

- T: 40.1 HR: 191 RR: 40 Pox: 92% on RA

- Clinging to MOC; sleepy but cries when you approach
- Nose: Copious amounts of clear/yellow nasal drainage
- Ears: TM: erythematous bilat. Clear fluid
- Lungs: course BS/crackles bilat
- Heart:S1S2 Tachy



Case #1
18 mo fever x 3 days

- T: 40.1 HR: 191 RR: 40 Pox: 92% on RA **BP: 82/48**
- ARE WE IN SHOCK????
- What do you want to do?
  - IVF, LABS, Abx

    OR
  - Motrin/Tylenol and re-eval

What is shock?

- What is shock?
- What vital signs define shock?
- What physical exam findings are consistent with shock?

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SHOCK

OXGEN SUPPLY FAILS TO MEET OXYGEN DEMAND

OXYGEN DELIVERY

CARDIAC OUTPUT X ARTERIAL OXYGEN CONTENT

- Cardiac Output
  - Heart rate
  - Stroke Volume
    - Preload
      - -Intravascular volume
      - -SVR
    - After load
    - Contractility
- Arterial oxygen content
  - -Hemoglobin
  - -Oxygen Saturation
  - -Partial pressure of oxygen dissolved in plasma

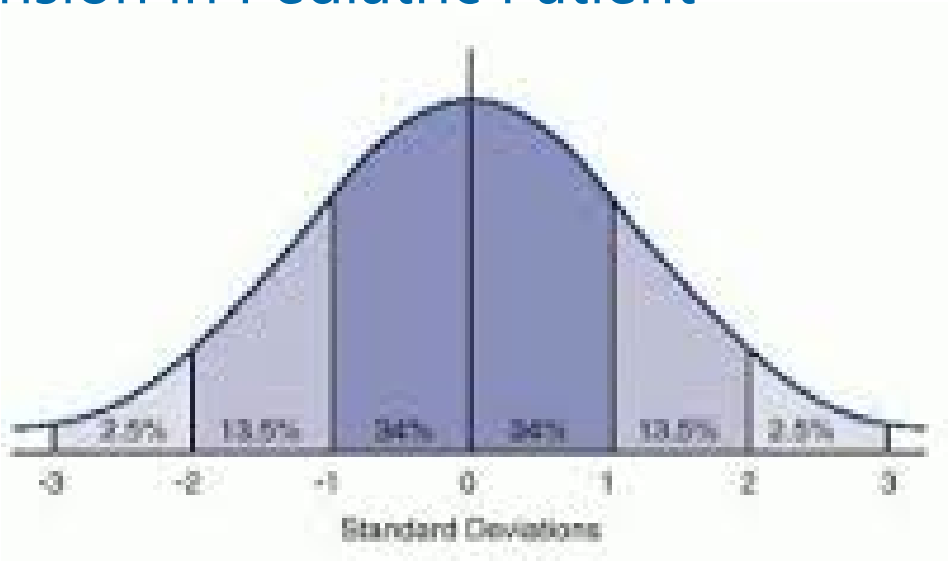
SHOCK

- Compensated Shock
  - ***Normal blood pressure***
    - Body is maintaining blood pressure in normal range
      - ↑ HR and SVR to maintain BP
  - Early shock
  - Need to recognize and act to prevent progression

- Uncompensated Shock
  - ***Hypotension***
  - Late finding
  - BAD SIGN→BIG TROUBLE
  - "Assume the crash position"

Vital signs: When to worry

- BP= Cardiac Output X System Vascular Resistance (SVR)
- CO= Stroke Volume X Heart Rate
- Quick Estimate of Hypotension in Pediatric Patient
- SBP≤ (2xAge)+70
  - 4 yo
  - SBP≤ (2x4)+70
  - SBP≤ 78



The Shock Index

- Shock Index= Heart Rate/Systolic BP
- shown to be useful in detecting adult patients with shock.
- Normal shock index values range between 0.5 and 0.7.
- SI values >1.0 were widely found to predict
  - Increased risk of mortality,
  - Increased need for massive transfusion,
  - Increased likelihood of admission to intensive care units.
- SI was >0.7:
  - 3 times higher likelihood of hyperlactatemia when compared to those with SI <0.7.

Shock Index, Pediatric Age-Adjusted (SIPA)

- When to use SIPA?
  - Patients 4-16 years old who have sustained blunt trauma.
  - Do not use in young infants, toddlers, or patients with penetrating trauma.
- What is normal Shock Index, Pediatric Adjusted (SIPA)
  - 4-6 years = 1.2
  - 6-12 years = 1
  - > 12 years = 0.9
- Comparing the patient's actual HR / Systolic BP to the SIPA was shown to perform better and identify those most severely injured following blunt trauma. (Acker, 2015)

Shock Index, Pediatric Age-Adjusted (SIPA)

- What does elevated SIPA mean?
  - Indicate a higher risk of severe outcomes,
    - longer ICU stays,
    - increased ventilator days,
    - higher mortality rates
    - identify those most severely injured following blunt trauma.

Case #2 R.S.

- 12y.o male No PMhx.
- Presents to PCP with 1 day of fever, leg pain and vomiting.
- Reports throwing up the first time during the night and then again in AM. MOC reports was crying his legs hurt and he had trouble walking from car to office b/c of legs hurting.
- Tmax=104 this AM
- 2 days ago dove for loose ball while playing basketball but didn't hurt legs, only small cut on right arm.
- Pt throws up in office waiting room and again when throat swap was obtained.
- T=102 HR=140 RR=36

Case #2 R.S.

- Exam notable for:
  - Gen: Ill/weak appearing
  - Mucous membranes-dry
  - Neck: supple FROM
  - Abd: soft, NT, ND, no masses.
  - Ext:
    - Right upper extremity with 1 cm laceration w/ scab in place minimal erythema and no red streaks up arm
    - Lower Ext: bilateral tenderness of thighs R>>L; FROM at knees
  - Skin- mottled appearance and delayed cap refill
- Rapid strep negative
- NOW WHAT???

Case #2 R.S.

- PCP tells family to go to the academic hospital nearby for IVF to make him feel better. Tells family he has stomach flu and will likely have diarrhea to go along with this.

- 19:14 arrived at hospital ED:
- HR: 143 RR: 28 T:100.9 BP 118/48 Wt: 77kg
- Pt treated with Zofran, 2 liters NS bolus and labs sent.
- 21:14 Pt no longer vomiting, thus decision made to d/c
- 21:26 T: 102 HR: 131 RR: 22 BP: 108/42
- D/c home with dx of stomach flu;
- Plan: Supportive care at home
- 00:30: Labs printed off showing ↑ WBC, (marked left shift)

Case #2 R.S.

- Pt continues to have fever and emesis during the night.
- Call PCP in AM instructed to alternate Tylenol and Motrin for fever.
- Pt develops diarrhea.
- Call PCP again and MOC describes patient as weak. Instructed to have him drink and eat some crackers.
- Pt screams in pain when legs are touch and is too weak to sit up
- MOC calls PCP and says his nose and legs are turning blue
- PCP instructs family to return to ED.

Case #2 RS

- Admitted to ICU
- Intubated
- Renal failure
- DIC
- Codes x2 and brought back
- Day 3 arrest 3rd time and dies.

- Group A strep sepsis

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- 2012 Death of Rory Staunton from unrecognized Group A Strep sepsis
- "Rory's Law"
- New York State legislates pediatric sepsis protocol requirements


The New York Times

New York

An Infection, Unnoticed, Turns Unstoppable

A 12-Year-Old's Infection, Unnoticed, Turns Unstoppable

The New York Times

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Cuomo Plans New Rules in Fight Against Sepsis

By JIM DWYER

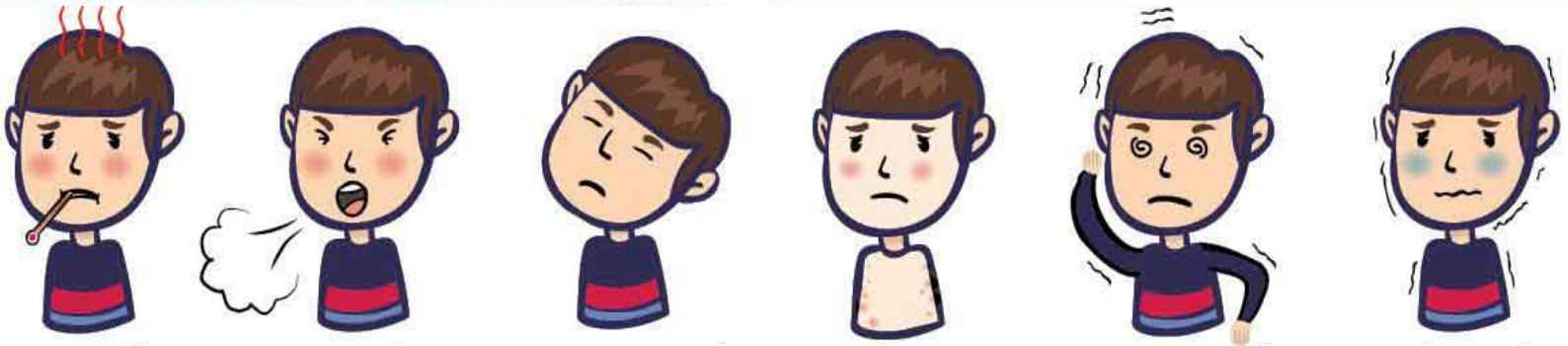
Published: January 7, 2013

Sepsis Kills.

250,000 Americans die each year from sepsis.
That's more than from AIDS, breast cancer and prostate cancer COMBINED. Sepsis is the body's life-threatening reaction to an infection. Anyone can get sepsis. A small cut, a bug bite or an infected tooth can all lead to sepsis.

Sepsis is preventable and treatable.

Do you know the Signs of Sepsis?



Fever/ Shivering or Very Cold

Rapid Breathing

Extreme Pain/ Physical Discomfort

Pale or Mottled Skin

Disoriented/ Confused & Sleepy/Difficult to Wake

Elevated Heart Rate

THE RORY STAUNTON FOUNDATION
FOR SEPSIS PREVENTION

Help Save Lives. Share the Signs of Sepsis with your family and friends.

For more information, visit **www.rorystauntonfoundationforsepsis.org**

How do we do better???

- Early Recognize of sepsis (and those at risk)
- Rapid IV Access
- Aggressive Fluid Resuscitation
- Early Antibiotics
- Reassess – **DO NOT TOLERATE HYPOTENSION**
- Early use of pressors

- Sepsis pathways and order bundles save lives!!!

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www.childrenscolorado.org

https://www.childrenscolorado.org

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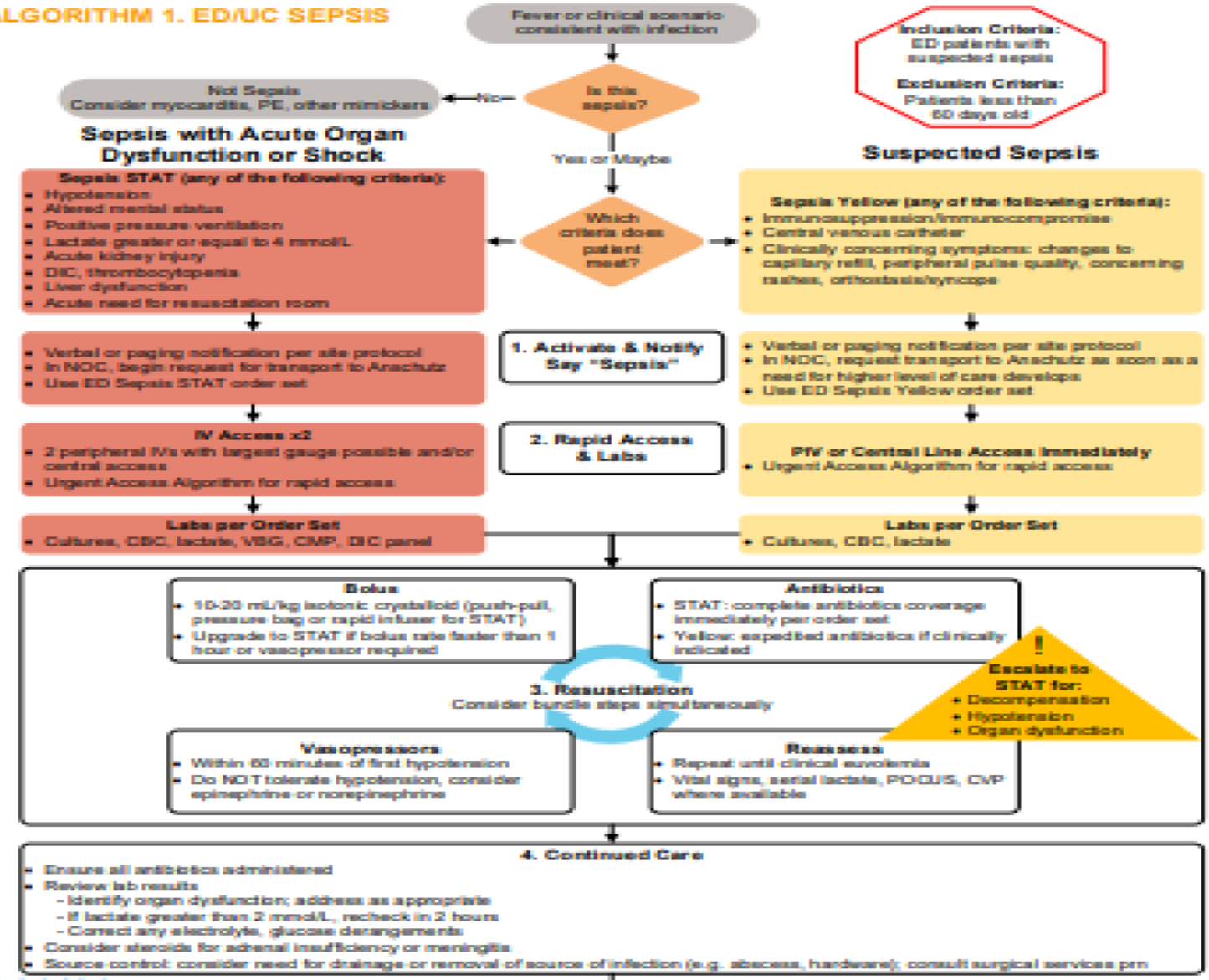
Sepsis Pathway: Initial Management

ALGORITHM 1. ED/UC SEPSIS



Quick Links

Emergent Abx Selection for Sepsis STAT

Urgent Access Algorithm

Early Recognition

- How do we know when to be concerned for sepsis
- Can’t treat sepsis without thinking of sepsis

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Physical Exam for Detection

Table 2 Sepsis clinical recognition signs present in ED as predictors of organ dysfunction within 24 hours

Individual predictor	Prevalence n (%)	Sensitivity	Specificity	Negative predictive value	Positive predictive value	Positive likelihood ratio	Concordance**
Altered Mental Status	43 (18%)	0.54 (0.29–0.77)	0.84 (0.78–0.88)	0.97 (0.93–0.99)	0.16 (0.07–0.30)	3.3* (1.8–5.9)	76%
Abnormal Capillary Refill	36 (15%)	0.08 (0.01–0.33)	0.85 (0.79–0.89)	0.94 (0.90–0.97)	0.03 (0.001–0.15)	0.5 (0.1–3.4)	96%
Abnormal Peripheral Pulses	8 (3%)	0.15 (0.04–0.42)	0.97 (0.94–0.99)	0.95 (0.92–0.98)	0.25 (0.03–0.65)	5.8* (1.2–26.0)	92%
Cold/Mottled Extremities	5 (2%)	0.08 (0.01–0.33)	0.98 (0.95–0.99)	0.95 (0.91–0.97)	0.20 (0.01–0.72)	4.3 (0.5–36.2)	100%
Number of predictors							
≥1	77 (32.2%)	0.62 (0.32–0.86)	0.69 (0.63–0.75)	0.97 (0.93–0.99)	0.10 (0.05–0.19)	2.0* (1.3–3.2)	72%
≥2	15 (6.3%)	0.23 (0.05–0.54)	0.95 (0.90–0.97)	0.96 (0.92–0.98)	0.20 (0.04–0.48)	4.4* (1.4–13.5)	72%

*Statistically significant associations.
**Based on 25 patients with two independent assessments.

Scott *BMC Emer Med* 2014

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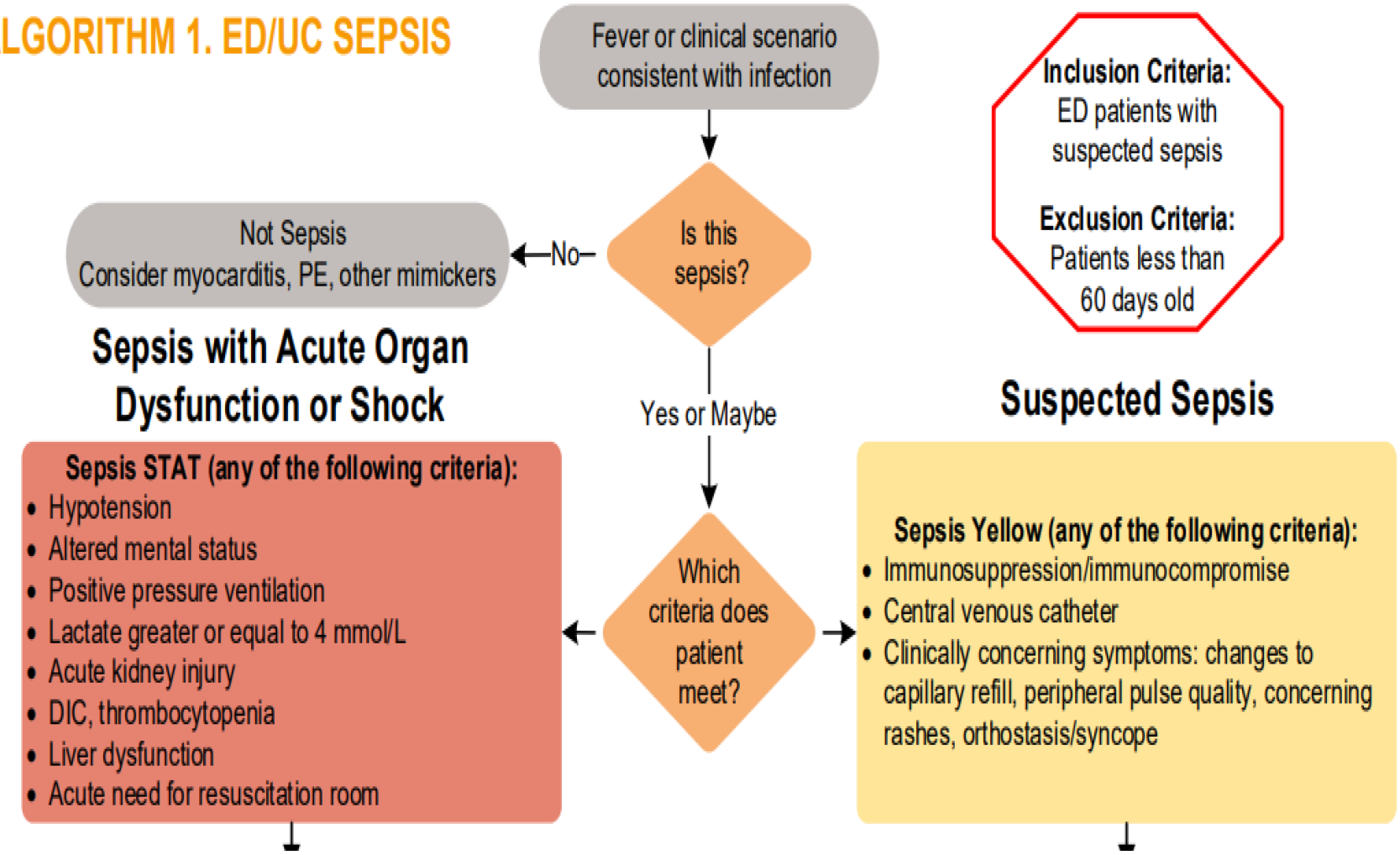
Sepsis Pathway: Initial Management

ALGORITHM 1. ED/UC SEPSIS



Sepsis = Infection + Organ Dysfunction

- Many organ dysfunctions require laboratory testing
- Diagnosis does not require microbiological confirmation
- Start treatment for suspicion of infection + organ dysfunction
- Consider de-escalation if clinical picture/labs do not support infection

CV: Hypotension, lactate, vasopressor use

Resp: New positive-pressure ventilation requirement

Neuro: Altered mental status

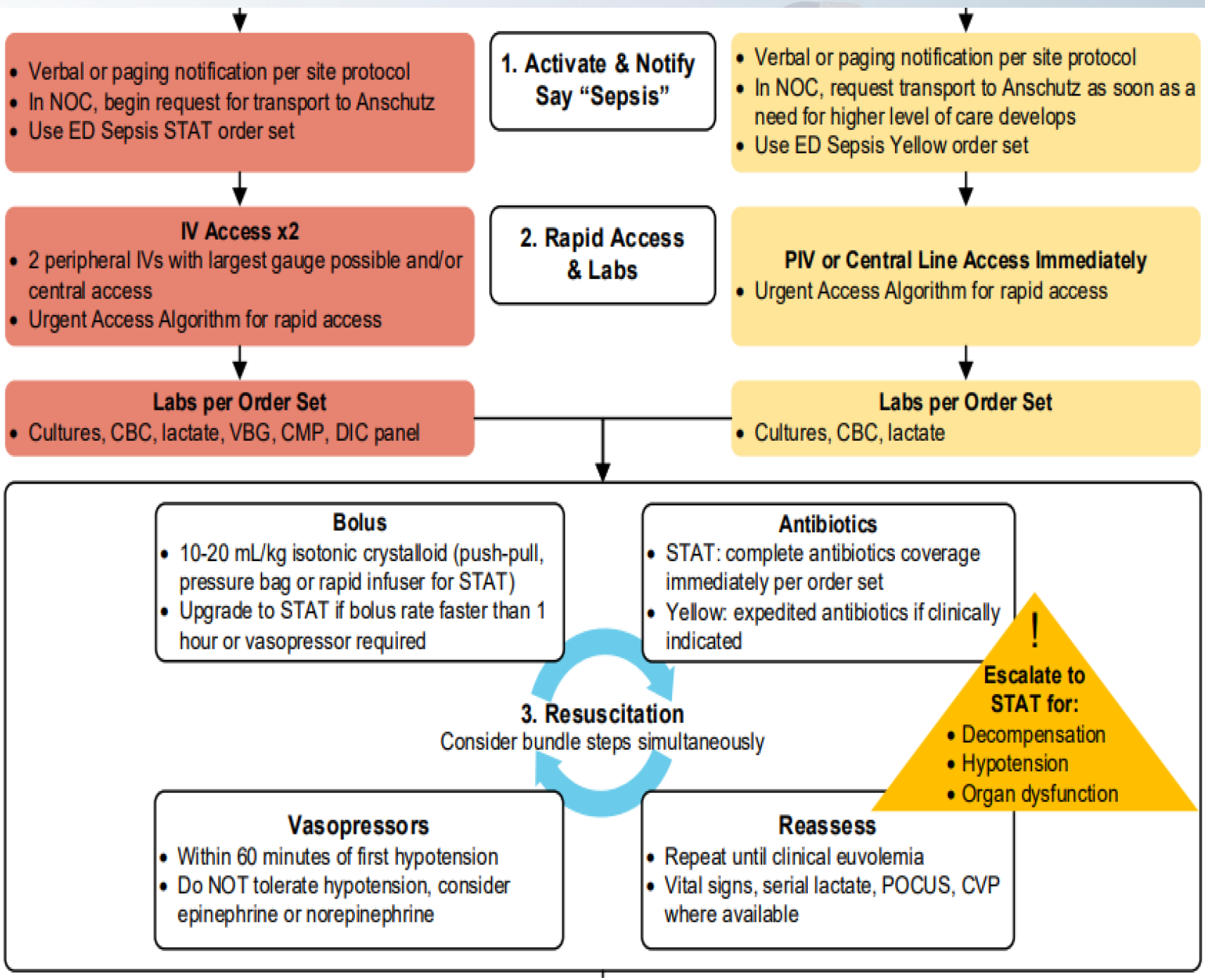
Renal: Acute kidney injury

Hepatic: Elevated LFTs

Heme: DIC, low platelets

Require labs to determine, thus takes time, so act quickly if have other signs.

Goldstein *PCCM* 2005, Matics *JAMA Pediatrics*, Weiss *PCCM* 2020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IV Access x2
• 2 peripheral IVs with largest gauge possible and/or central access
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Consider bundle steps simultaneously
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Escalate to STAT for:
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• Organ dysfunction
Vasopressors
• Within 60 minutes of first hypotension
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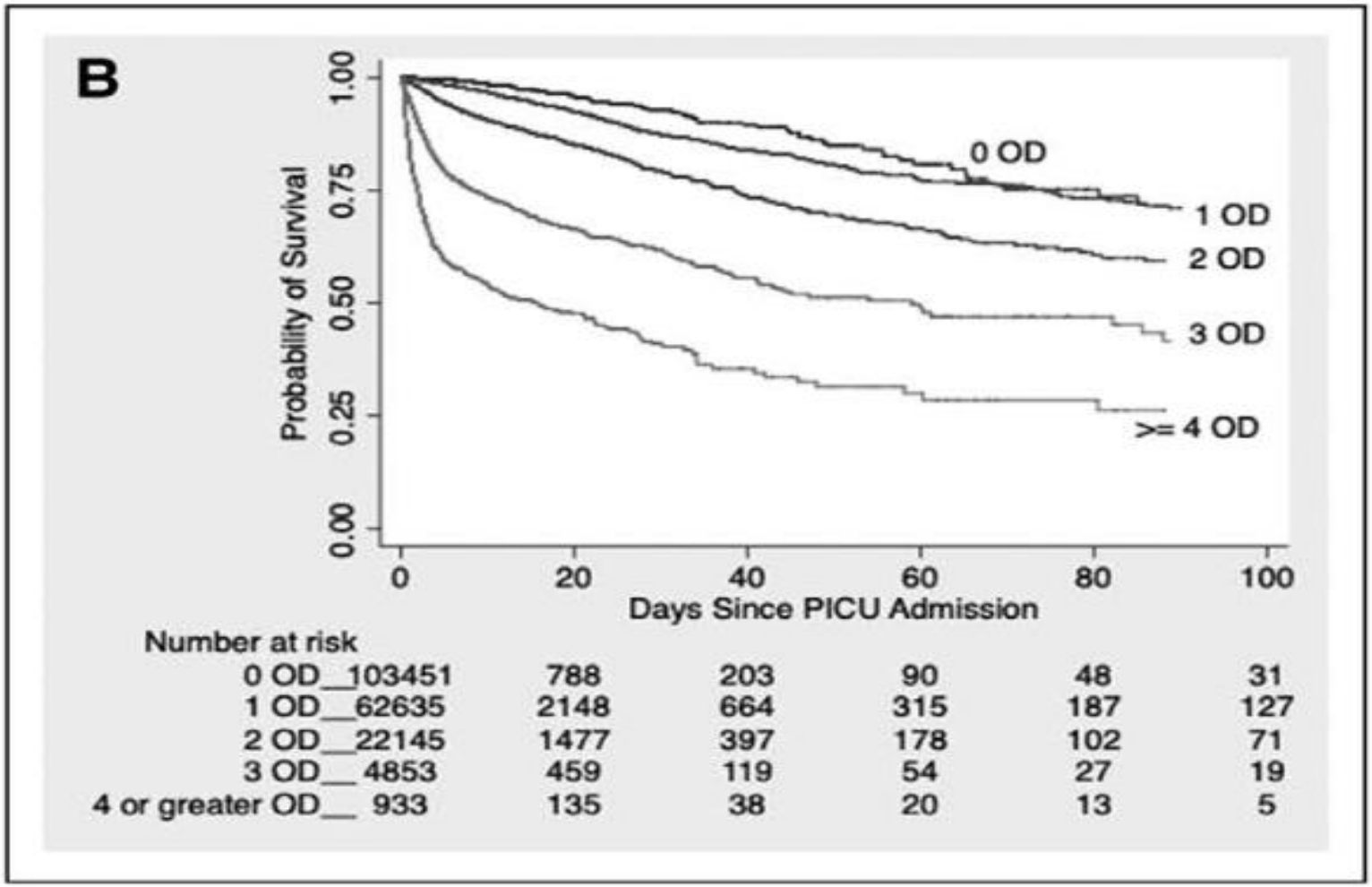
Why is organ dysfunction important?



Number at risk					
0 OD 103451	788	203	90	48	31
1 OD 62635	2148	664	315	187	127
2 OD 22145	1477	397	178	102	71
3 OD 4853	459	119	54	27	19
4 or greater OD 933	135	38	20	13	5

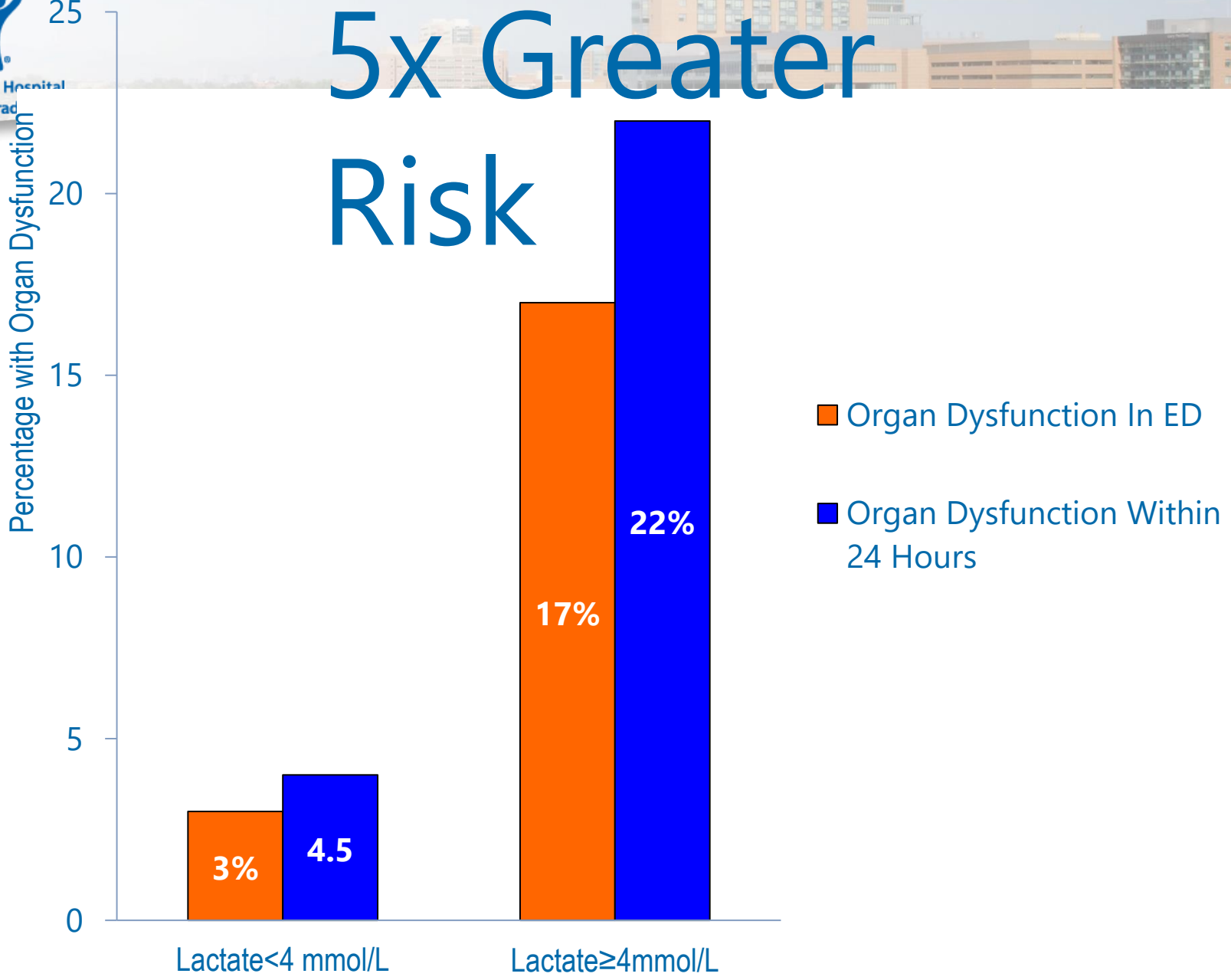
Typpo *PCCM* 2019

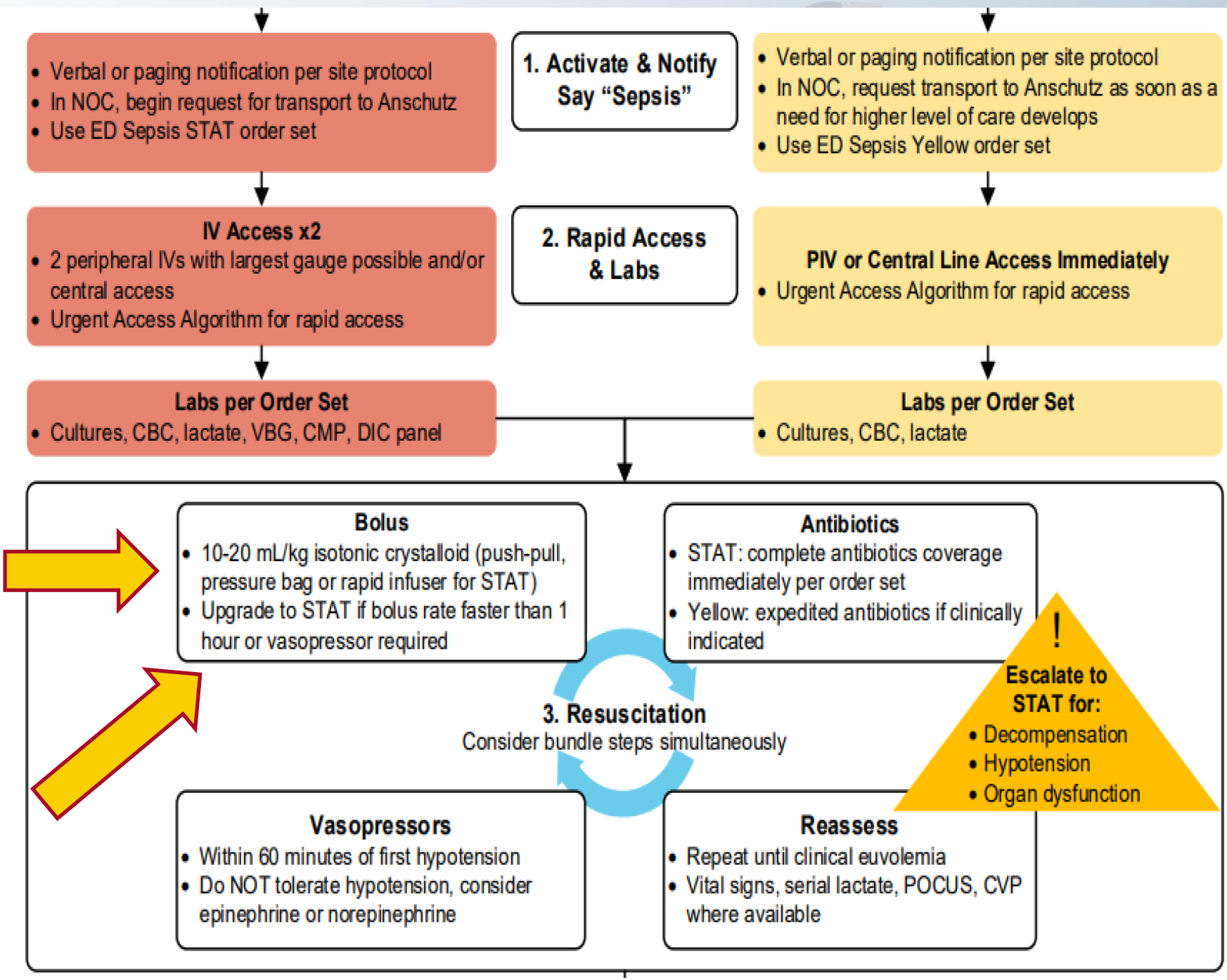
Lactate and Sepsis

- Lactate in recognition and treatment in adult sepsis is well studied and accepted practice
  - Lactate is associated with increased mortality in adults w/sepsis
  - Lactate clearance correlates with improved outcomes
  - Use of lactate and lactate clearance to direct therapy is associated with equal or superior outcomes for adults with sepsis
  - Clinical care bundles that include use of lactate have shown to improve outcomes.

- What does elevated lactate mean for the patient?

5x Greater Risk

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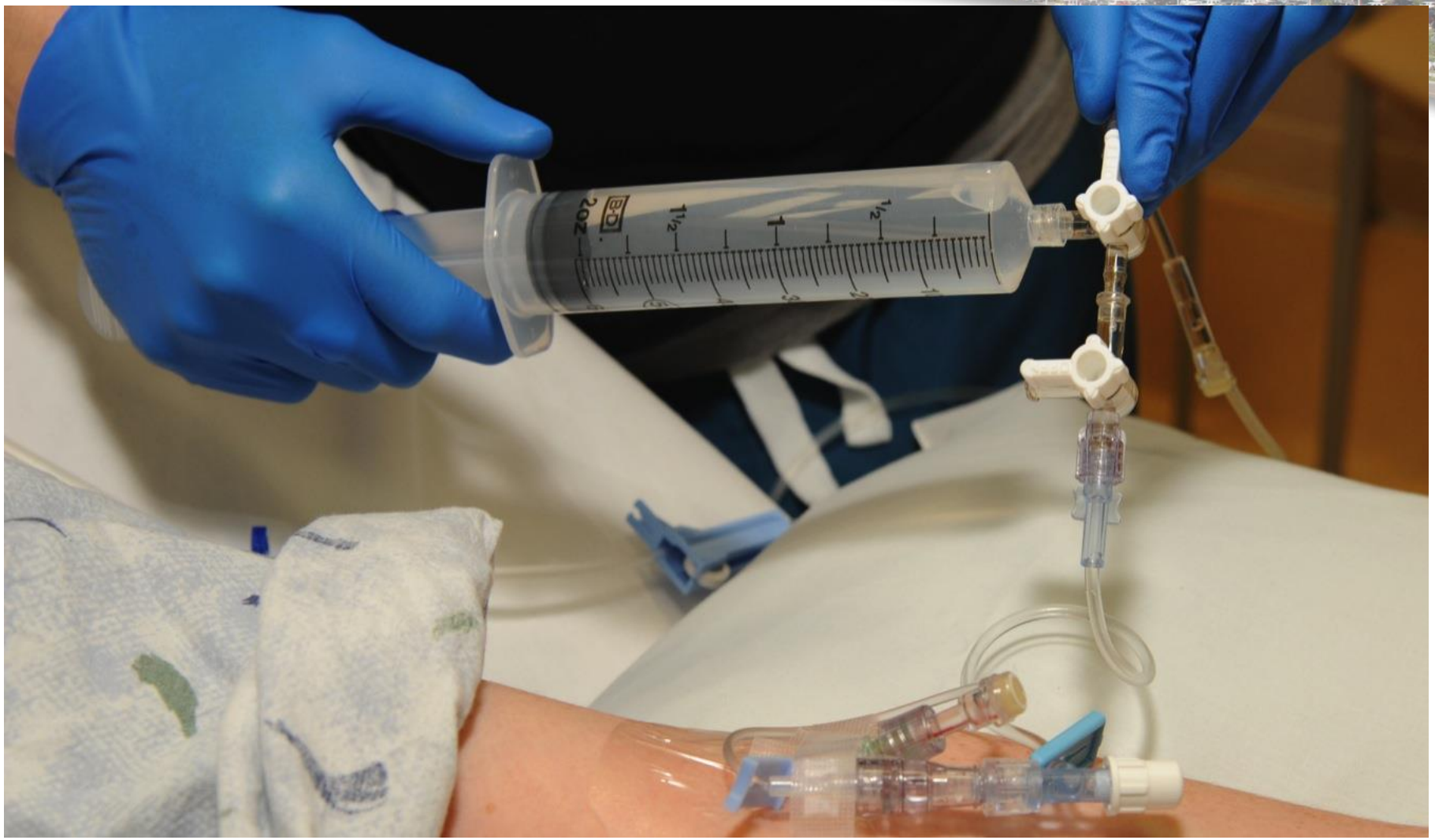
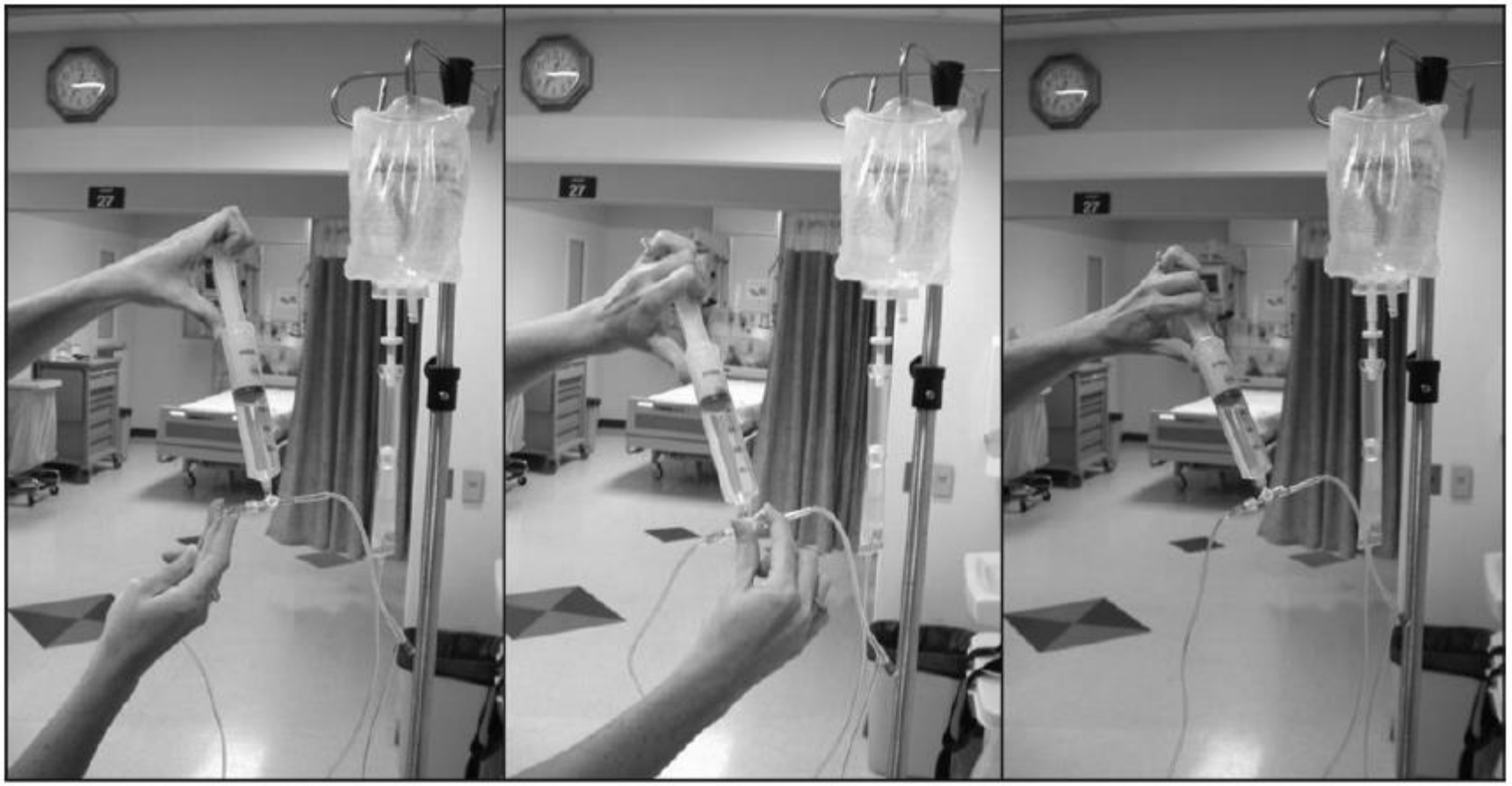
Fluids





Stoner Annals EM 2007

Rapid Infuser

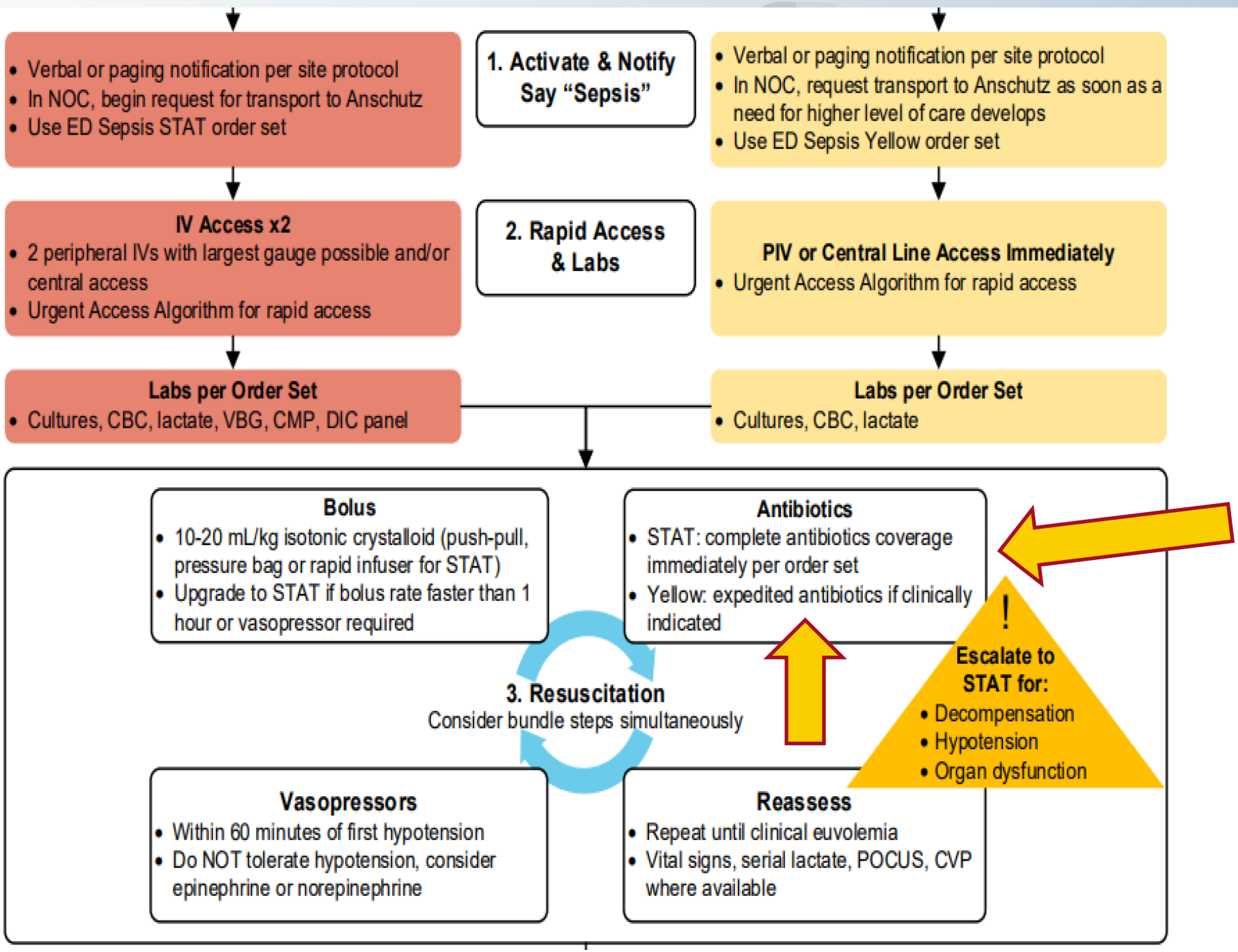
- Flow rates from 2.5-1000ml/min
- Temperature controlled fluids
- Can be used down to 10kg.

LifeFlow

- Rapid infusion of fluids and/or blood
- Deliver 500ml of fluid in less than 2 minutes through a 20G IV catheter
- 4x faster than pressure bag for fluids and ~3x faster for blood

How much fluid should I give?

- In most cases, start with at least 20 ml/kg, some patients may require up to 40-60 ml/kg or more to achieve euvolemia.
- If you have achieved euvolemia, per your clinical assessment, and the patient remains hypotensive, start vasopressors/inotropes.
- There is debate about exactly what amount of fluid is right for sepsis, and it is probably different for each child.
  - If child doesn't have a specific fluid sensitivity (such as a brain tumor, renal failure, heart failure or severe anemia)
  - Being studied but no definitive studies yet.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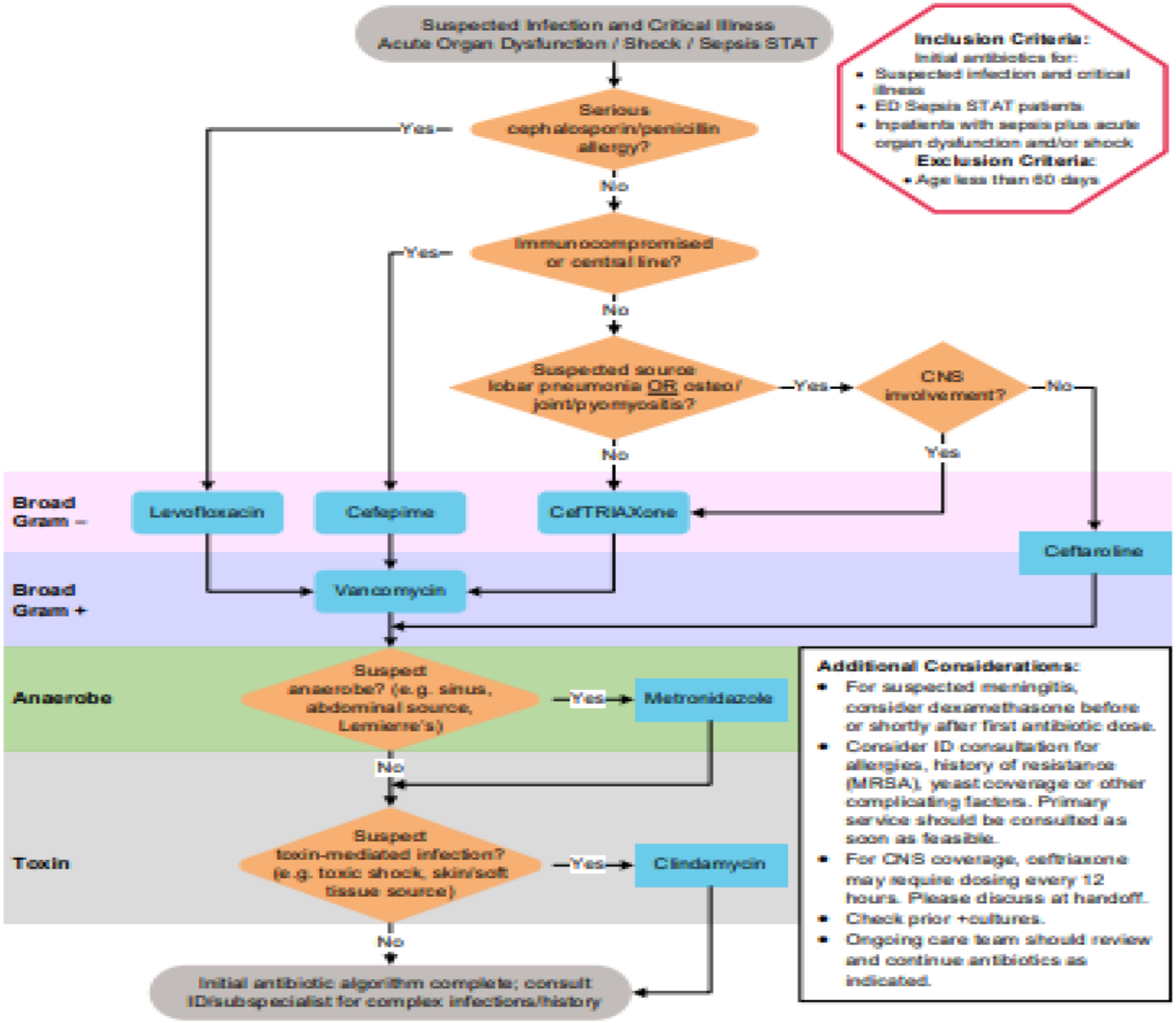

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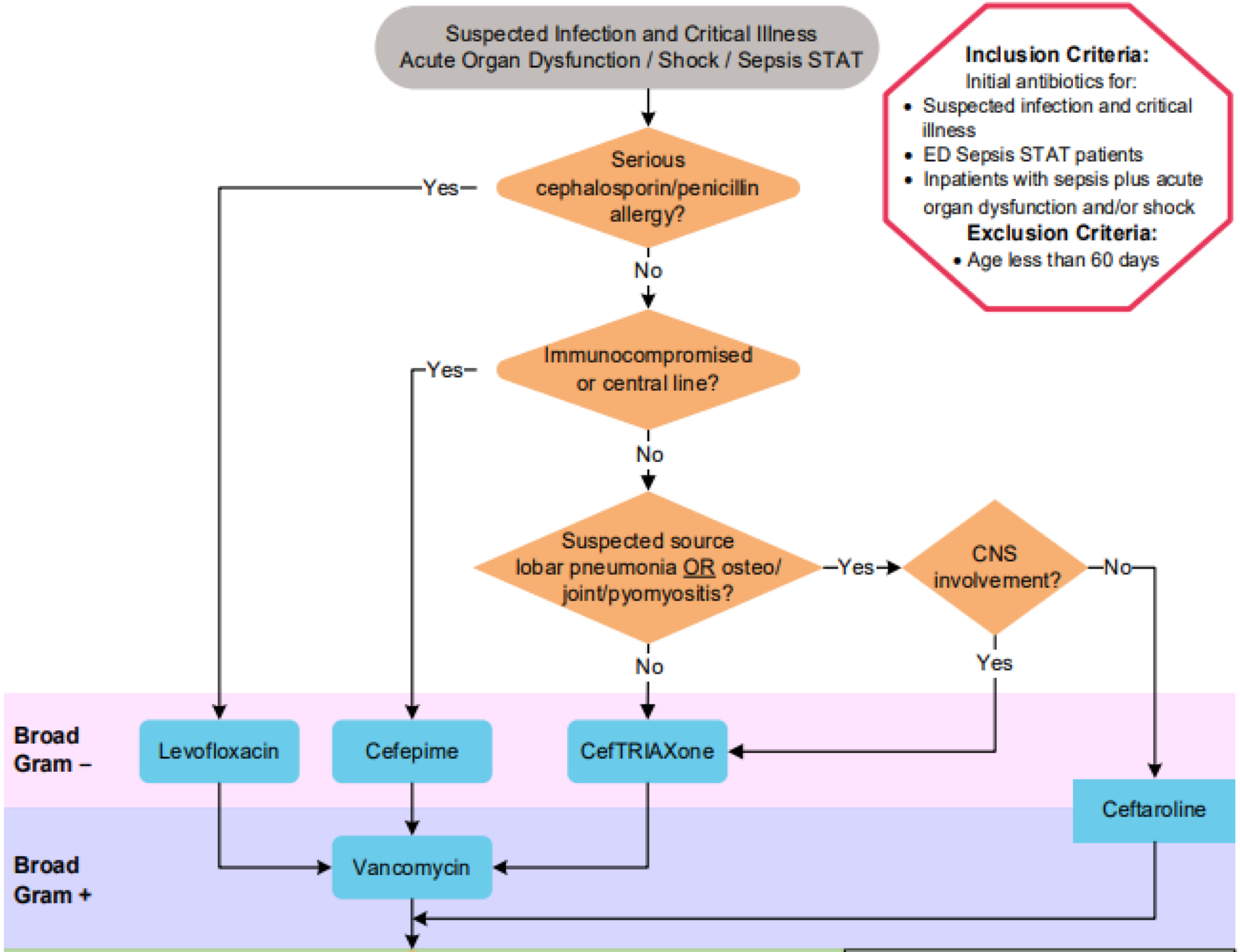
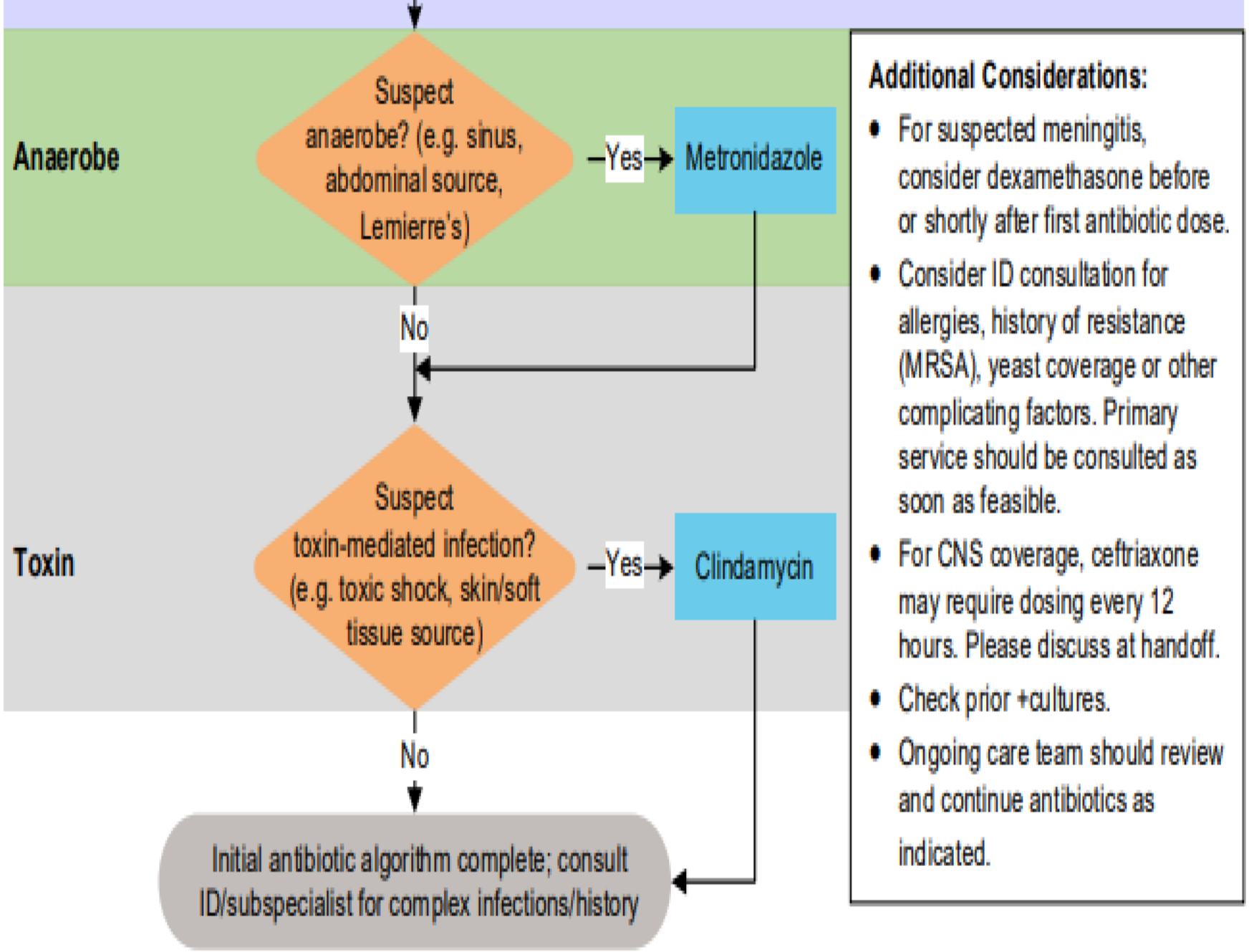
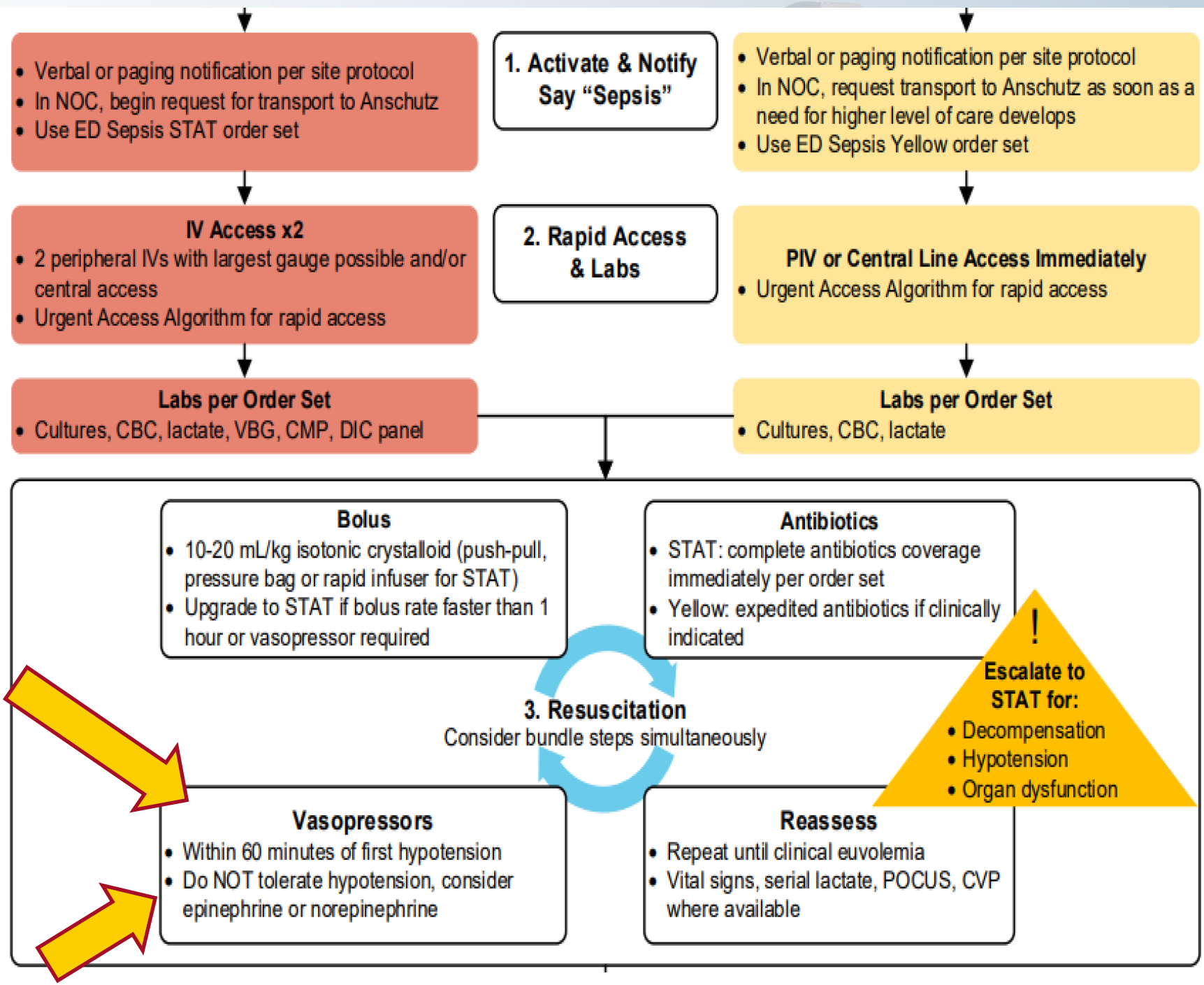



Anaerobe
Suspect anaerobe? (e.g. sinus, abdominal source, Lemierre's)
Yes
Metronidazole
No
Toxin
Suspect toxin-mediated infection? (e.g. toxic shock, skin/soft tissue source)
Yes
Clindamycin
No
Initial antibiotic algorithm complete; consult ID/subspecialist for complex infections/history
Additional Considerations:
For suspected meningitis, consider dexamethasone before or shortly after first antibiotic dose.
Consider ID consultation for allergies, history of resistance (MRSA), yeast coverage or other complicating factors. Primary service should be consulted as soon as feasible.
For CNS coverage, ceftriaxone may require dosing every 12 hours. Please discuss at handoff.
Check prior +cultures.
Ongoing care team should review and continue antibiotics as indicated.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• Use ED Sepsis STAT order set
1. Activate & Notify Say "Sepsis"
• Verbal or paging notification per site protocol
• In NOC, request transport to Anschutz as soon as a need for higher level of care develops
• Use ED Sepsis Yellow order set
IV Access x2
• 2 peripheral IVs with largest gauge possible and/or central access
• Urgent Access Algorithm for rapid access
2. Rapid Access & Labs
PIV or Central Line Access Immediately
• Urgent Access Algorithm for rapid access
Labs per Order Set
• Cultures, CBC, lactate, VBG, CMP, DIC panel
Labs per Order Set
• Cultures, CBC, lactate
Bolus
• 10-20 mL/kg isotonic crystalloid (push-pull, pressure bag or rapid infuser for STAT)
• Upgrade to STAT if bolus rate faster than 1 hour or vasopressor required
Antibiotics
• STAT: complete antibiotics coverage immediately per order set
• Yellow: expedited antibiotics if clinically indicated
3. Resuscitation
Consider bundle steps simultaneously
!
Escalate to STAT for:
• Decompensation
• Hypotension
• Organ dysfunction
Vasopressors
• Within 60 minutes of first hypotension
• Do NOT tolerate hypotension, consider epinephrine or norepinephrine
Reassess
• Repeat until clinical euvolemia
• Vital signs, serial lactate, POCUS, CVP where available

Mortality and functional morbidity after use of PALS/APLS by community physicians

- Early shock reversal was associated with reduced mortality (5.06% vs 16.37%) and functional morbidity (1.56% vs 4.11%) rates.
- Early use of PALS/APLS-recommended interventions was associated with reduced mortality (8.69% vs 15.01%) and functional morbidity (1.24% vs 4.23%) rates.

CONCLUSIONS:

- Pediatric shock recognition and resuscitation in the community hospital improves survival and functional outcome regardless of diagnostic category.
- The development of shock/trauma systems for children with and without trauma seems prudent.

Carcillo *Pediatrics* 2009

Mortality in patients referred for shock for transport to pediatric ICU

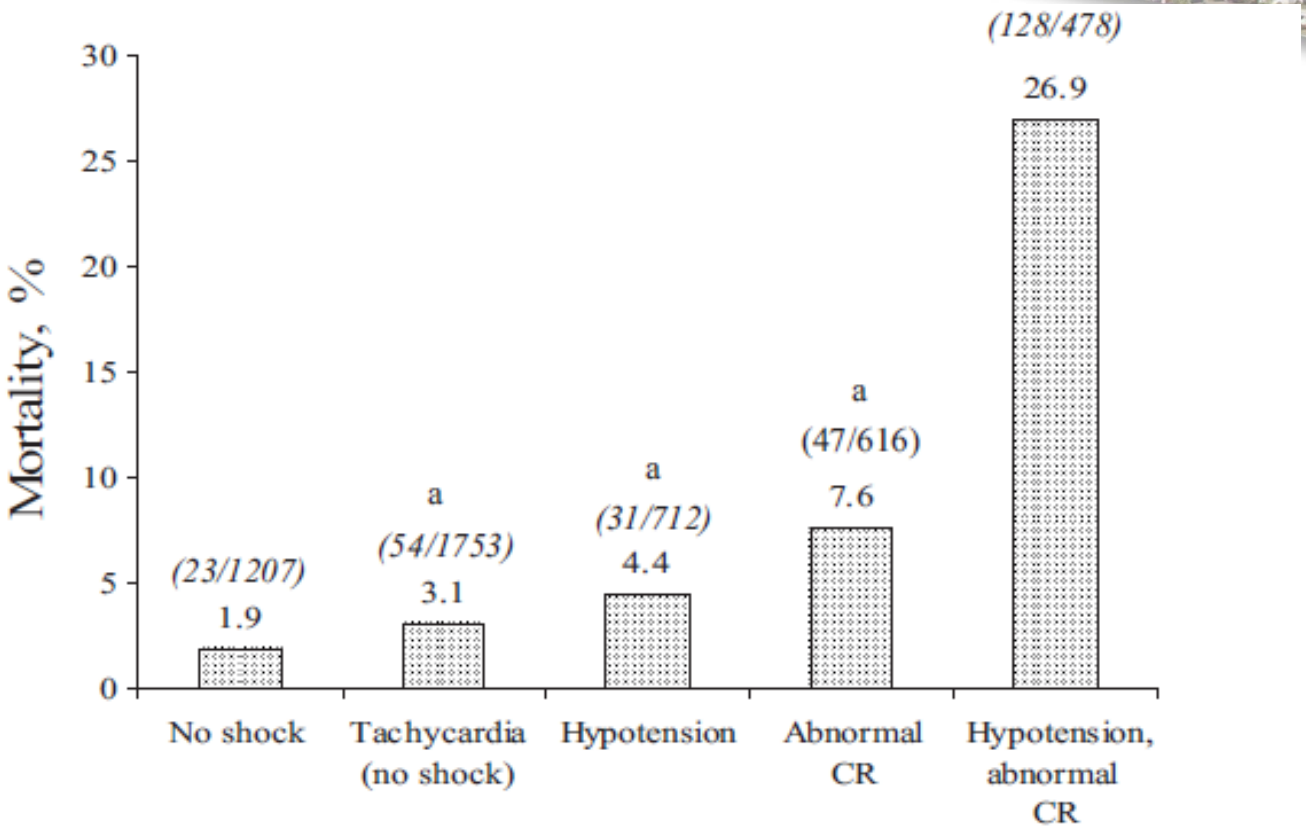

FIGURE 1

Mortality rates increase according to the degree of hemodynamic abnormality at presentation to the community hospital. CR indicates capillary refill time. [a] $P < .05$ versus no shock.

Carcillo *Pediatrics* 2009

Early Reversal of Shock

- At arrival of transport team (median 75 min): 26% achieved shock reversal – associated with 96% survival
- Each additional hour persistent shock…

Han YY, Carcillo JA, Dragotta MA, Bills DM et al. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatrics. 2003;112:793-799.

Early Reversal of Shock

- At arrival of transport team (median 75 min): 26% achieved shock reversal – associated with 96% survival
- Each additional hour persistent shock…

Risk of death doubled

Han YY, Carcillo JA, Dragotta MA, Bills DM et al. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatrics. 2003;112:793-799.

Treat hypotension

- IVF bolus-
  - 20 ml/kg
  - Give rapidly
  - Reassess/Repeat
  - Goal improved circulation (~60 ml/kg) in first 60 min
- Pressors:
  - Epi/NorEpi (yes can be given through PIV)
- Steroids:
  - If concern for adrenal insufficiency→Hydrocortisone
    - Infants: 25mg
    - Children: 50mg
    - Adolescents: 100mg

Do Not Tolerate Hypotension

- Traditionally learned to give all fluid first ~60ml/kg), and then start pressors, it may be better to work on both simultaneously (try to get at least 1-2 boluses in first). (*Shrink the tank and fill it at the same time*).

- The new pediatric sepsis guidelines recommend that no patient should be hypotensive 60 min w/out having a vasopressor/inotrope on board.
- If the patient has been persistently hypotensive, get pressors on board,
  - Plan ahead: Order pressors by the 30 minute mark.

First-Line Vasoactive Agents (an ED guide)

	Inotropy	Systemic Vascular Resistance	BP	Use in Sepsis?
Norepinephrine (alpha > beta)	+	+++	↑	Most patients Premixed at all CHCO sites, More familiar in general ED's
Epinephrine (beta > alpha)	+++	+	↑	Younger Community-acquired gram positive Significant cardiogenic component
Dopamine (5-10 mcg/kg/min) Beta>alpha, dopa	++	++	↑	If desperate Problems: 'dirty drug' (variable effects at different doses), arrhythmogenic, HPA/immune effects (decreases GH, prolactin)
Vasopressin, milrinone, dobutamine… potentially useful, most sepsis should be in ICU by then…				

Epi/NorEpi

- Can be given peripherally in an emergency, but central access is preferred.
  - There have been significant instances of patient harm from infiltration (KEEP CLOSE EYE ON IV)
  - This is even more of a concern in the early phases of resuscitation when our IV's (and IO) may be tenuous and patients may be moved and transported.
- Be careful with dosing.
- Let pharmacy make drips whenever possible.

Case #3

- 18:52 Phone call: 4 year old won't drink and has a fever. Language barrier.

- 19:10 EMS arrival on scene
- 4 year-old, no PMH
- Seen 2 weeks ago at ED for fever and was given medicine that made him better
- Recovered, was back at pre-school
- Now 4 days of new fever, worsening cough, vomiting and not drinking
- Mom reports: Has only had 1 can Mountain Dew for 24 hours.. No urine output in 12 hours

Case#3: On Scene

- 19:12 T=100 HR:132 RR:30 SpO2: 86%
- Moaning and grabbing abdomen
- Crying, moaning, grunting
- Refuses to walk – carried to stretcher

- 19:25 Call to Hospital:
  - "This is **** agency coming to ED non-emergent with a 4 year old male for fever and vomiting. Vitals are HR: 148 RR:30 Pox: 88% but I don't believe it bc hands are cold and not getting good reading, but he is on blow-by O2. We are 10 minutes out."

Case #3 in ED

- 19:39 Arrive at ED→Room 12
  - VS: T-102 RR:34 BP: 82/42 Pox: 86% on RA Wt: 15 kg
- 19:52 Orders:
  - Chest Xray
  - Zofran
  - Motrin
- 21:30 CXR shows possible LLL pneumonia
  - PO amoxicillin ordered
- 21:45
  - VS T-100.6 HR:164 RR: 60 BP: 74/32 Pox=92 on 4-5L NC,
  - Sleepy; does not cry with exam
  - Extremities cool, weak pulses
- 21:48 Provider alerted to change in status

Case #3 in ED

- 21:50 IVF bolus, CBC, Blood cultures ordered
- 21:52 IV attempt R arm not successful
- 21:53 IV attempt R hand not successful
- 21:55 IV attempt L hand not successful
- 21:58 IV L foot not successful
- 22:14 Charge nurse to bedside for IV attempt
- 22:20 22g in right foot.
  - Labs obtained/sent.
  - IVF 20ml/kg started at 300ml/hr
- 22:32 Pt unresponsive.
- 22:35 VS: HR 164 BP:63/23 RR: 12. Intubation
- 22:42 CPR started

Case #3 in ICU

- Day 1-
  - NorEpi drip
  - No urine output
  - DIC
- Day 2-
  - CPR required x2
  - No brain activity on EEG
- Day 3
  - Family removes support and pt passes.

- Autopsy: Group A Strep grew from pulmonary fluid
  +Influenza

What went wrong?

- What were the warning signs?
- What were the reassuring signs?
- What steps could have been better?

What do you notice about this case?

- Initial vitals not that bad
- Exam findings may be subtle
- Return of fever, or worsening, after initial febrile prodrome

- No focus on blood pressure, early access, IV fluid, antibiotics in the treatment plan until too late

- High-risk difficulty airway for intubation

What makes an intubation a difficult intubation?

- Trauma- Direct airway trauma and/or C-collar
- Anatomical abnormalities
- Inexperience for patient type
- Hemodynamically unstable patient
  - Hypotension
  - Hypoxia
  - Acidosis

Risk Factors for Peri-intubation Cardiac Arrest in a Pediatric Emergency Department

Nicholas Pokrajac, MD, Emily Sbiroli, MD,† Kathryn A. Hollenbach, PhD, MPH,‡ Michael A. Kohn, MD, MPP,* Edwin Contreras, MD,§ and Matthew Murray, MD†*

PEC Jan 2022

TABLE 2. Hemodynamic, Respiratory, and Intubation Characteristics of Cases and Controls

	PICA (n = 21)	Controls (n = 84)	OR (95% CI)	*P*
Hemodynamic and respiratory characteristics				
Elevated HR	11 (52.4)	53 (63.1)	0.6 (0.2–1.7)	0.455
Systolic hypotension (or unobtainable)	12 (57.1)	6 (7.1)	**17.3 (5.2–57.5)**	**<0.001**
Diastolic hypotension (or unobtainable)	11 (52.4)	6 (7.1)	**14.3 (4.3–47.1)**	**<0.001**
Elevated SI	6 (37.5)	17 (20.2)	2.4 (0.8–7.4)	0.191
Delayed CRT (>2 s)	18 (85.7)	19 (22.6)	**20.5 (5.5–77.2)**	**<0.001**
Received at least 10 mL/kg IVF	5 (23.8)	31 (36.9)	0.5 (0.2–1.6)	0.312
Hypoxia (or unobtainable)	13 (61.9)	2 (2.4)	**66.6 (12.7–349.1)**	**<0.001**

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TABLE 2. Hemodynamic, Respiratory, and Intubation Characteristics of Cases and Controls

	PICA (n = 21)	Controls (n = 84)	OR (95% CI)	*P*
Type of paralytic agent				0.639
Rocuronium	13 (61.9)	72 (85.7)		
Vecuronium	2 (9.5)	7 (8.3)		
Succinylcholine	1 (4.8)	2 (2.4)		
No paralytic agent	5 (23.8)	2 (2.4)	**12.8 (2.3–71.9)**	**0.003**
Type of sedative agent				0.452
Etomidate	3 (14.3)	29 (34.5)		
Ketamine	2 (9.5)	5 (6.0)		
Benzodiazepine	2 (9.5)	24 (28.6)		
Pentobarbital	3 (14.3)	16 (19.0)		
Other	1 (4.8)	7 (8.3)		
No sedative agent	10 (47.6)	3 (3.6)	**24.5 (5.8–103.2)**	**<0.001**
Night intubation (7:00 PM to 7:00 AM)	9 (42.9)	29 (34.5)	1.4 (0.5–3.8)	0.612
Greater than 1 intubation attempt	14 (66.7)	23 (27.4)	**5.3 (1.9–14.8)**	**0.001**

Physiologically Difficult Airway

Patients at increased risk of peri-intubation decompensation if have:

- Hypoxia
- Hemodynamic instability
- Cardiac dysfunction
- Acid/base derangements
- Asthma patient

Plan for Successful RSI

1. Identifying the physiologically difficult
2. Do you need to intubate? Do we need to **RIGHT NOW**?
3. Optimization of physiologic status prior to tracheal intubation
    1. Correct Hypoxia– pre-oxygenation, apneic oxygenation (don't tolerate hypoxia)
    2. Get as close as possible to hemodynamically stable
        1. IVF bolus (improve preload)
        2. Pressors (improve cardiac squeeze and vascular tone→ preload
            1. Epi drip, or "Low dose Epi" (1/10th code dose epi)
    3. Correct acidosis (Myocardium doesn't like acidosis)
4. Having cardiac arrest precaution measures in place
5. Optimize first past success- paralytic, induction agent, and most-experienced intubator

Case#4

- 00:15 911call: 5 year-old, fever, not drinking

- 00:27 Arrive on scene:
  - 5 year-old, no PMH
  - Fever, malaise, cough x 1 day
  - Decreased po, no UOP today
- T=37.9 HR=146 RR=40 Sat 82% BP = 86/55
  - Sleepy but cries with exam (no tears) Coughing;
  - Heart:S1S2 Tachy
  - Lungs: marked decreased BS on left
  - Cap refill~4sec
- 00:42 O2 15 liters via NRB

Case#4: Back of ambulance

- 00:45 Repeat Vitals
  - HR: 172 RR: 42 BP: 82/32 Pox:92% O2 15 liters via NRB
  - Broselow: 18kg
- 00:47 Call to ED:
  - "Agency *** coming to ED with 5 y.o with concern for septic shock. Pt with fever and poor PO intake and cough for 1 day. Current vital signs: HR 178 RR42 BP:80/32 Pox: 93%on 15 liters NRB. Pt is 18kg white by Broselow. Again I am concerned for septic shock and we are 8 minutes out"

Case#4 in ED

- 00:48:
  - Trauma/resuscitation Room 1 prepared
    - Nursing staff, respiratory therapy and pharmacy called to Room 1
    - EM physician assigns roles
    - Airway equipment readied
    - Belmont rapid infuser prepared for IVF 360ml (20ml/kg)
- 00:54 Arrival time
  - HR: 168 RR:58 BP: 78/32 Pox: 87% on NRB
  - Bigamy noted on monitor
  - Pt coughing up blood.
- 00:57 18g IV attempted Right upper ext-Blows
- 00:58 20g IV left hand w/out success
- 00:59 IO placed in right proximal tibia

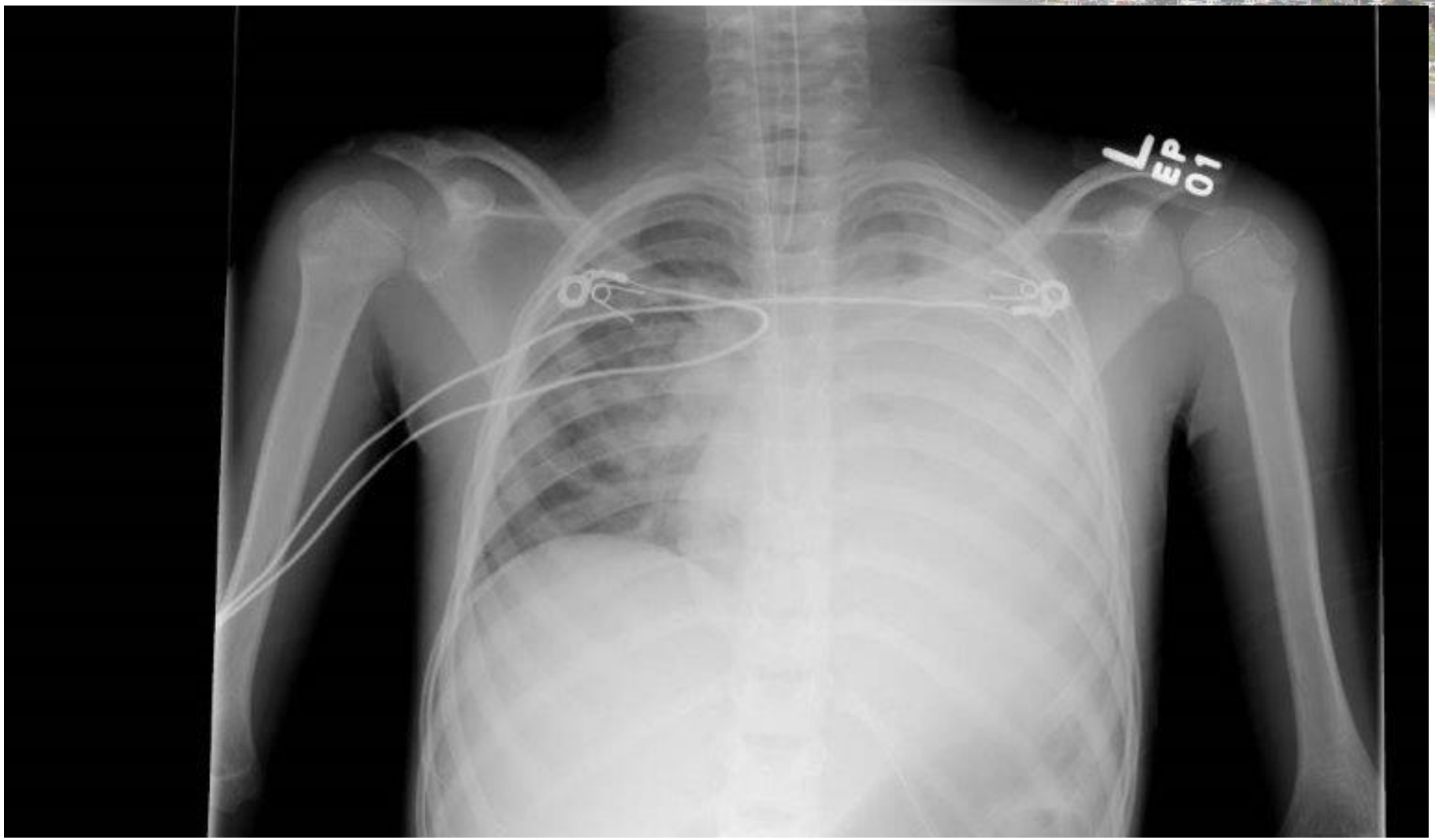
Case#4 in ED

- 01:00 IVF bolus started via rapid infuser
- 01:02 20g IV in right hand
  - Labs:
    - VBG
    - Blood culture
    - CMP
    - PT/PTT
    - Lactate
- 01:08 IVF bolus 20ml/kg completed
  - HR: 149 BP: 82/32 CR>4 sec RR:64 T:40.4
- 01:10 IVF bolus#2 started on push pull system
- 01:12 Abx ordered/started:
  - Ceftriaxone 100mg/kg
  - Vancomycin 20mg/kg
  - Tamiflu-via NG
- 01:15 Team discussed need to intubate patient

Case#4 in ED

- 01:28 2nd IVF bolus complete
  - HR: 132 BP: 88/42 Cap Refill~3 sec
- 3rd IVF bolus started
- 01:40 Decision made to intubate (HR:138 BP 90/48)
  - RSI and Low Dose Epi (1/10 code dose)
    - Ketamine 2mg/kg
    - Rocuronium 0.5mg/kg
  - Frank blood below cords
- 01:42 Labs:
  - VBG: 7.08/68/10/BE-16
  - CBC: WBC=1.1 ANC=490
  - Lactate: 6.25
  - Glucose: 46
- 01:44 Portable CXR

5 y.o. with cough, fever, SOB



Case#4 5yo fever/cough

- 01:52 5ml/kg D10 given and Norepi drip started
- 01:56 3rd IVF bouls completed (total 60 ml/kg)
  - HR 125 BP: 98/46 Cap refill~3 sec
- 02:12 Vitals prior to transfer to ICU
  - HR: 138 BP: 92/48 Cap refill~3 sec

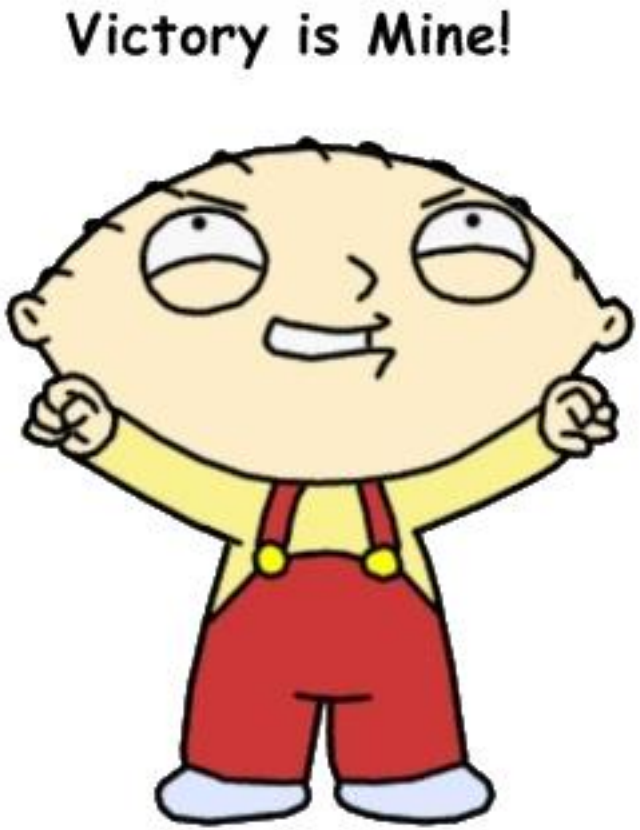
Case#4 5yo in ICU

- 02:30 Repeat Lactate-2.2 (was 6.25)
- 02:40 Left subclavian central line placed
- 07:00 Labs:
  - Influenza B positive
  - Group A Strep positive blood culture

6 hours later in PICU
5 y.o. with cough, fever, SOB

5 y.o. with cough, fever, SOB 12 days later

- Pt discharged home and walked out of hospital



Important Differences in Cases?

- Similar age patients
- Similar presentations
- Same bacteria sepsis

- Why did one patient die and the other walk out of the hospital?

Sepsis Take Home

- The first hour of care saved a life
- EMS recognition and stating concern for sepsis
- Recognition of SHOCK and INFECTION
  - Lactate levels can be helpful
- Access, oxygen, fluid, antibiotics
- Hypotension is bad
- Sepsis protocols work
  - Establishing sepsis clinical care guidelines improves outcomes

Questions?

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