



Pediatric Updates: Sepsis

Patrick Mahar, MD
Section of Emergency Medicine
Children's Hospital Colorado
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Financial Disclosures

- No relevant financial relationships with any commercial interests.

.....but I am seeking an endorsement deal

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?????



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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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Patrick Mahar, MD

Patrick.mahar@childrenscolorado.org



Pediatric Sepsis

- Pediatric Severe Sepsis
 - >75,000 yearly cases in US
 - US In-Hospital Mortality estimates
 - Over \$4.8 billion in healthcare costs in the United States



Pediatric Definitions

- **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 or elevated lactate)

Systemic Inflammatory Response Syndrome

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

- Core Temp $> 38.5^{\circ}\text{C}$ or $< 36^{\circ}\text{C}$
- Tachycardia / Bradycardia
- Tachypnea
- WBC elevated or depressed

Case #1

18 mo fever x 3 days

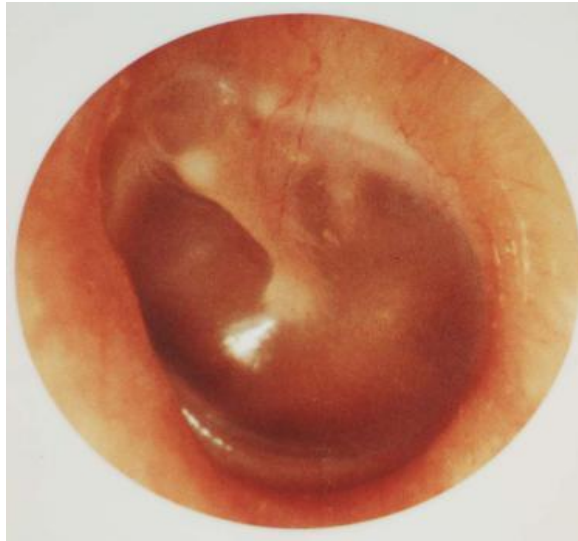
- 18 mo female; no PMHx
- Cough, congestion and runny nose for 5 days
- Fever started 3 days ago. T_{max}=103.5
- Tylenol given but fever returns
- Seen by PCP 2 days ago and diagnosed with bronchitis and a double ear infection, started on Azithromycin
- Post-tussive emesis x4 over past 24 hours
- Decreased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



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What is shock?

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



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SHOCK

OXYGEN SUPPLY FAILS TO MEET OXYGEN DEMAND

OXYGEN
SUPPLY



OXYGEN
DEMAND



OXYGEN DELIVERY

CARDIAC OUTPUT X ARTERIAL OXYGEN CONTENT

Cardiac
Output

Heart rate

-Intravascular
volume
-SVR

Stroke Volume

Preload
After load
Contractility

Arterial oxygen content

-Hemoglobin
-Oxygen Saturation
-Partial pressure of
oxygen dissolved in
plasma

SHOCK

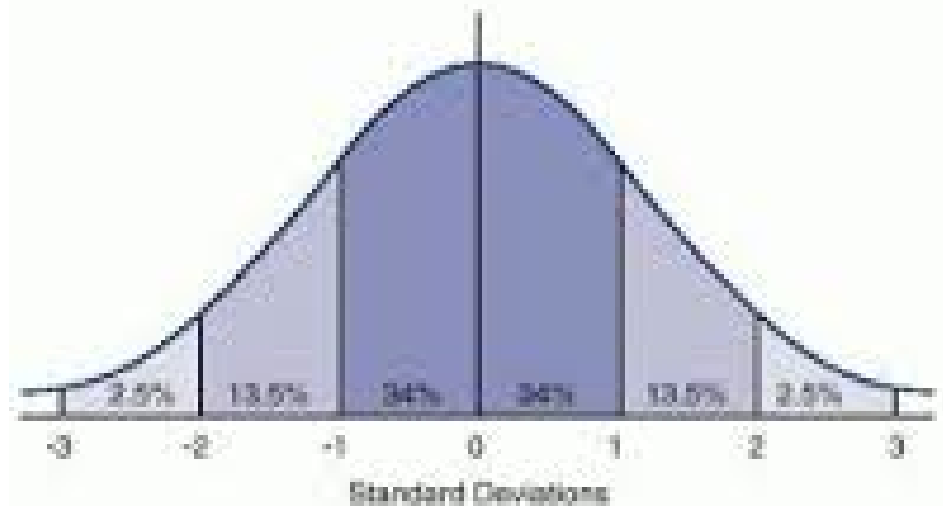
- Compensated Shock
 - **Normal blood pressure**
 - Body is maintaining blood pressure in normal range
 - ↑ HR and SVR to maintain BP
 - Early shock
 - Need to recognize and act to prevent progression

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



Vital signs: When to worry

- $BP = \text{Cardiac Output} \times \text{System Vascular Resistance (SVR)}$
- $CO = \text{Stroke Volume} \times \text{Heart Rate}$
- Quick Estimate of Hypotension in Pediatric Patient
- $SBP \leq (2 \times \text{Age}) + 70$
 - 4 yo
 - $SBP \leq (2 \times 4) + 70$
 - $SBP \leq 78$



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

Neuro: Altered mental status

Renal: Acute kidney injury ←

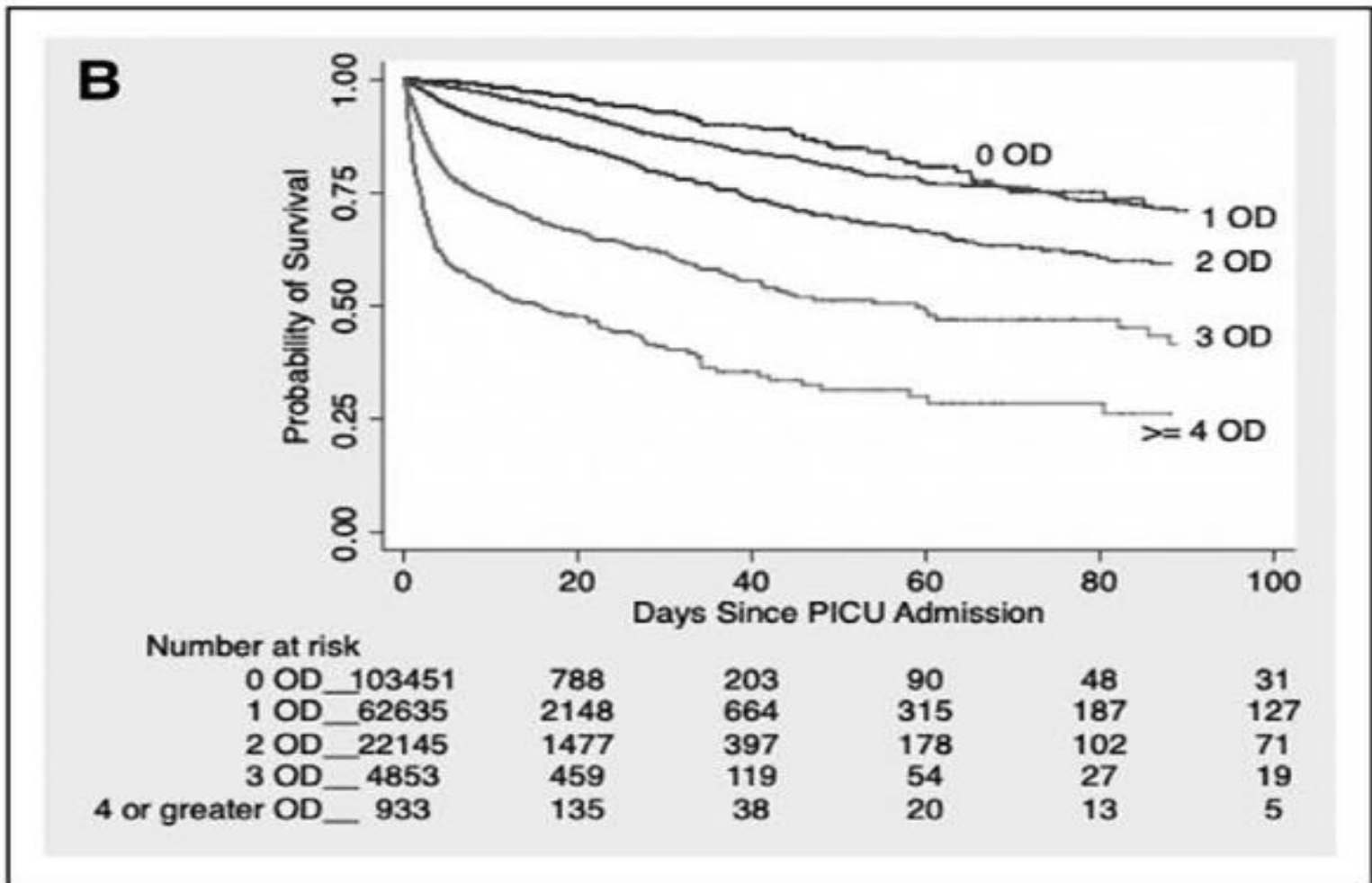
Hepatic: Elevated LFTs ←

Heme: DIC, low platelets ←

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



Why is organ dysfunction important?





SHOCK WARM vs COLD

	WARM shock	COLD shock
<i>Peripheries</i>	warm, flushed	cold, clammy, cyanotic
<i>Capillary refill</i>	< 2 sec	> 2 sec
<i>Pulse</i>	bounding	weak, feeble
<i>Heart rate</i>	tachycardia	tachycardia or bradycardia
<i>Blood pressure</i>	relatively maintained	hypotension
<i>Pulse pressure</i>	widened	narrowed



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:
 - 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.



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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

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TWIDDY
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T-W-I-D-D-Y
K-N-O-W-S
O-C-E-A-N-F-R-O-N-T...297 HOMES




Cuomo Plans New Rules in Fight Against Sepsis

By JIM DWYER
Published: January 7, 2013



SEVERE SEPSIS TRIAGE SCREENING TOOL

RORY'S RESULTS

Does the patient have any three of the following?

- Suspected Infection
- Temp > 100.4 or < 96.5 or rigors
- HR > 90
- RR > 20
- Any alteration of mental status
- O2 Sat < 90%
- SBP < 90
- Suspected/Known Immunocompromise (AIDS/Active Cancer/Organ Transplant Patient)

Yes No

If Yes clicked:

Go to Nursing Sepsis Panel Orders.

Triage Sepsis Panel Orders

(all boxes should be checked by default)

- Notify clinician to initiate verbal order for sepsis panel
- CBC
- Metabolic Panel
- Lactate (venous or arterial)
- Draw and Hold PT/PTT
- Draw and Hold Blood Cultures
- Record Vital Signs Q1 hour plus temperature

Is the patient's SBP < 90 or MAP < 65

Yes No

If Yes clicked:

Present case to physician.

If patient meets criteria, but you feel the patient doesn't need lab testing, please speak to



NYU Hospitals Center
Patient Record
NYUMC

Patient: STAUNTON,
DOB: 05/13/1999
Attending: [REDACTED]
Admit Date: 03/29/2012
Location: EMERG-TH

This report contains documentation entered between 03/29/2012

Vital Signs & Measurements F/S General

03/29/2012 21:26

Authored By:

BLOOD PRESSURE

Blood Pressure Systolic Systolic : 103 mmHg
Blood Pressure Diastolic Diastolic : 50 mmHg
Blood Pressure Mean Mean : 67 mmHg

TEMPERATURE

Temperature Temperature (F) degree F : 102 degrees F
Temperature Temperature (C) degree C : 38.8 degrees C

PULSE

Pulse Pulse Rate Rate (bpm) : 131 bpm

RESPIRATORY

Respirations Respiratory Rate Rate /min : 22 /min

PULSE OXIMETRY

Pulse Oximetry Saturation O2 Sat (room air) % (Room Air) : 99
29-Mar-2012 21:26 Vital Signs & Measurements F/S General
Norma (Nursing Attendant, Nursing Attendant, BENNEN02)

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



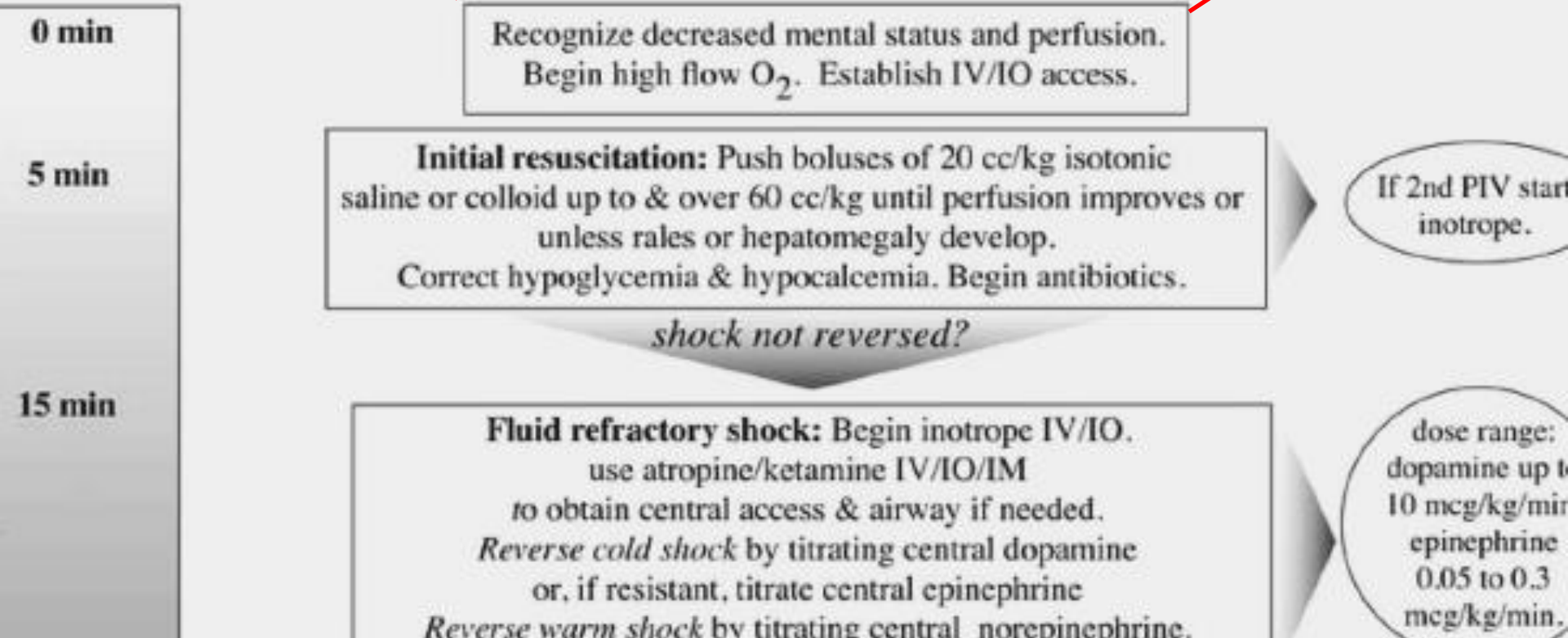
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How do we do better???

- 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

Recognize decreased mental status and perfusion.

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What Clinical Signs and Hemodynamic Variables Can be Used to Direct Treatment of Newborn and Pediatric Shock?

Table 2. American College of Critical Care Medicine hemodynamic definitions of shock

Cold or warm shock

Decreased perfusion manifested by altered decreased mental status, capillary refill >2 secs (cold shock) or flash capillary refill (warm shock), diminished (cold shock) or bounding (warm shock) peripheral pulses, mottled cool extremities (cold shock), or decreased urine output <1 mL/kg/h



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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.



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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



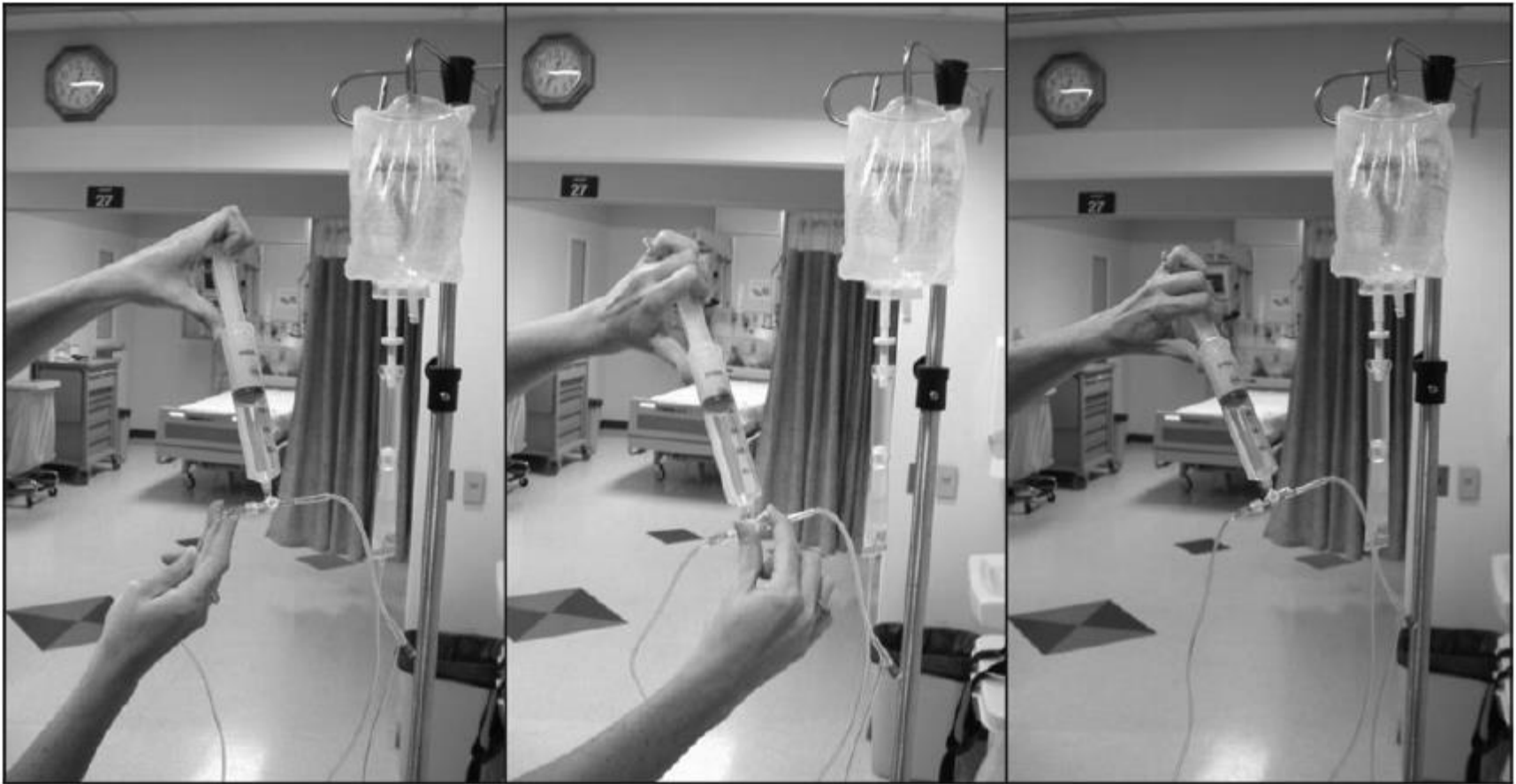
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Fluids





Chi



Pull from IV bag

Turn stopcock

Push to patient

← Repeat →



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

First evidence for early fluid in pediatric sepsis

- All children with septic shock with PA catheter by 6 hours
- 34 patients, mean age 13.5 months

	1st Hour Fluid	N	Mortality
Group 1	<20 ml/kg	14	57%
Group 2	20-40 ml/kg	11	64%
Group 3	>40 ml/kg	9	11%

- ARDS (n=11), cardiogenic pulmonary edema (n=5) not associated with volume received
- At time of PA placement: Hypovolemia more frequent in Groups 1&2, all hypovolemic patients died (n=8)

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.

Mortality in patients referred for shock for transport to pediatric ICU

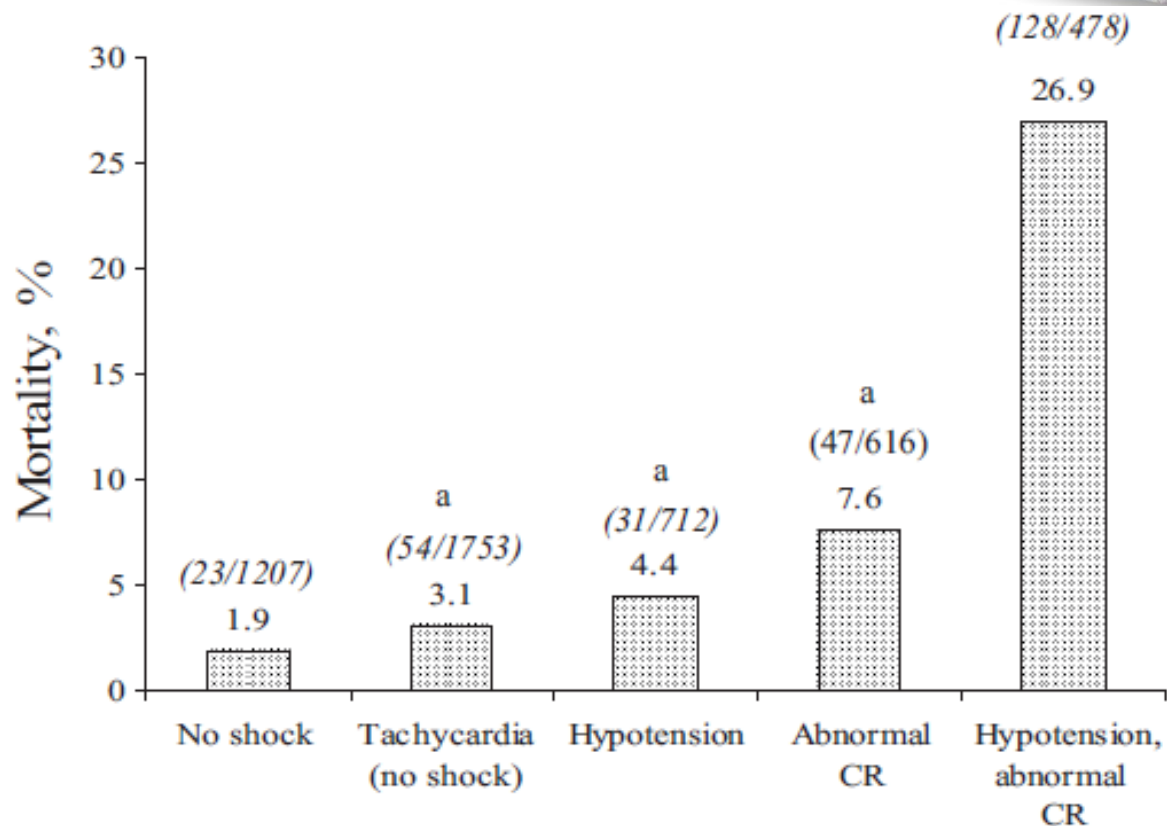


FIGURE 1

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.



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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.



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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.



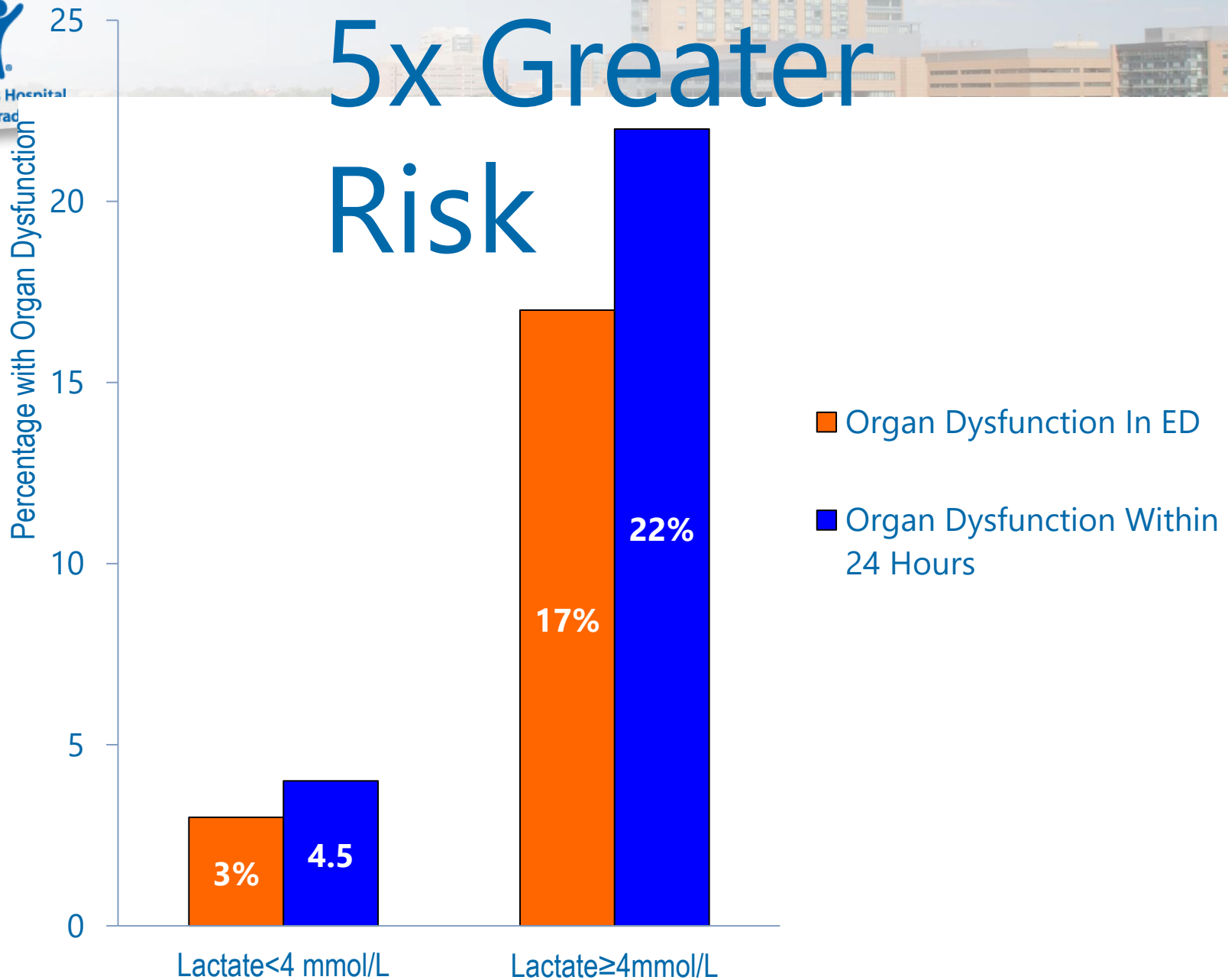
Treat hypotension

- 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

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





Sepsis Treatment And Recognition Program

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Sepsis Stat

Does the patient have fever and/or concern for infection with any of the below symptoms:

- **Hypotension with tachycardia or poor perfusion?**
- **Severe alterations in mental status/perfusion/respiratory distress?**
- **Critically-ill appearance?**

Sepsis Yellow

Does the patient have fever with concern for infection with any of the below symptoms:

- Persistent/worsening tachycardia despite treatment of fever & dehydration?
- Immunosuppression/immuno-deficiency or central line and worsening clinical status?
- Consider for:
 - Changes to mental status + infection
 - Cool extremities, poor capillary refill, diminished pulses, mottling
 - Flushed, warm extremities, bounding pulses, flash capillary refill

	Sepsis STAT	Sepsis Yellow
Concept	Septic Shock Full resuscitation now	High-risk for bacterial infection; not critical Prevent deterioration Ongoing clinical-decision making
Location	Move to a resuscitation bay	Stay in regular ED room
Staffing	Additional nurse to bedside	Bedside nurse (charge nurse watches the bedside nurse's other patients)
Pharmacy	Hand-delivers antibiotic	Expedited tubed antibiotic with nurse page
Fluid	Rapid bolus start, reassess	Consider, reassess *If faster than on a pump needed, upgrade to STAT
Antibiotics	Rapid antibiotics	Consider, reassess (stewardship)
PROS	Phenomenal coordinated resuscitation response	Lowers psychological barrier to clinicians activating & may prevent full shock state Allows expedited evaluation without committing to antibiotics Unifying protocol for all high-risk conditions
CONS	Resource-intensive	Underuse of Sepsis STAT



Sepsis Yellow

Activation Procedure: Nurse or provider may decide to activate a Sepsis Yellow Alert.

- Tells unit secretary to send Sepsis Yellow Page
- Page response from ED charge nurse, pharmacists
- Secretary records time of page
- Bedside RN notifies attending MD or activating MD notifies bedside RN

RN Procedures:

Charge RN ensures bedside RN is supported in care of other pts to allow bedside RN to prioritize the following immediate steps:

- Assess mental status, ABCDEs
- CR Monitor, Pulse Ox, Vital Signs *including BP q15 min*
- PIV access immediately, or access central line. If no access after 15 min, consider options for escalation.
- Obtain MD orders for:
 - Lab studies
 - NS Bolus if indicated
 - Antibiotics if indicated
- Control fever (antipyretics if not contraindicated)
- Begin bolus within 15 min of activation

MD Procedures:

- Rapid assessment
- Determine & order appropriate antibiotics if required. Pharmacist will be "on alert" for 30 min.
- Order bolus if required – upgrade to Sepsis STAT if bolus rate faster than 1hr desired
- Use ED Septic Shock order set to order:
 - Lab Studies
 - NS Bolus if indicated
 - Antibiotics if indicated
 - Antipyretics
- Continue full H&P and re-evaluation

Pharmacy Procedures:

- Prioritize review of antibiotic order by pharmacist
- IV room will call 73112 (ED charge nurse) when abx tubed to ED
- Pharmacist will be on alert awaiting antibiotic order within 30 min, call ED attending (73111) when 30 min alert period ending if no antibiotics ordered

Sepsis STAT

Activation Procedure: Nurse or provider may decide to activate a Sepsis STAT Activation.

- Tells unit secretary to send Sepsis STAT Page
- ED charge nurse, pharmacists, critical care resource nurse, PICU charge nurse, ED clinical coordinator/department educator, ED clinical practice specialist
- Secretary records time of page
- Bedside RN notifies attending MD or activating MD notifies bedside RN

RN Procedures:

2nd RN to bedside as soon as possible to assist bedside RN in the following immediate steps:

- Start the "Count-up" clock
- Assess mental status, ABCDEs, Weight
- CR Monitor, Pulse Ox, Vital Signs w/BP q 5 min until stable
- Start nasal cannula O2
- IV Access x2:
 - Peripheral IV with largest gauge possible (Consider IO, EJ if symptoms severe and access difficult)
 - Ports require 2nd IV's (Double-lumen large central lines do not)
 - If no access w/in 15 min, consider I/O
- Send sepsis labs, run 2 iSTAT's (CG8+, CG4+)
- Obtain MD orders for:
 - Lab studies
 - NS Bolus if indicated
 - Antibiotics if indicated
- Set up push-pull < 40 kg; Level 1 infuser for ≥ 40 kg
- Begin rapid infusion of 1st bolus w/in 15 min of activation
- Control fever (antipyretics if not contraindicated)
- Administer antibiotics (through central line if patient has one)
- Input/Output, consider Foley catheter

RN Ongoing Procedures:

- Monitor mental status, capillary refill, peripheral pulses, temperature
- CR Monitor, BP q 15 min once stable
- Continuous pulse ox
- Assure continued IV fluids
- Assure antibiotics completed

MD Procedures:

- Rapid assessment
- Use ED Septic Shock order set to order:
 - Lab Studies
 - NS Bolus
 - Antibiotics per antibiogram
 - Antipyretics
 - Dopamine infusion as indicated
- Consider central line, I/O, EJ if no access at 15 min
- Consider indications for additional medications: hydrocortisone (adrenal suppression), ID/specialty consult for difficult antibiotics (allergies, multidrug resistance, special infections), dextrose, dexamethasone (meningitis)

MD Ongoing Procedures:

- Continue H&P, consults & re-evaluation
- Evaluate immediately after every bolus, determine if additional bolus warranted
- Recheck dextrostick, other lab studies as indicated

Pharmacy Procedures:

- Prioritized review of antibiotic order by pharmacist
- Pharmacist CALLS IV room when order faxed for preparation
- IV room pages pharmacist when abx tubed to 412
- Pharmacist picks up at station & delivers to bedside, checks whether any other bedside pharmacist needs
- If no order within 30 min, pharmacist calls ED attending 73111 to verify whether abx needed

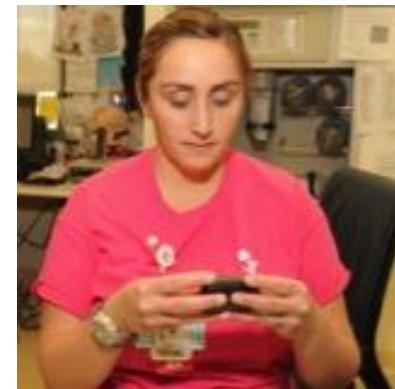




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Sepsis Activation

- Verbal request to unit secretary
 - Nursing or physician can initiate a sepsis activation
- Secretary activates page to relevant staff:
 - Charge nurse (ED / ICU), Pharmacist, Physicians
- Secretary clicks a timestamp button in EPIC





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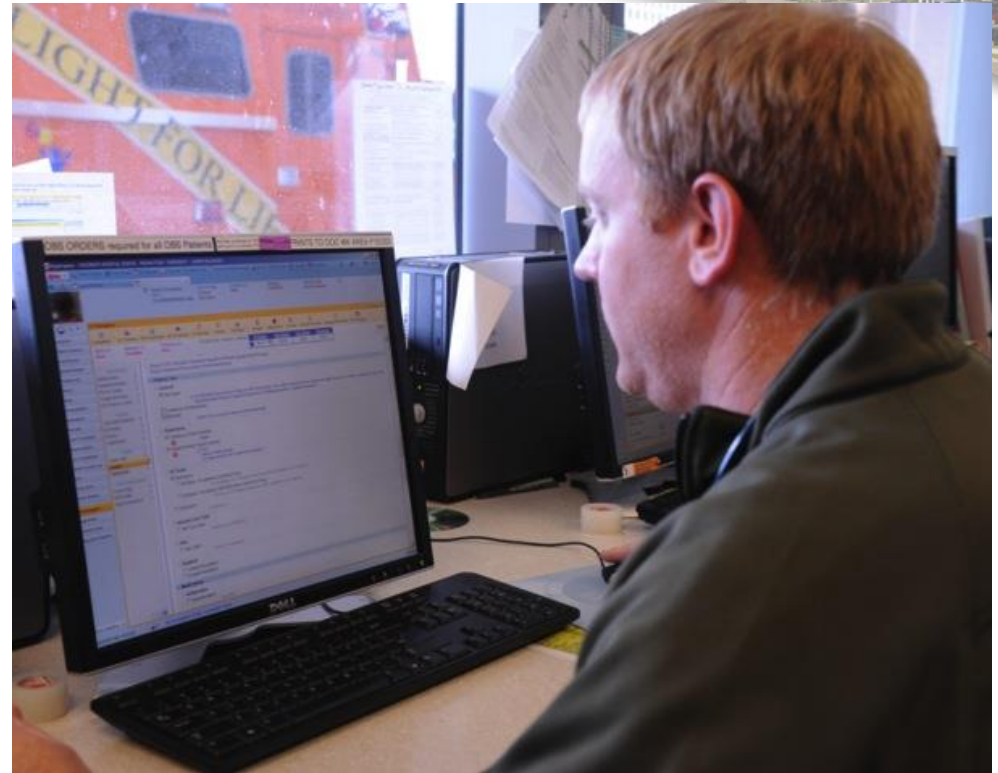
Order Sets

Pre-checked:

Vitals
Fluid
Laboratories

Key antibiotic elements:

- Indication in order set
- Dosing preprogrammed
- Max dose automatic correction
- Can be ordered in one "click"





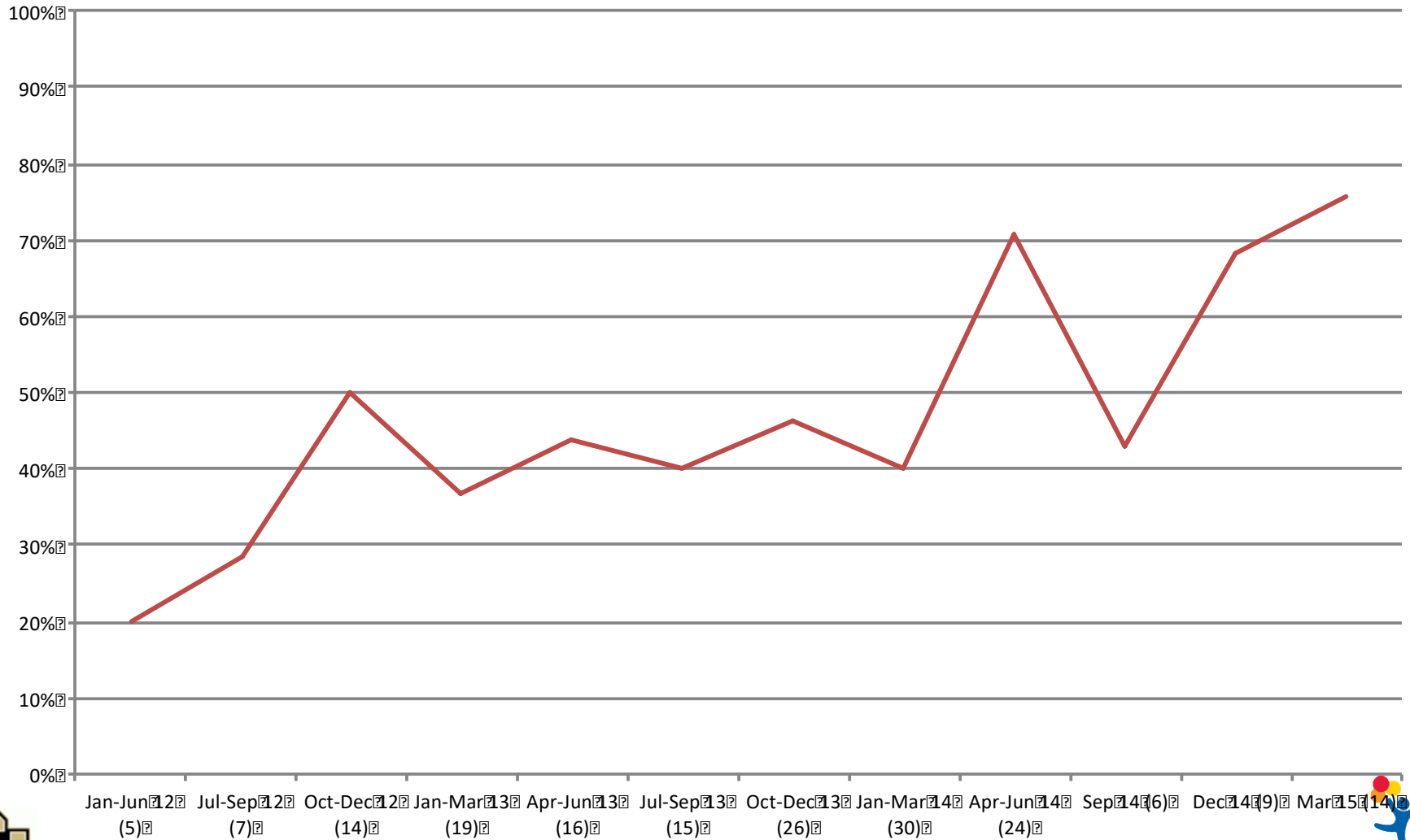
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Antimicrobial Therapy

1. In children with septic shock, we recommend starting antimicrobial therapy *as soon as possible*, within 1 hr of recognition (strong recommendation, very low quality of evidence).
2. In children with sepsis-associated organ dysfunction but without shock, we suggest starting antimicrobial therapy *as soon as possible* after appropriate evaluation, within 3 hr of recognition (weak recommendation, very low quality of evidence).
3. Additional recommendations: start broad/narrow coverage, stop asap, source control, specific pharmacodynamic/double coverage recommendations

ED Sepsis Stat Patients:

Percent Receiving Antibiotic in 60 min of Triage



Outcomes: Hospital Length of Stay





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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



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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.”



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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



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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
- 22:04 Charge nurse to bedside for IV attempt
- 22:06 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: 22 (intubated)→ICU
- 22:42 CPR started



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Case #3 in ICU

- Day 1-
 - Dopamine and Epi 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



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What went wrong?

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



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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



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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



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




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ORIGINAL CONTRIBUTION



Identification of the Physiologically Difficult Airway in the Pediatric Emergency Department

Preston N. Dean, MD^{1,2} , Erin F. Hoehn, MD^{1,2,3}, Gary L. Geis, MD^{1,2}, Mary E. Frey, MSN¹, Mary K. Cabrera-Thurman¹, Benjamin T. Kerrey, MD, MS^{1,2}, Yin Zhang⁴, Erika L. Stalets, MD, MS^{2,5}, Matthew W. Zackoff, MD, MEd^{2,5}, Andrea R. Maxwell, MD^{2,5}, Tena M. Pham⁵, and Andrew J. Lautz, MD^{2,5}

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-primary outcome: peri-intubation cardiac arrest, defined as cardiac arrest (documented chest compressions or non-perfusing rhythm within 10 minutes of the completion of tracheal intubation)



Ch Table 1
Clinical Characteristics of Patients Undergoing Tracheal Intubation in the PED by Risk Group

Characteristic	High Risk (<i>n</i> = 36)	Standard Risk (<i>n</i> = 177)	p-value*
Age (months)	8.5 (1-118.5)	18 (2-89)	0.489
Indication for RSI			<0.0001
Respiratory	16 (44)	71 (40)	
Altered mental status	9 (25)	30 (17)	
Sepsis	5 (14)	0	
Cardiac arrest	3 (8)	0	
Seizure	3 (8)	76 (43)	
High-risk criteria met			Not applicable
Hypotension	15 (42)	0	
Cardiac dysfunction	12 (33)	0	
Hypoxia	11 (31)	0	
Metabolic acidosis	8 (22)	0	
Post-ROSC	7 (19)	0	
Status asthmaticus	2 (6)	0	

Table 2
Outcome Data for Patients Undergoing Tracheal Intubation in the PED by Risk Group

Outcome	High Risk (<i>n</i> = 36)	Standard Risk (<i>n</i> = 177)	% Difference (95% CI)	p-value*
Peri-intubation arrest	2 (5.6)	0	5.6 (1.0 to 18.1)	0.0279
Any postintubation arrest in STS	4 (11.1)	0	11.1 (4.1 to 25.3)	0.0007
In-hospital mortality	9 (25)	4 (2.3)	22.7 (11.0 to 38.9)	<0.0001
ECMO	3 (8.3)	0	8.3 (2.5 to 21.8)	0.0044
First-attempt success	17 (47.2)	117 (66.1)	-18.9 (-35.5 to -1.5)	0.0382

Data are reported as *n* (%).



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Physiologically Difficult Airway

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

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



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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 pass success- paralytic, induction agent, and most-experienced intubator



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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



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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"



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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
 - IVF 360ml (20ml/kg) prepared in push-pull set up.
- 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



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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:
 - Ceftriaxone 100mg/kg
 - Vancomycin 20mg/kg
 - Tamiflu-via NG
- 01:15 Decision made to intubate



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Case#4 in ED

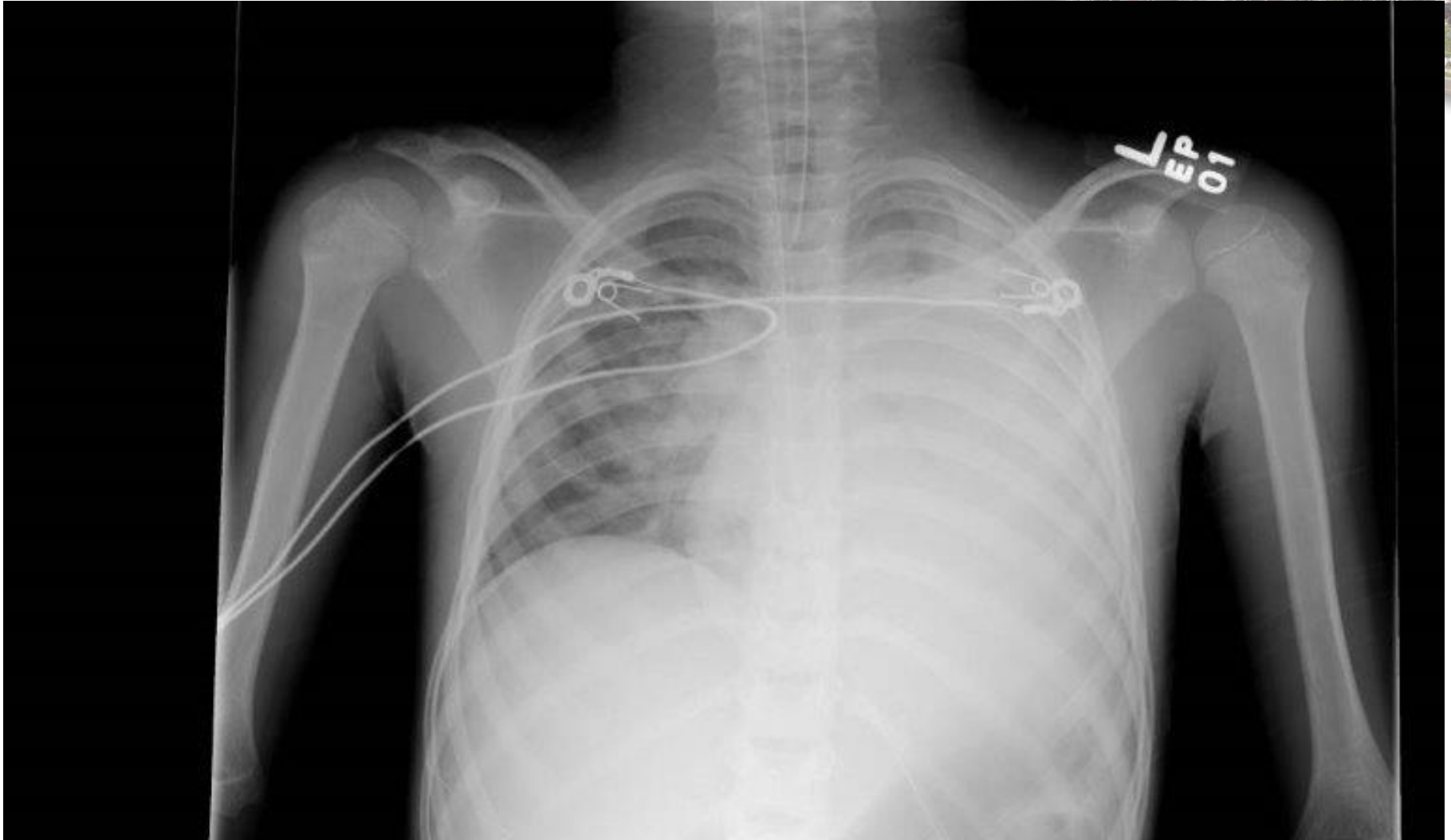
- 01:28 2nd IVF bolus complete
 - HR: 132 BP: 88/42 Cap Refill~3 sec
- 3rd IVF bolus started
- 01:40 Decision made to intubate (HR:138 BP 90/48)
 - RSI and Low Dose Epi
 - Ketamine 2mg/kg
 - Rocuronium 0.5mg/kg
 - Frank blood below cords
- 01:42 Labs:
 - VBG: 7.08/68/10/BE-16
 - CBC: WBC=1.1 ANC=490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





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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



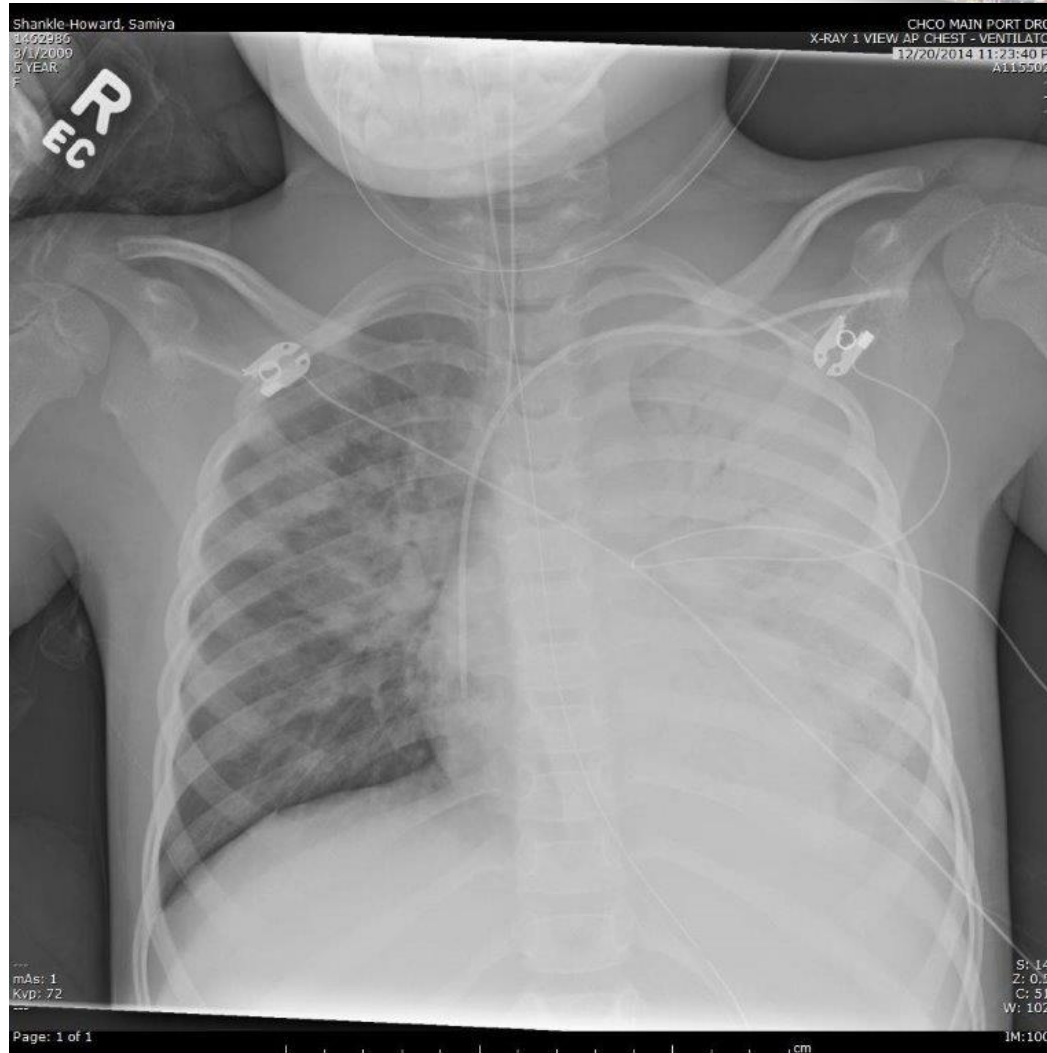
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Case#4 5yo in ICU

- 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





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

- Pt discharged home and walked out of hospital

Victory is Mine!





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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?



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.



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 longer than 1 hour without having a vasopressor/inotrope on board.
- If the patient has been hypotensive for 1 hour, we want to see pressors on board, so please start ordering and planning for them by the 45 minute mark.



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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.



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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?



Children's Hospital Colorado

Affiliated with



University of Colorado
Anschutz Medical Campus
School of Medicine

Patrick Mahar, MD

Patrick.mahar@childrenscolorado.org



Figure 2. Prevalence of Severity Measures by Categorical Lactate Group

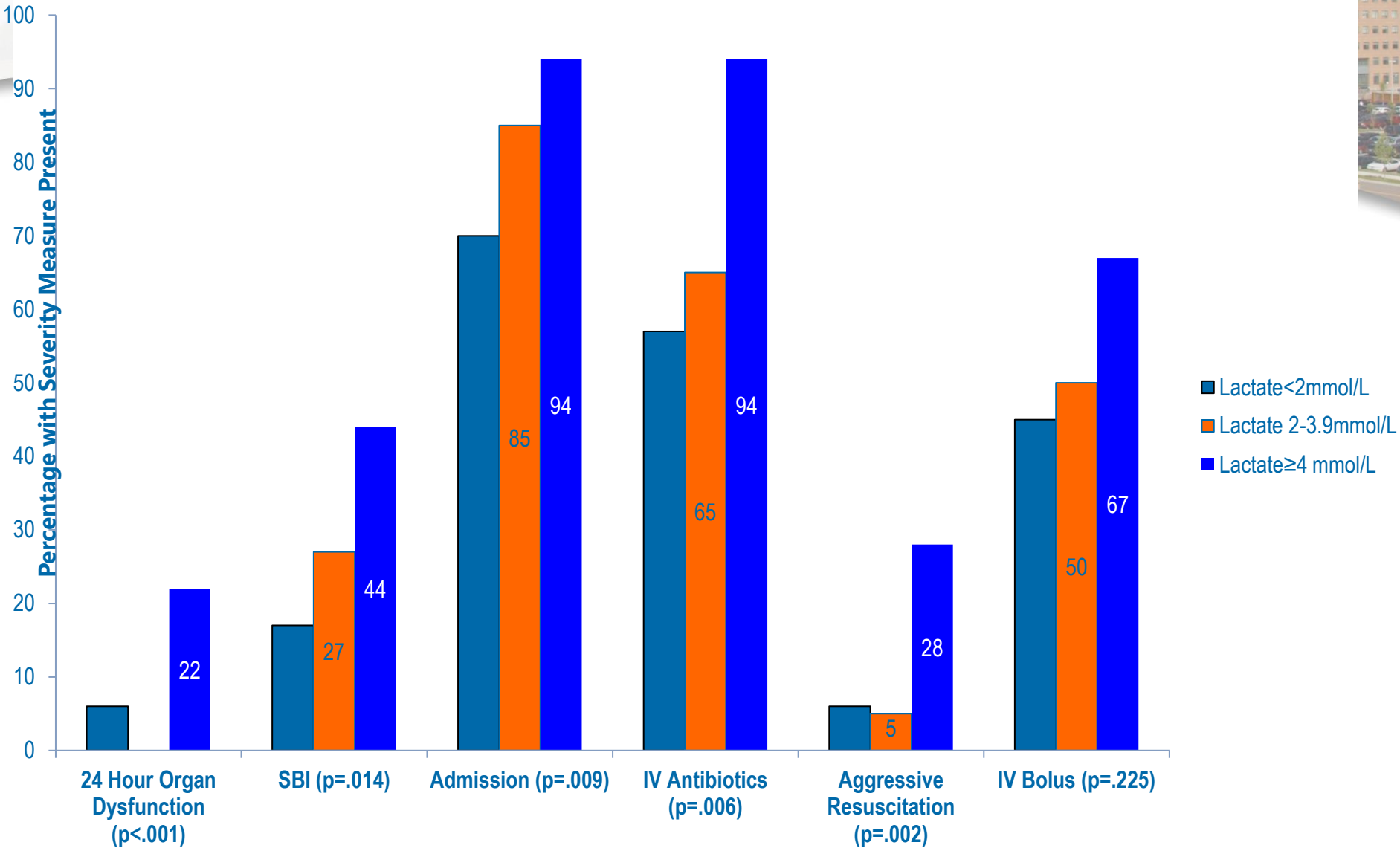


Figure 2: Prevalence of Severity Measures in Categorical Lactate Groups. Chi-squared test was used to assess for significance of associations.