Sepsis Prediction Scores

Jon Jui MD, MPH

DISCLOSURE for Continuing Medical Education Purposes

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IMPACT of Sepsis on U.S. Population

- Sepsis represents one of the **most significant** public health burdens in the United States, accounting for **over 1.7 million adult hospitalizations and at least 350,000 deaths annually**.

Surviving Sepsis Campaign **2026** Guidelines

- Hospitals should implement **performance improvement programs** for sepsis, including screening, standard operating procedures, and quality improvement strategies (strong recommendation).

- For screening, **NEWS, NEWS2, MEWS, or SIRS** are recommended over qSOFA as a single screening tool (strong recommendation), given qSOFA's poor sensitivity.

- Blood **lactate measurement** is suggested for all adults with suspected sepsis.

Antimicrobial Therapy

Early appropriate antimicrobial therapy remains **the most impactful** intervention to reduce mortality:

- **Septic shock** (possible, probable, or definite): Administer antimicrobials **immediately, ideally within 1 hour** of recognition (strong recommendation).
- **Probable or definite sepsis without shock**: Administer antimicrobials **immediately, ideally within 1 hour** (strong recommendation) — *upgraded from the 2021* guideline's 3-hour window for this group.
- **Possible sepsis without shock**: Conduct a **time-limited rapid investigation** (within 3 hours); administer antimicrobials if concern for infection persists (conditional recommendation).

Prehospital Antibiotics

- **Prehospital antibiotics** are now suggested for patients with definite/probable sepsis and hypotension when anticipated time to in-hospital evaluation exceeds 60 minutes (new recommendation).

Initial Fluid Resuscitation

- For sepsis-induced hypoperfusion or septic shock, at least **30 mL/kg of IV crystalloid** within the first 3 hours is suggested (conditional recommendation).

Key updates in the 2026 guidelines include:

- For patients with **BMI >30**, fluid volume should be calculated using **adjusted or ideal body weight**.

- **Balanced crystalloids** (e.g., lactated Ringer's) are now suggested over 0.9% saline (conditional recommendation, upgraded certainty), based on meta-analyses showing probable reductions in mortality and need for renal replacement therapy.

SIRS: Systemic Inflammatory Response Syndrome

Sepsi: *SIRS* Criteria

Temperature	< 36◦C or > 38 ◦C
Heart Rate	> 90 beats per minute
Tachypnea	> 20 breaths per minute or $PaCO_2$ < 32 mmHg
White Blood Cell count	WBC < 4,000/mm^3 or WBC >12,000/mm^3 or > 10% immature (band) forms

Systemic inflammatory Response Syndrome
- ≥ 2 criteria

Sepsis
- SIRS *plus* confirmed or presumed infection

Severe Sepsis
- Sepsis plus organ dysfunction

Septic Shock
- Severe Sepsis plus refractive Hypotension

Multiple Organ Dysfunction Syndrome
- Evidence of ≥ 2 organs failing

qSOFA

qSOFA = Quick Sequential Organ Failure Assessment	
Altered Mental Status (**AMS**)	Glasgow Coma Scale (**GCS**) < 15
Respiratory Rate (**RR**)	>22 bpm
Systolic Blood Pressure (**SP**)	< 100 mmHg

Components of SIRS, qSOFA, MEWS, and NEWS

	SIRS	qSOFA	MEWS	NEWS
Temperature	✓		✓	✓
Heart rate	✓		✓	✓
Blood Pressure		✓	✓	✓
Respiratory Rate	✓	✓	✓	✓
Oxygen saturation				✓
Use of supplemental oxygen				✓
Mental status		✓	✓	✓
Leukocyte count	✓			
Urine output			✓	

SIRS: Systemic Inflammatory Response Syndrome; **qSOFA:** quick Sequential Organ Failure Assessment; **MEWS:** Modified Early Warning Score; **NEWS:** National Early Warning Score

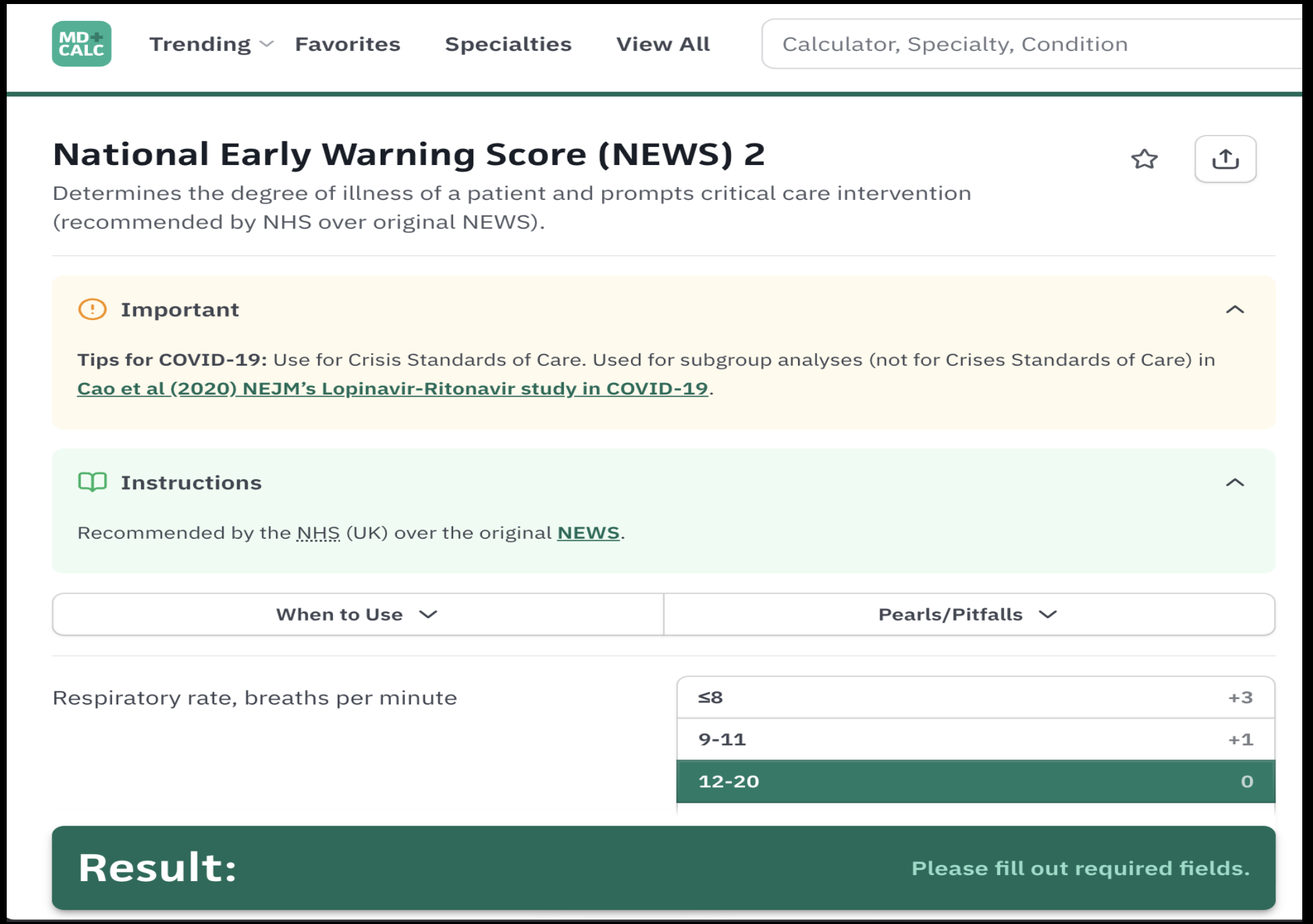
NEWS 2

Variable	Zero
Respiration	12-20
SpO_2 (scale 1)	> 96
SpO_2 (scale 2)	>93
Air or O_2	Air
Systolic Blood Pressure (SBP)	111-219
Pulse	51-90
Consciousness	Alert
Temperature	36.1 to 38 ◦C

NEWS 2

NEWS2 Score		Clinical Risk			Response	
6			Medium		Key Threshold for Urgent Response	
3	2	1	0	1	2	3
Respiratory rate (per minute						
≤ 8		9 -11	12 -2 0		21-24	>25
SpO_2 Scale 1						
≤ 91	92-93	94-95	≥ 96			
SpO_2 Scale 12						
≤ 83	84-85	86-87	88-92 ≥ 93 (air)	93-94 (O_2)	95-96 (O_2)	≥ 97 (O_2)
Air or O_2						
	O_2		Air			
Systolic Blood Pressure (mmHg)						
≤ 90	91-100	101-110	111- 219			≥220
Pulse (per minute)						
≤40		41-50	51-90	91-110	111-130	≥131
Consciousness						
			Alert			CVPU
Temperature						
≤ 35		35.1-36	36.1-38	38.1-39	≥ 39.1	

MD Calc NEWS 2



Important

$ETCO_2$ has been studied as a physiologic enhancer (especially for sensitivity), not yet as a codified element of Sepsis-3 or NEWS2.

SIRS (≥2 criteria)

- Baseline performance (without $ETCO_2$)

Outcome	Sensitivity	Specificity
Severe sepsis / organ dysfunction	85–95%	15–35%

- Interpretation
  - Extremely sensitive, very nonspecific
  - Flags inflammation, not organ failure
  - Poor discrimination for severity

- Good **screen-out** tool, poor **rule-in** tool.

qSOFA (≥2 criteria)

	Sensitivity	Specificity
Severe sepsis / organ dysfunction	25–50%	80–95%

- Interpretation
  - Misses many early or compensated septic patients
  - Strong association with mortality, weak early detector

📌 Clinical takeaway: Late-stage flag, not a screening tool.

NEWS2 (≥5 or ≥7)

- Threshold — Sensitivity — Specificity
  - ≥5 — 75–90% — 45–65%
  - ≥7 — 60–75% — 70–85%
- Interpretation
  - Best overall balance
  - Captures respiratory failure, hypotension, altered mental status earlier

📌 Clinical takeaway: Best single score for early sepsis recognition in ED/EMS.

Effect of adding $ETCO_2$

- Why $ETCO_2$ matters physiologically

- Low $ETCO_2$ in sepsis reflects:
  - ↑ Lactate → buffering → ↑ CO_2 clearance
  - ↓ Cardiac output / distributive shock
  - ↑ Dead-space ventilation

- 📉 $ETCO_2$ ≤ 25 mmHg strongly correlates with:
  - Lactate ≥4 mmol/L
  - Septic shock
  - Increased mortality

1. SIRS + $ETCO_2$

- Performance with $ETCO_2$ added ($ETCO_2$ ≤25 mmHg)

Outcome	Sensitivity	Specificity
Severe sepsis	90–97%	30–50%

- Sensitivity improves slightly
- Specificity doubles compared to SIRS alone

📌 Hospital relevance: Excellent early warning + physiologic severity marker

qSOFA + $ETCO_2$

Outcome	Sensitivity	Specificity
• Severe sepsis	55–70%	85–95%

- Sensitivity improves substantially
- Specificity remains very high

📌 EMS relevance: Converts qSOFA from a “late flag” into a meaningful field tool

NEWS2 + $ETCO_2$

	Sensitivity	Specificity
• Severe sepsis	90–95%	65–80%

- 🔹 Best overall diagnostic performance
- 🔹 Strong correlation with lactate and vasopressor need

📌 EMS relevance: Best combined rule-in/rule-out approach

Head-to-head summary

Tool	Sensitivity	Specificity	Early Detection	EMS Utility
SIRS	★★★★★	★	★★★★★	Good
qSOFA	★★	★★★★★	★	Limited alone
NEWS2	★★★★	★★★	★★★★	Excellent
SIRS + $ETCO_2$	★★★★★	★★☆	★★★★★	Very good
qSOFA + $ETCO_2$	★★★☆	★★★★★	★★★	Good
NEWS2 + $ETCO_2$	⭐⭐⭐⭐⭐	⭐⭐⭐⭐	⭐⭐⭐⭐⭐	Best

Practical EMS interpretation

Best single approach

- NEWS2 ≥5 + $ETCO_2$ ≤25 mmHg

- High-risk septic shock phenotype
  - $ETCO_2$ ≤25 mmHg
  - MAP <65 or SBP <90
  - Altered mentation
  - RR ≥22

- → High probability of lactate ≥4 mmol/L

What About the Following?

- Lactate

- Perfusion Index

Summary

SIRS: sensitive but nonspecific

qSOFA: specific but dangerously insensitive alone

NEWS2: best baseline tool

$ETCO_2$ markedly improves all three, especially:

- qSOFA sensitivity
- NEWS2 specificity

NEWS2 + $ETCO_2$ currently offers the strongest diagnostic performance for severe sepsis in EMS and ED settings

The END

Jon Jui MD, MPH

Drugs For Bugs

Dr P. R. Banerjee

Medical Director Polk County Fire Rescue

Assistant Professor in Emergency Medicine

NOVA Southeastern College of Medicine

Associate Professor Orlando College of Osteopathic Medicine

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Antibiotics in Sepsis

Every 60 min DELAY

7.6% increase in MORTALITY

SIDP SOCIETY OF INFECTIOUS DISEASES PHARMACISTS

Kumar A, et al. Crit Care Med 2006; 34(6):1589-96.

What about Blood Cultures?


GATORS
G
SUCK

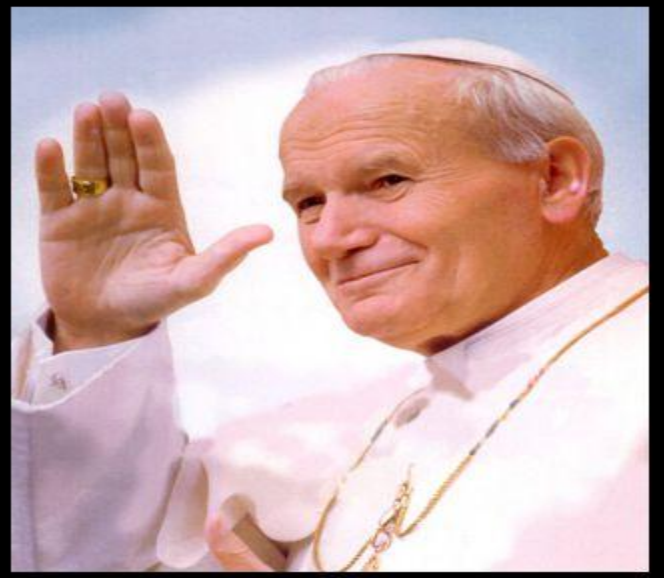
Polk County : 2015 - 25
10 years of Sepsis Alert Data

ALL Polk County	NS Only 2015 - 2022	Shock +Rocephin 2023-24	Rocephin 2025
Total Sepsis Alerts	*3995*	*919*	*474*
% Diagnosed with Sepsis	*56%*	*67%*	*70%*
% Admitted	*94%*	*88%*	*85%*
Positive lactate Levels	*50%*	*54%*	*56%*
Mortality	*15.8%*	*7.1%*	*7.9%*

PaulBanerjee@Polkfl.gov

Mariana Bridi Costa,
Brazilian model

All of them died secondary to sepsis



Pope John-Paul II

Etta James, singer

Pediatric Sepsis:

Scoring Big Time in Small Ones

Peter Antevy, MD, FAEMS
EMS Medical Director

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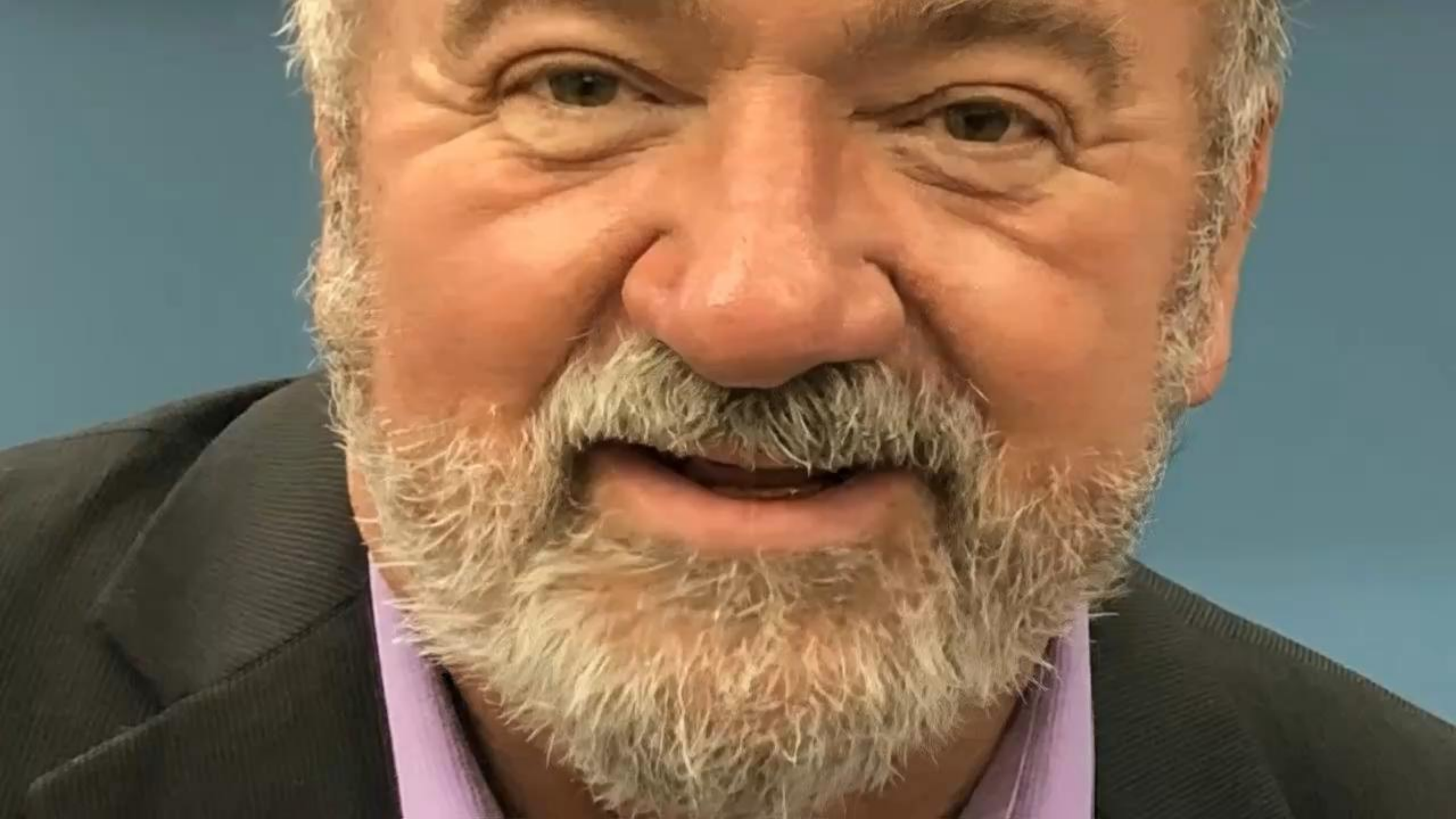
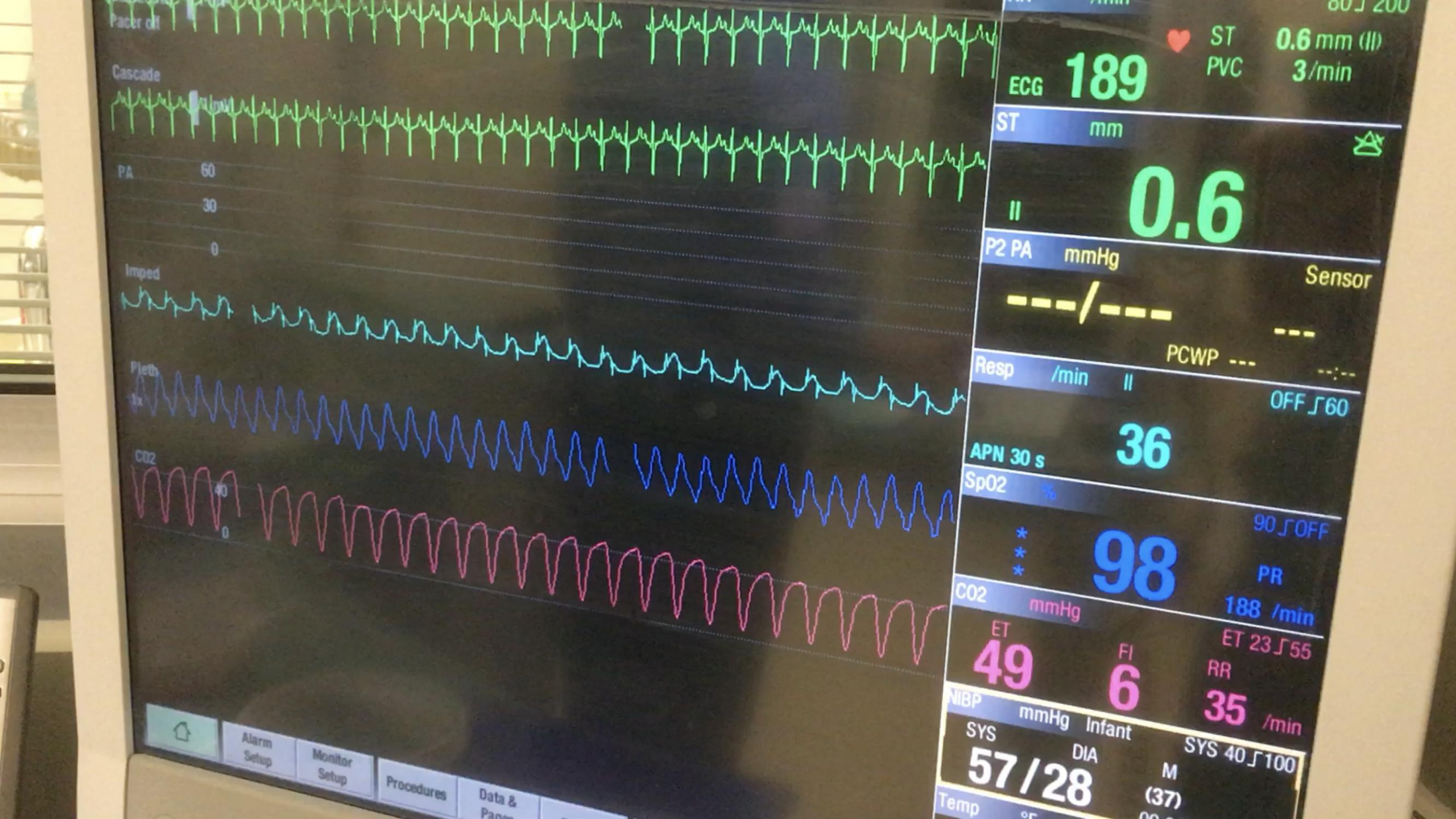
Additional DISCLOSURE in this case

for Continuing Medical Education Purposes …

It should be noted that Dr. Antevy does have a consulting relationship with

However, this CME activity has been designed and reviewed by an independent committee with no relevant financial ties to ensure that the content is free of commercial bias and evidence-based. Accordingly, all of the relevant financial relationships listed for Dr. Antevy have been mitigated.




Pacer off
Cascade
PA
60
30
0
Imped
Pleth
CO2
40
0
ECG 189
ST 0.6 mm (II)
PVC 3 /min
ST mm
II 0.6
P2 PA mmHg
Sensor
---/---

PCWP ---
Resp /min II
OFF ⌠60
APN 30 s
36
SpO2 %
90 ⌠OFF
98
PR
188 /min
CO2 mmHg
ET
49
FI
6
ET 23 ⌠55
RR
35
/min
NIBP mmHg Infant
SYS
DIA
57/28
SYS 40 ⌠100
M
(37)
Temp
Alarm Setup
Monitor Setup
Procedures
Data &

Recognition

Resuscitation

Research

The Phoenix Sepsis Score

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

International Consensus Criteria for Pediatric Sepsis and Septic Shock

Luregn J. Schlapbach, MD, PhD; R. Scott Watson, MD, MPH; Lauren R. Sorce, PhD, RN; Andrew C. Argent, MD, MBBCh, MMed; Kusum Menon, MD, MSc; Mark W. Hall, MD; Samuel Akech, MBChB, MMED, PhD; David J. Albers, PhD; Elizabeth R. Alpern, MD, MSCE; Fran Balamuth, MD, PhD, MSCE; Melania Bembea, MD, PhD; Paolo Biban, MD; Enitan D. Carrol, MBChB, MD; Kathleen Chiotos, MD; Mohammod Jobayer Chisti, MBBS, MMed, PhD; Peter E. DeWitt, PhD; Idris Evans, MD, MSc; Cláudio Flauzino de Oliveira, MD, PhD; Christopher M. Horvat, MD, MHA; David Inwald, MB, PhD; Paul Ishimine, MD; Juan Camilo Jaramillo-Bustamante, MD; Michael Levin, MD, PhD; Rakesh Lodha, MD; Blake Martin, MD; Simon Nadel, MBBS; Satoshi Nakagawa, MD; Mark J. Peters, PhD; Adrienne G. Randolph, MD, MS; Suchitra Ranjit, MD; Margaret N. Rebull, MA; Seth Russell, MS; Halden F. Scott, MD; Daniela Carla de Souza, MD, PhD; Pierre Tissieres, MD, DSc; Scott L. Weiss, MD, MSCE; Matthew O. Wiens, PharmD, PhD; James L. Wynn, MD; Niranjan Kissoon, MD; Jerry J. Zimmerman, MD, PhD; L. Nelson Sanchez-Pinto, MD; Tellen D. Bennett, MD, MS; for the Society of Critical Care Medicine Pediatric Sepsis Definition Task Force

New Definitions:

Sepsis = **Infection** + **Organ Dysfunction**

And ≥ 2 Points

- Respiratory (0-3)
- **Cardiovascular (0-6)**
- Coagulation (0-2)
- Neurological (0-2)

Septic Shock

At least 1 point CV

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]	0-200 and IMV or 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				
		int each (up to 3)	Points each (up to 6)	
	No vasoactive medications[d]	tive medicati	≥2 Vasoactive medications[d]	
	Lactate <5 mmol/L[e]	Lac 9 m	Lactate ≥11 mmol/L[e]	
Age based[f]				
	Mean arterial pressure, mm Hg[g]			
<1 mo	>30	17-3	<17	
1 to 11 mo	>38		<25	
1 to <2 y	>43		<31	
2 to <5 y	>44	44	32	
5 to <12 y	>48	36-48		
12 to 17 y	>51	38-51	<	
Coagulation (0-2 points)[h]				
		1 Point each (maximum 2 points)		
	Pl × 10^3/μL	Platelets <100 × 10^3/μL		
	ational normalized ratio	International normalized ratio >1.3		
	D-dimer ≤			
	Fibrinogen			
Neurological (0-2 points)[i]				
	Glasgow C pupils reactive[j]		y	

Too Late (PICU)

PEDIATRICS/ORIGINAL RESEARCH

Development of a New Screening Tool for Pediatric Septic Shock

Nathan Georgette, MD*; Kenneth Michelson, MD, MPH; Michael Monuteaux, ScD; Matthew A. Eisenberg, MD, MPH

*Corresponding Author. E-mail: nathan.georgette@gmail.com.


PS5 Pro

quick Pediatric Septic Shock Screening Score

- 9 Years (2012-2021)
- 47,000 patients
- Retrospective cohort study

qPS4

Strictly Vital sign based

- AVPU or GCS
- Capillary Refill
- Heart Rate
- Mean Arterial Pressure (MAP)
- Temperature (C^0)

$$S.I. = \frac{HR - (T - 37) \times 10}{SBP \quad MAP}$$

quick Pediatric Septic Shock Screening Score

- 9 Years (2012-2021)
- 47,000 patients
- Retrospective cohort study

qPS4

Strictly Vital sign based

- AVPU or GCS
- Capillary Refill
- Heart Rate
- Mean Arterial Pressure (MAP)
- Temperature (C^0)

TAMSI

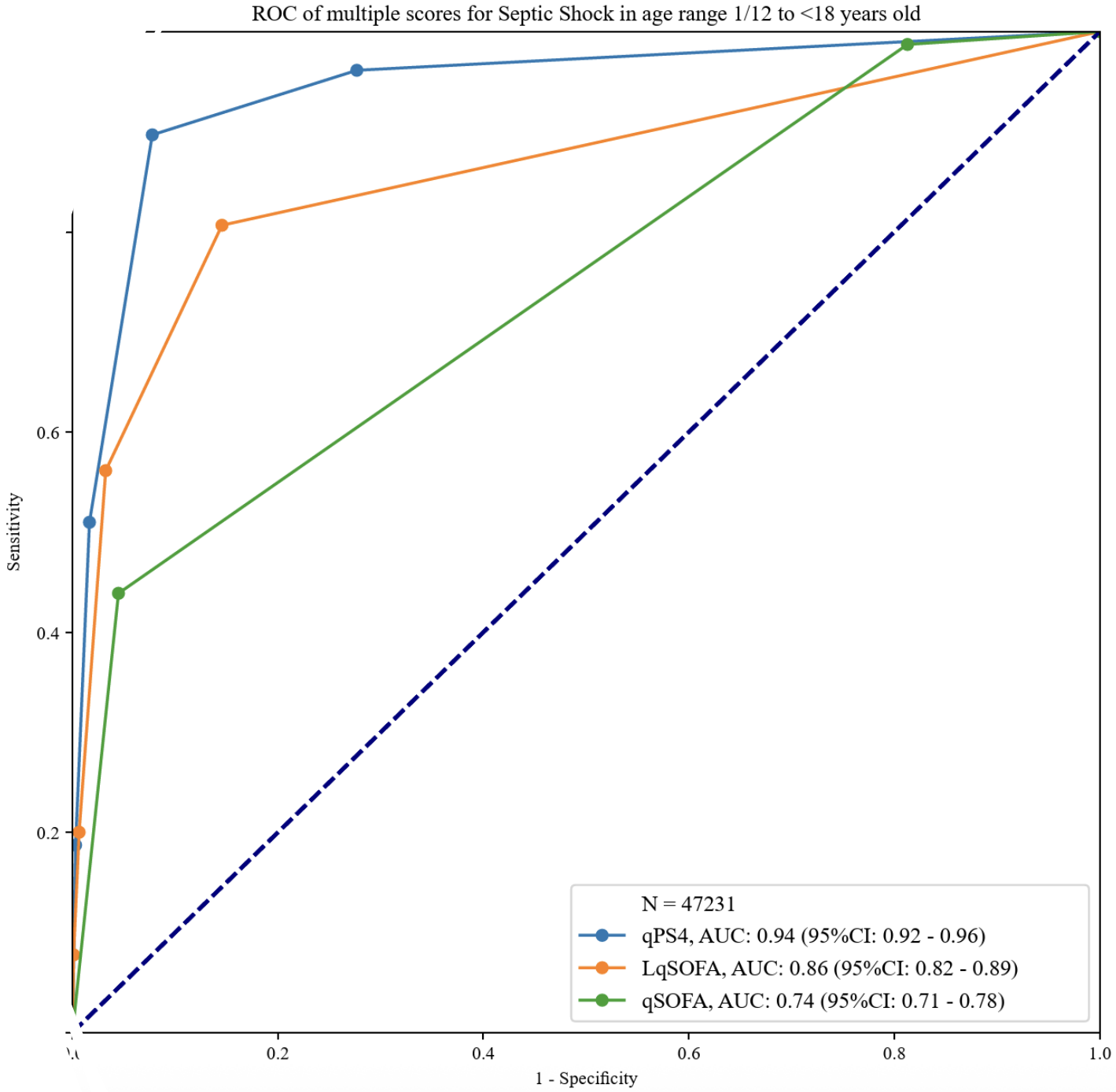
Temperature Adjusted Mean Shock Index

$$S.I. = \frac{HR - (T - 37) \times 10}{MAP}$$

Criteria*	Score=0	Score=1
Altered mentation	Alert or GCS=15	Not alert or GCS<15
Respiratory rate		
1-11 mo	≤55	>55
1-2 y	≤47	>47
3-5 y	≤33	>33
6-11 y	≤25	>25
12-17 y	≤21	>21
TAMSI		
1-12 mo	≤2.64	>2.64
1-2 y	≤2.29	>2.29
3-5 y	≤1.96	>1.96
6-11 y	≤1.68	>1.68
12-17 y	≤1.54	>1.54
Capillary refill time	<3 s	≥3s

How Accurate is the qPS4

- The qPS4 correctly identified 94 out of 100 pediatric patients when predicting the likelihood of septic shock.



Sepsis Prediction Score: Additional comments

Aileen M Marty MD, FCAP

SSC 2026 Sepsis Probability Framework

- **Definite sepsis**: Sepsis confirmed by history, exam, and diagnostics; alternative diagnosis very unlikely
- **Probable sepsis**: High suspicion; sepsis is the most likely diagnosis; alternative less likely
- **Possible sepsis**: Moderate suspicion; sepsis is a possible diagnosis but alternative also likely
- **Unlikely sepsis**: Low suspicion; clinical assessment not consistent with sepsis or alternative more likely

- **Treatment implications:**
  - **Definite/probable** sepsis **± shock** → Antimicrobials immediately, ideally within 1 hour (strong recommendation)
  - **Possible sepsis without shock** → Rapid investigation within 1 hour; antibiotics if concern persists (conditional recommendation)
  - **Unlikely sepsis** → Defer antimicrobials; continue monitoring

Pathogens in Sepsis: What EMS Needs to Know

- A pathogen is **identified** in only **~60–70%** of sepsis cases; blood cultures are positive in only 10–20%
  - **Gram-negative bacteria** (~55% of culture-positive sepsis): *E. coli* (most common single isolate), *Klebsiella*, *Pseudomonas*
    - Pulmonary, and UTI (Urinary Tract Infection) account for ~ 55-90% of culture positive cases
    - Abdominal, and soft tissue
  - **Gram-positive bacteria** (~47%): *Staphylococcus aureus* (including MRSA), *Streptococcus pneumoniae* — typically from skin/soft tissue, pneumonia, line infections
  - **Fungi** (*Candida* spp.)**:** Third most common blood culture pathogen in U.S.; associated with immunocompromise, prolonged ICU stay — highest mortality
  - **Viral**: More common in **pediatrics** (21% of pediatric ICU sepsis) and during pandemics
- Culture-negative: ~30–40% of cases; mortality comparable to or higher than culture-positive

The EMS Recognition Gap

- Sepsis incidence in EMS is **1.6%**
  - Close to that of MI (Myocardial Infarction) (2.6%) and stroke (2.7%) !
- *But 30-day case fatality is **3× higher*** than MI or stroke (31.7% vs. 13.4% vs. 11.8%)
- **Paramedics**
  - **never documented sepsis suspicion** in a study of 110,419 EMS cases; emergency physicians documented it in only 0.1%
  - Only **8.2%** of EMS cases documented Complete vital signs
- In a 2026 study, EMS explicitly suspected sepsis in only **3 of 12 confirmed cases (25%)**; retrospective application of scoring tools substantially improved detection
- After implementing a structured EMS sepsis screening protocol (PRESS), recognition increased from **12% to 59%**, and time-to-antibiotics decreased by **24 minutes**

Prehospital SEPSIS Actions: Beyond Antibiotics

The 5-Step Framework

1

SCREEN

Use NEWS2 (± $ETCO_2$ ≤25 mmHg) — best combined prehospital tool

2

IDENTIFY SOURCE

Focused history → lungs, abdomen, urinary, skin/wound, device

3

RESUSCITATE

500–1,000 mL balanced crystalloid (e.g., LR [Lactated Ringer's]) for SBP <100 mmHg; titrate O_2 to SpO_2 ≥92% (88–92% for known COPD/Scale 2

4

MEASURE

Point-of-care lactate if available (prehospital lactate >3 mmol/L is an independent predictor of 30-day mortality (OR [Odds Ratio] 2.20) and identifies high-risk patients missed by triage scores alone; $ETCO_2$ ≤25 mmHg + lactate ≥2 mmol/L achieves sensitivity 89.9%, specificity 91.7% for sepsis

5

NOTIFY

Prenotify receiving ED with suspected source, NEWS2 score/trend, $ETCO_2$ value, hemodynamic status, fluid given→ shortens time-to-antibiotics

When Sepsis Doesn't Look Like Sepsis

- **Elderly (≥65 years):**
- Highest incidence AND highest mortality of any age group
- Check for **confusion, falls, or functional decline** rather than fever/tachycardia
- Hypothermia (temp <36°C) more common and carries worse prognosis than fever
- Beta-blockers may mask tachycardia; baseline hypertension means SBP 110 may represent significant hypotension
- **Immunocompromised:**
- Attenuated inflammatory response → may lack fever, leukocytosis, or typical biomarker elevations
- Higher risk of atypical/resistant pathogens (fungal, opportunistic)
- Can appear stable initially then deteriorate rapidly within hours
- Standard screening tools may underperform in this population

EMS **Red Flags** in These Populations:

- New confusion or altered GCS (Glasgow Coma Scale) in elderly → sepsis until proven otherwise
- Any acute deterioration in immunocompromised patient → lower threshold for sepsis suspicion
- Hypothermia + tachypnea → high-risk combination often missed

**In a study of 131,745 EMS patients, elevated temperature had the highest probability for infection diagnosis, but abnormal GCS and low BP had the highest probability for sepsis diagnosis specifically*

Structured ED Handoff: Sepsis SBAR

S — Situation:

Sepsis alert: [age/sex] with suspected [source] infection

B — Background:

Known comorbidities

- diabetes, immunosuppression, COPD, renal disease, indwelling devices

Recent healthcare exposure, antibiotics, or hospitalizations

Baseline functional status

A — Assessment:

- NEWS2 score: ___ (trend: improving/worsening/stable)
- $ETCO_2$: ___ mmHg
- Lactate (if available): ___ mmol/L
- SSC probability tier: definite / probable / possible
- Key vitals: HR, RR, BP, SpO_2, Temp, GCS

R — Recommended:

Fluids given: ___ mL

"Requesting immediate sepsis workup:

- blood cultures, lactate, source-directed imaging"

"Patient meets/does not meet criteria for prehospital antibiotics"

Summary
Sepsis Chain of Survival: 6 Key Takeaways for EMS

1. **RECOGNIZE** — *Sepsis kills more than MI or stroke, but EMS identifies it far less often*
   - 30-day case fatality: sepsis 31.7% vs. MI 13.4% vs. stroke 11.8%
   - EMS explicitly suspects sepsis in only ~25% of confirmed cases
   - Use NEWS2 ≥5 (± $ETCO_2$ ≤25 mmHg) as the best prehospital screening combination (slides 22–24)
2. **CLASSIFY** — Use the SSC 2026 probability tiers to guide urgency
   - Definite/probable → act immediately
   - Possible → rapid investigation within 3 hours
   - Unlikely → monitor, do not delay transport
3. **IDENTIFY THE SOURCE** — The **most impactful prehospital clinical assessment**
   - Lungs (40–60%), abdomen (15–30%), urinary (15–30%), skin/wound, device
   - The specific pathogen does NOT change field management — but source identification accelerates ED antibiotic selection
4. **RESUSCITATE** — Start treatment, don't just transport
   - 500–1,000 mL balanced crystalloid (LR preferred) for SBP <100 mmHg
   - O_2 to SpO_2 ≥92% (88–92% for COPD/Scale 2)
   - Point-of-care lactate if available; $ETCO_2$ ≤25 mmHg as a lactate surrogate
   - Prehospital antibiotics ONLY if: definite/probable sepsis + hypotension + transport >60 min
5. **COMMUNICATE** — Structured prenotification saves lives
   - Sepsis SBAR: Situation → Background → Assessment (NEWS2, $ETCO_2$, probability tier) → Recommendation
   - Prehospital notification shortens time-to-antibiotics; EMS screening tools enhanced 3-hour bundle adherence from 44% to 80%
6. **REMEMBER *THE EXCEPTIONS*** — Sepsis doesn't always look like sepsis
   - Elderly: confusion/falls may be the only sign; hypothermia > fever; beta-blockers mask tachycardia
   - Immunocompromised: attenuated inflammatory response; may appear stable then crash
   - New confusion in elderly = sepsis until proven otherwise

Sepsis is a time-sensitive emergency!

EMS is the first link in the chain.

SCREEN → CLASSIFY → IDENTIFY → RESUSCITATE → COMMUNICATE → REMEMBER THE EXCEPTIONS.

QUESTIONS?

QUESTIONS?

QUESTIONS?

amarty@fiu.edu