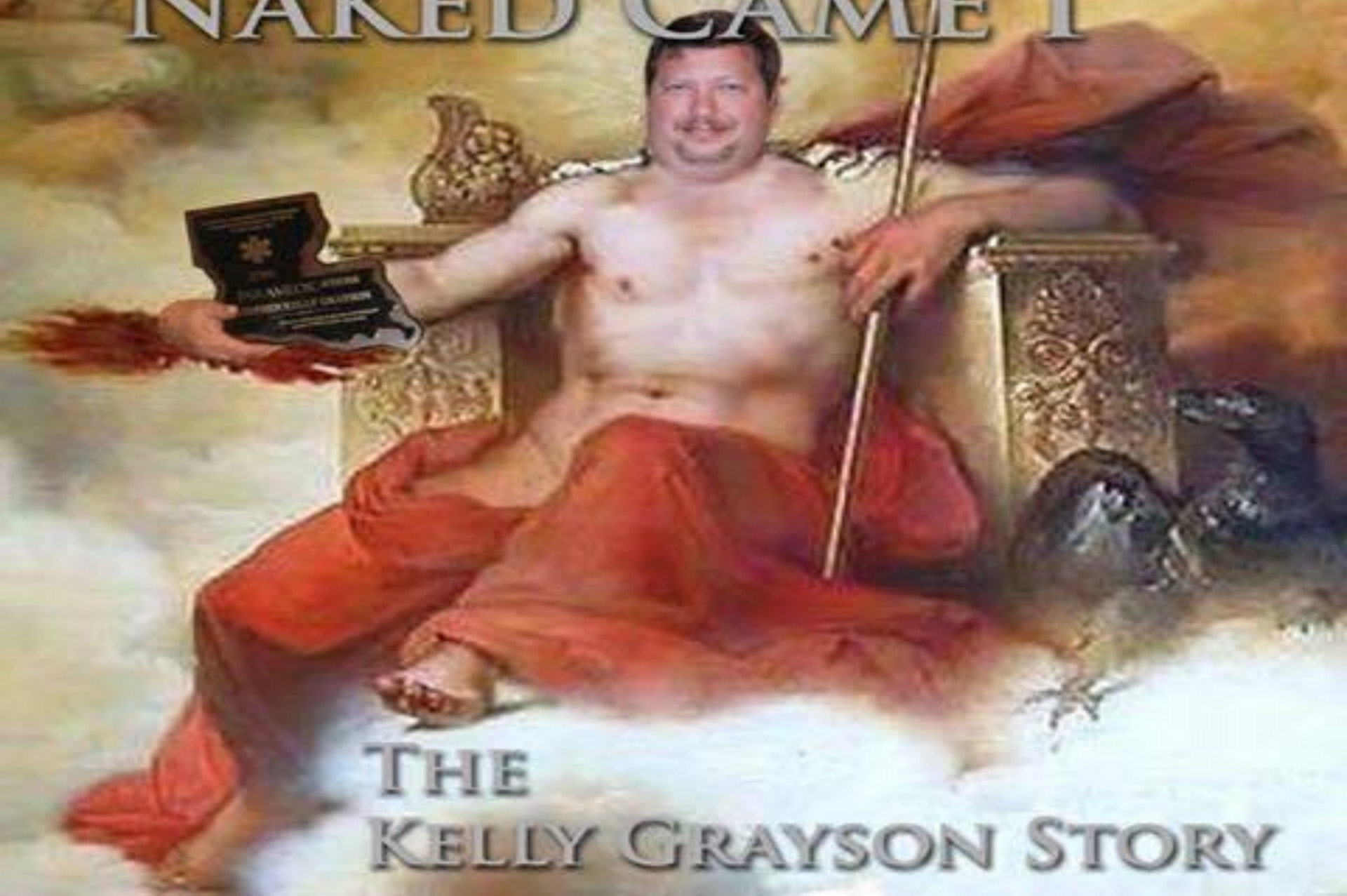






“NAKED CAME I”



THE
KELLY GRAYSON STORY





No phone, no lights, no motorcars...

Sepsis



When More Cowbell Isn't Enough

Kelly Grayson, NRP, CCEMT-P



Objectives

- * Discuss pathophysiology of Systemic Inflammatory Response Syndrome (SIRS)
- * Discuss SIRS and qSOFA clinical criteria.
- * Discuss current prehospital and ED assessment and management of sepsis.



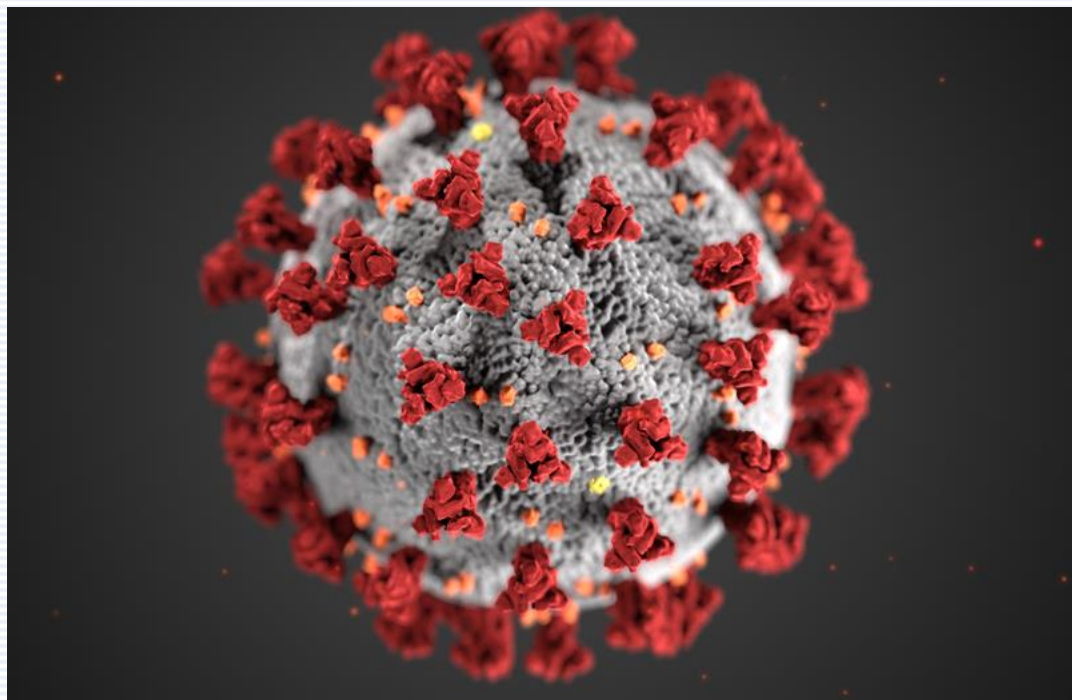
Sepsis III Consensus Definitions

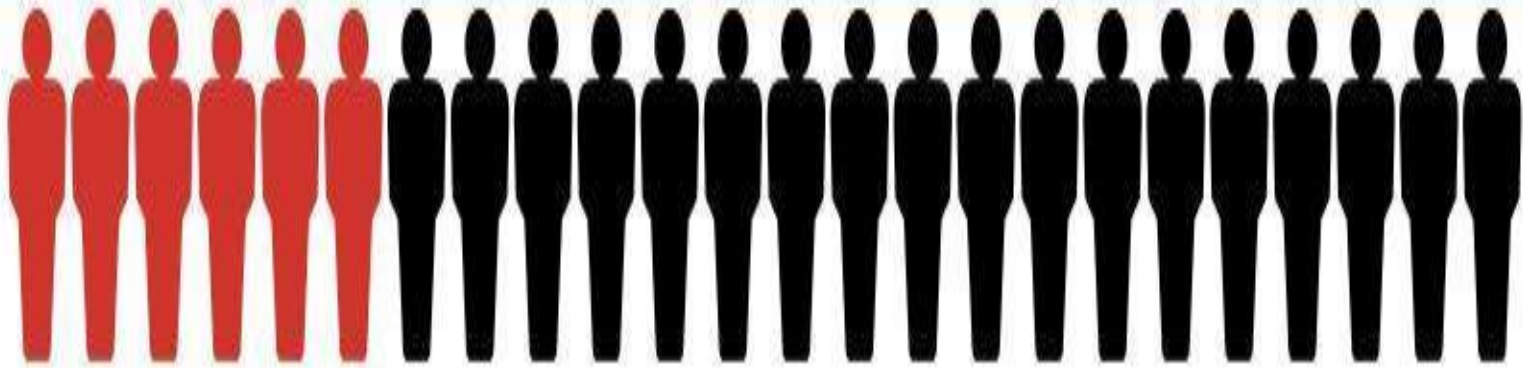
- * **Sepsis: Life-threatening organ dysfunction caused by dysregulated host response to infection.**
- * **Organ dysfunction is defined as an increase in SOFA score ≥ 2 points.**
- * **Septic shock is sepsis with circulatory and cellular/metabolic abnormalities profound enough to substantially increase mortality.**



Sources of Sepsis

- * Bacterial
- * Viral
- * Fungal
- * Parasitic





Each year, at least **1.7** million adults in America develop sepsis.

Nearly **270,000** Americans die as a result of sepsis each year.

1 in **3**

One in three patients who die in a hospital have sepsis.

States with the highest death rate (per 100,000)



States with the lowest death rate (per 100,000)



In 2015, the average cost for treating hospital-associated sepsis was

\$58,000

That jumped to

\$70,000

in 2018.

Patients who develop sepsis in the hospital are

10%

more likely to have septic shock than those with sepsis upon admission.

According an analysis by Premier, mortality rates among sepsis patients dropped 8% and readmissions fell 7% between 2015 and 2018.

30 MILLION

Number of people worldwide who develop sepsis each year

1.7 MILLION

Number of Americans who develop sepsis each year

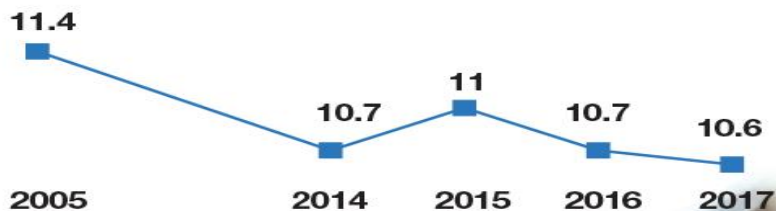
270,000

Number of Americans who die each year from sepsis

1 in 3

patients who die in a U.S. hospital have sepsis

Sepsis death rates in U.S. (per 100,000)



\$24 BILLION

Total annual U.S. hospital costs for treating sepsis



Sources: Centers for Disease Control and Prevention, Premier, World Health Organization

GETTY IMAGES

Poll

* Which is the more prevalent time-sensitive, life-threatening illness?

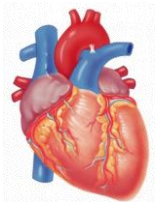
* Stroke

* STEMI

* Sepsis



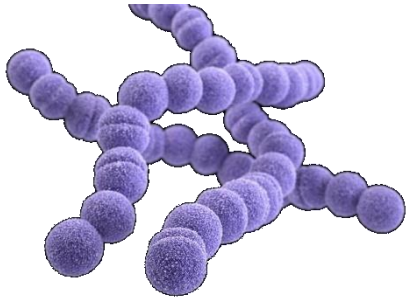
Emergency Medical Services (EMS) personnel transport more than 50% of all sepsis cases to the hospital emergency department (ED).



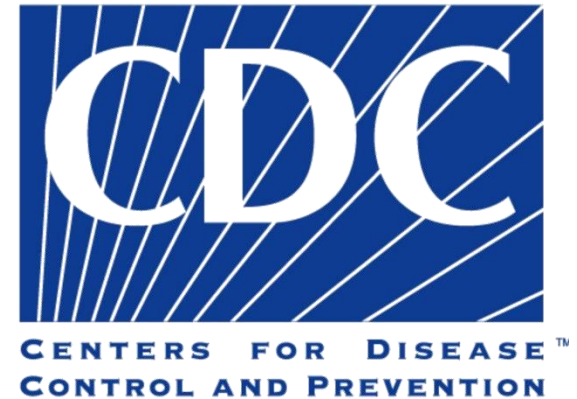
2.3 per 100 EMS patients



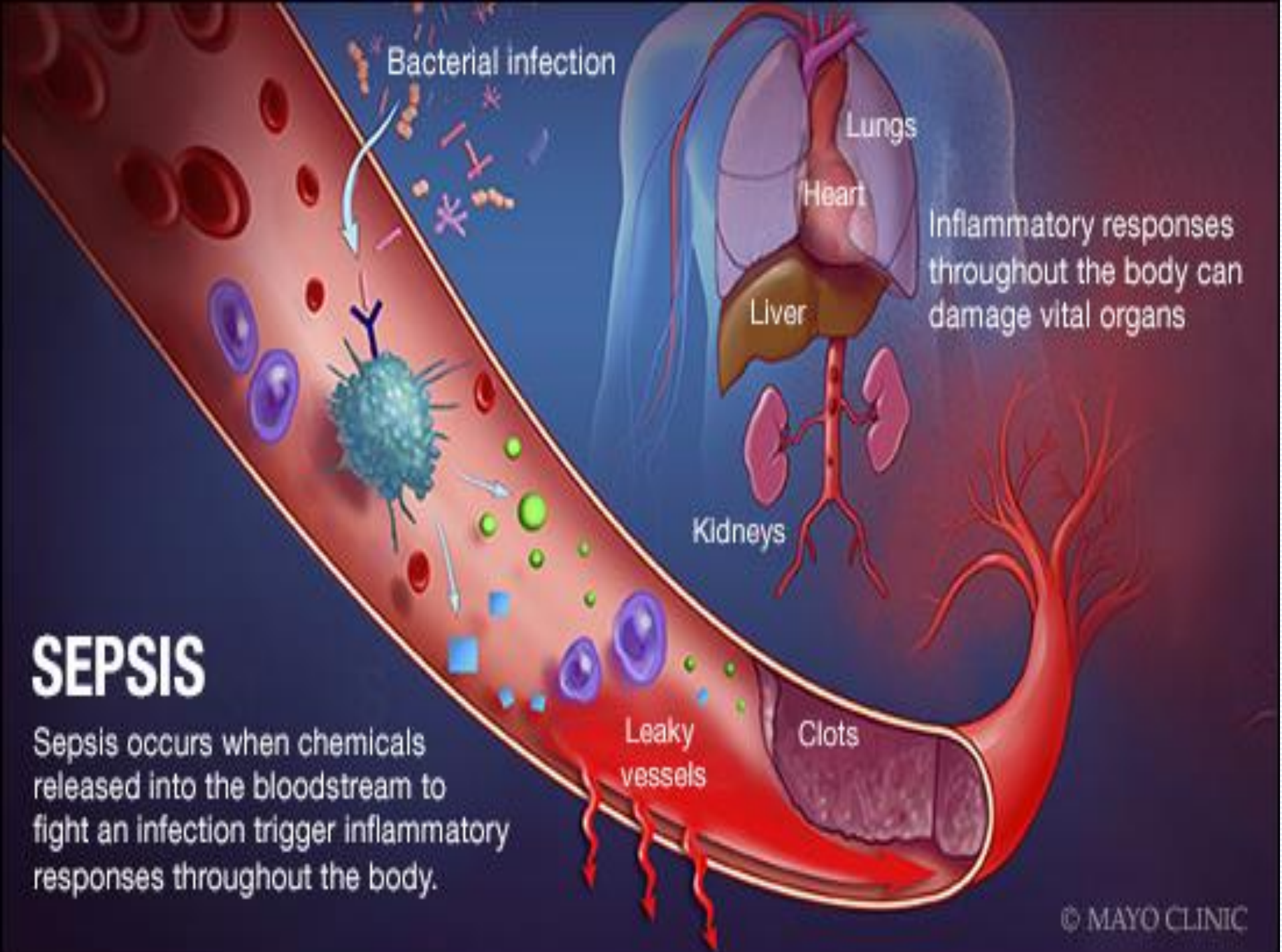
2.2 per 100 EMS patients



3.3 per 100 EMS patients. 60,000 more sepsis patients each year than heart attack and stroke patients combined.



EMS personnel frequently represent the first medical contact for sepsis patients since as many as 87% of sepsis cases start in the community, prior to hospitalization.



Bacterial infection

Lungs

Heart

Liver

Kidneys

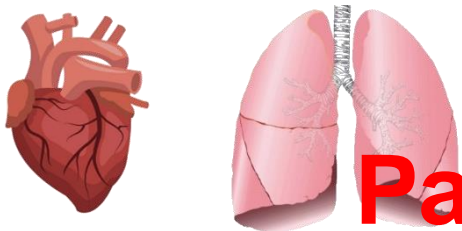
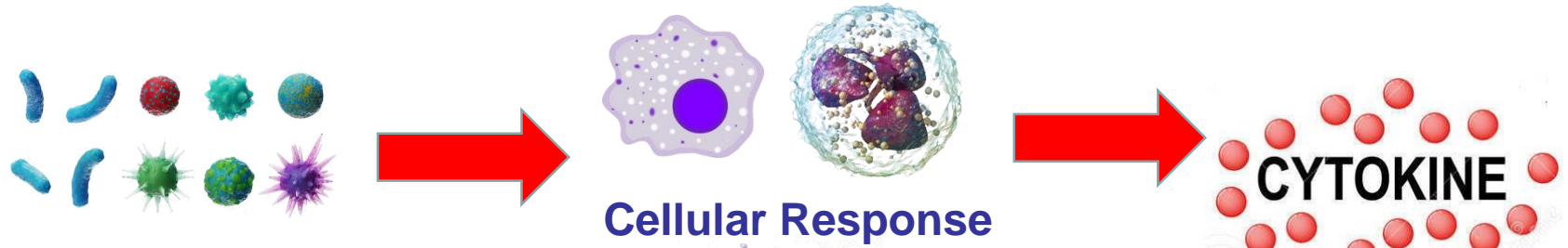
Inflammatory responses throughout the body can damage vital organs

Leaky vessels

Clots

SEPSIS

Sepsis occurs when chemicals released into the bloodstream to fight an infection trigger inflammatory responses throughout the body.

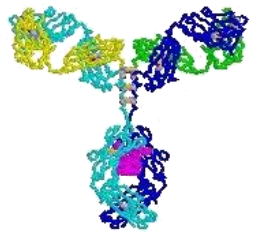
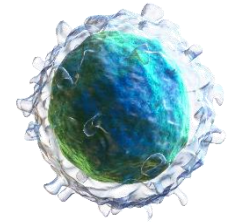


Shock and MODS

Pathogenesis of Sepsis



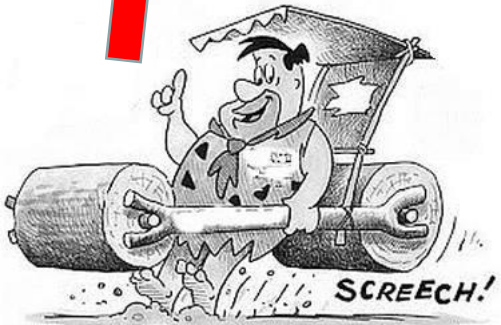
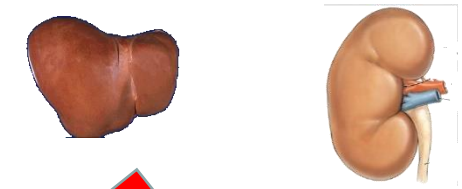
B Cell Activation



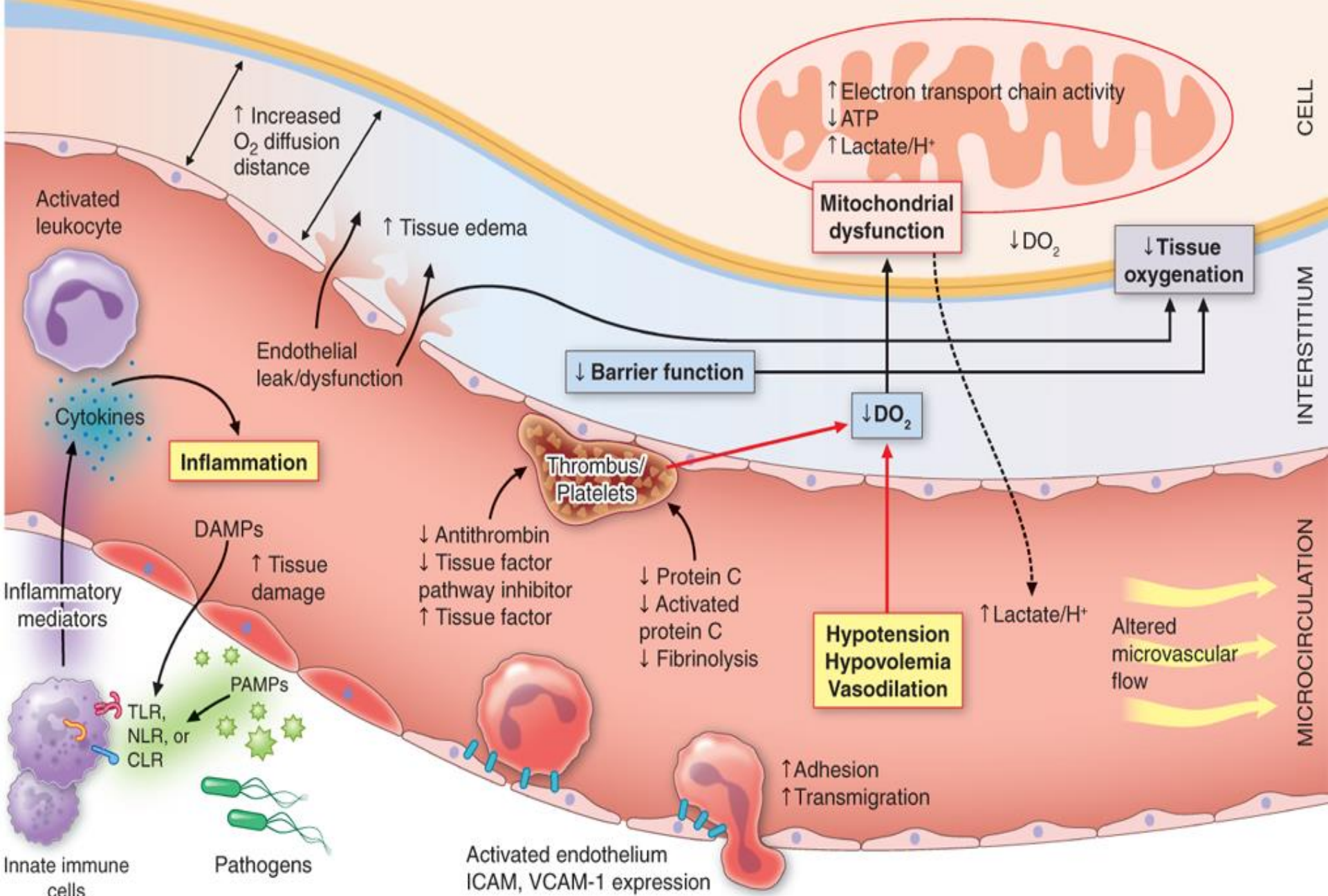
Humoral Response

SIRS Criteria

- $T > 101^{\circ} F$ or $< 96.8^{\circ} F$
- $RR > 20$ or $MV > 10$ liters
- $HR > 90$
- **WBC Count**
 - $> 10,000/mm^3$
 - $< 4,000/mm^3$



Immune Dysregulation









**CIRCLE
FRACK**
A RACING TECHNOLOGY





Populations at Risk

- * Geriatrics
- * Pediatrics
- * Chronically bedbound
- * Immunocompromised
 - * HIV and AIDS
 - * Chronically ill
- * Immunosuppressed
 - * Transplant recipients
 - * Chemotherapy
- * Surgical patients



Clinical Signs of Sepsis

- * **Hyperdynamic state (warm shock)**
 - * **Tachycardia**
 - * **Elevated or normal cardiac output**
 - * **Poor systemic vascular resistance**
- * **Hypodynamic state (cold shock)**
 - * **Decreased cardiac output**
 - * **Late, and very ominous sign**



SOFA Scoring

- * **S**epsis-related **O**rgan **F**ailure **A**ssessment
- * Used to determine a patient's level of organ function.
- * 1-4 scale, based upon six criteria:
 - * Respiratory
 - * Cardiovascular
 - * Hepatic
 - * Coagulation
 - * Renal
 - * Neurological
- * Score is a strong predictor of mortality:
 - * Increase in first 24-48 hours in ICU = 50-95% mortality.
 - * Score of < 9 = 33% mortality, > 11 = 95% mortality.



qSOFA Scoring

- * Intended to be a rapid bedside SOFA assessment for prehospital and ED personnel.
- * Replaces SIRS prehospital criteria
- * 0-3 scale, assessing:
 - * Tachypnea (respirations ≥ 22): 1 point
 - * Hypotension (systolic ≤ 100): 1 point
 - * Altered mentation (GCS < 15): 1 point



Limitations of Sepsis III Definitions

- * SOFA and qSOFA are mortality predictors, not screening tests for sepsis, although they will inevitably be viewed that way.
- * Sepsis III guidelines may be more sensitive than Sepsis II guidelines, but they have not yet been validated for specificity.



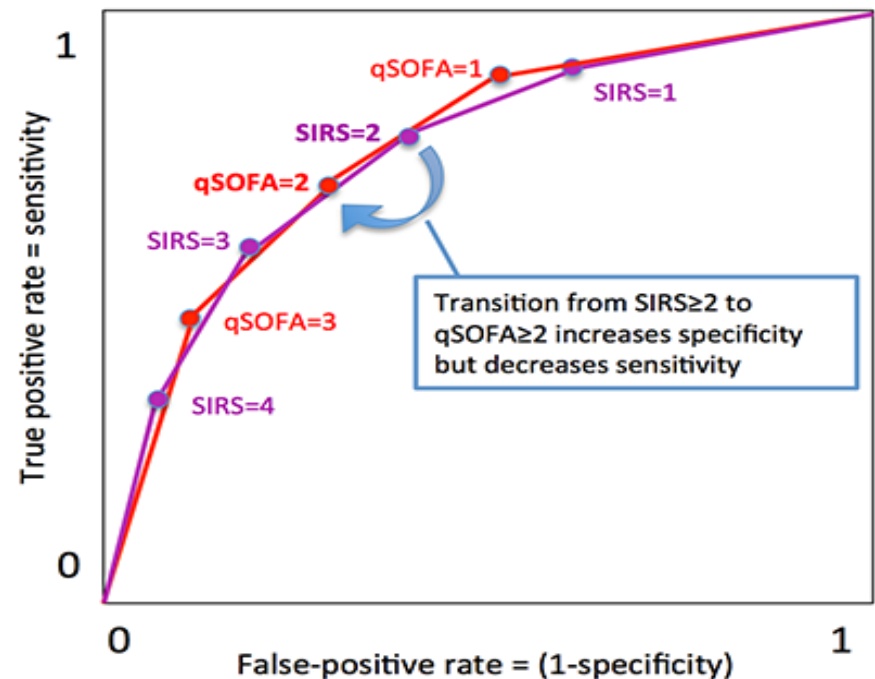
Limitations of qSOFA

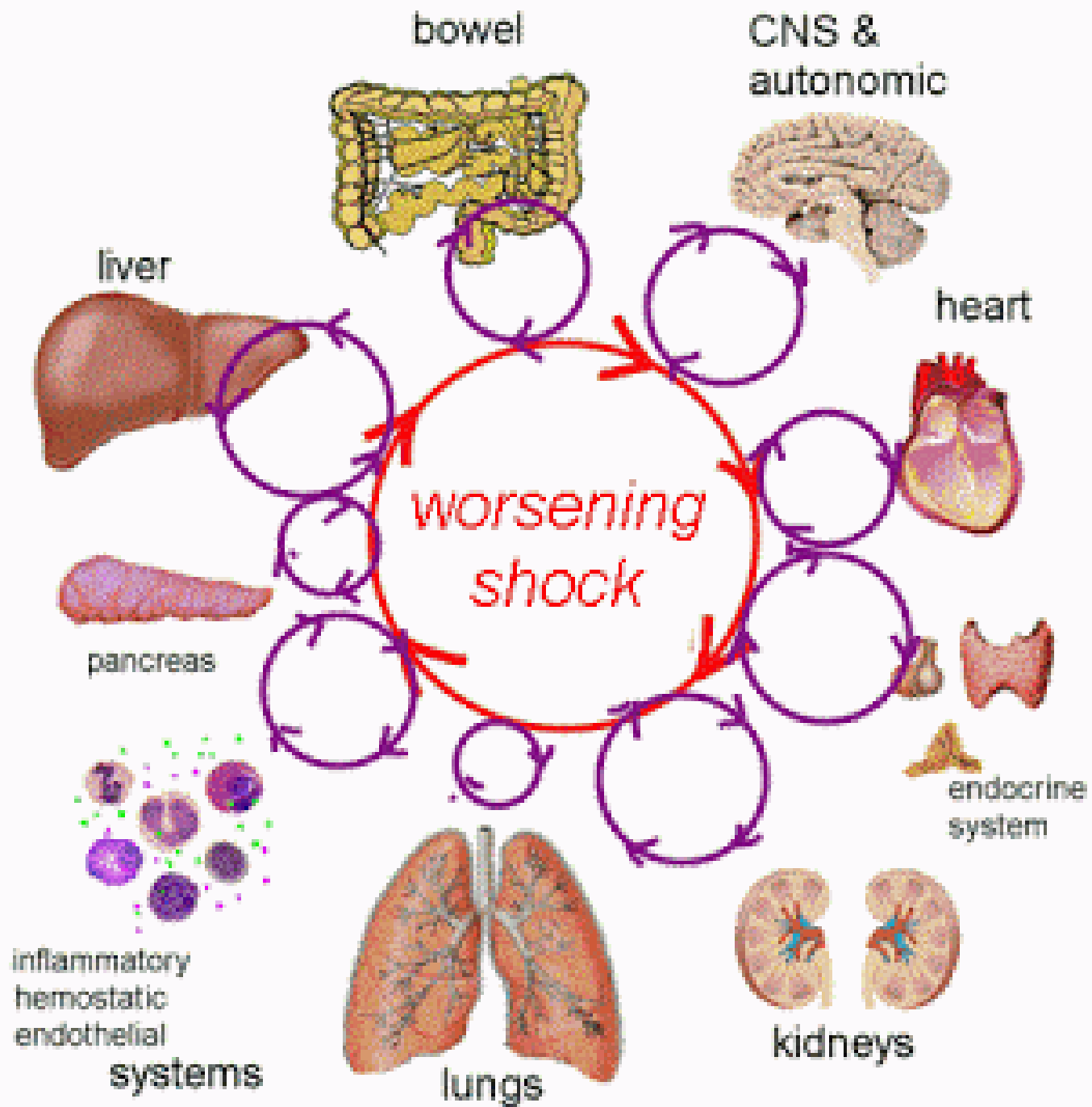
- * Not appreciably better than old SIRS criteria.
- * Traded sensitivity for specificity.
- * Less specific in other conditions that cause hypotension, ALOC, and tachypnea
- * Potential for many more false positives.

Ability to predict mortality among patients with possible infection outside the ICU

Test	Area under ROC curve	Sensitivity for mortality	Specificity for mortality
SIRS ≥ 2	0.76	64%	65%
SOFA ≥ 2	0.79	68%	67%
qSOFA ≥ 2	0.81	55%	84%

Imagined ROC curves for SIRS vs. qSOFA for mortality prediction



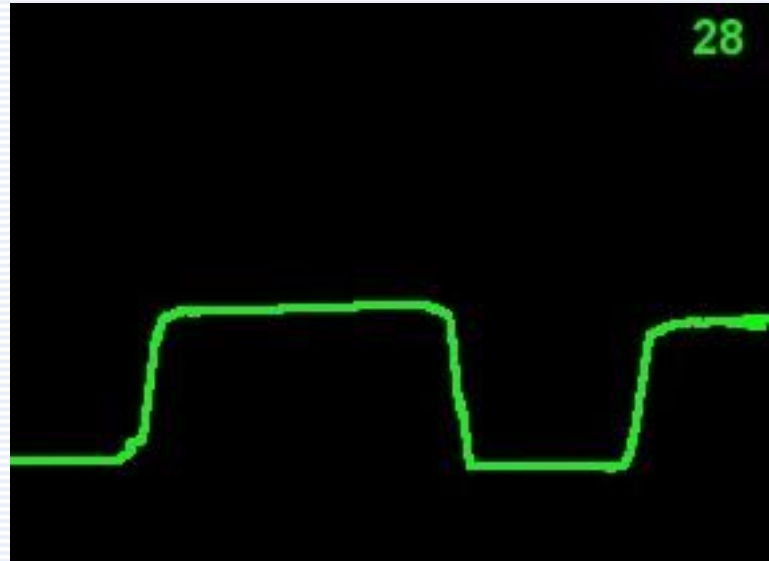


**ONE DOES NOT SIMPLY HAVE
SEPSIS**

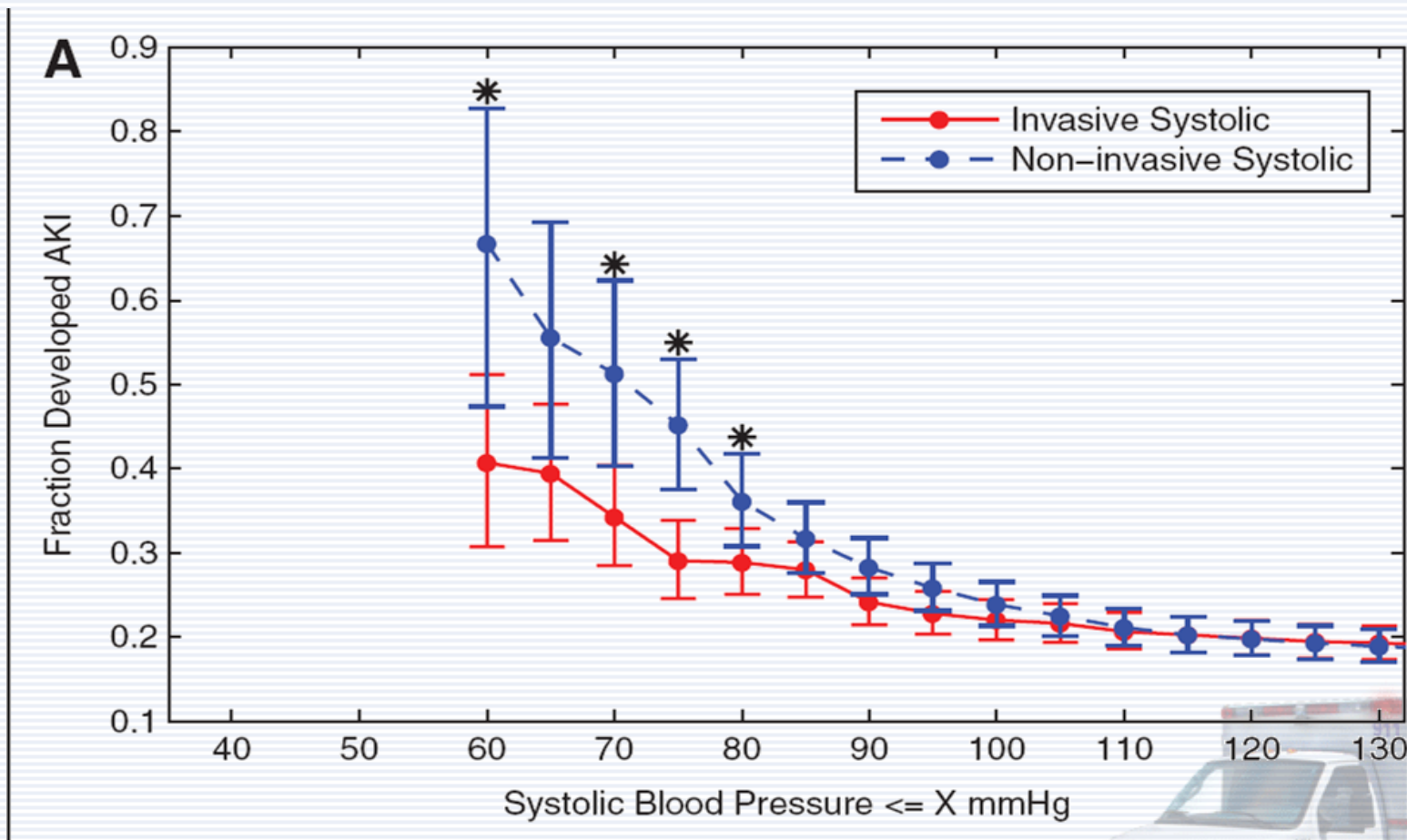
**BECAUSE 2/4 SIRS CRITERIA ARE
PRESENT**

Waveform Capnography

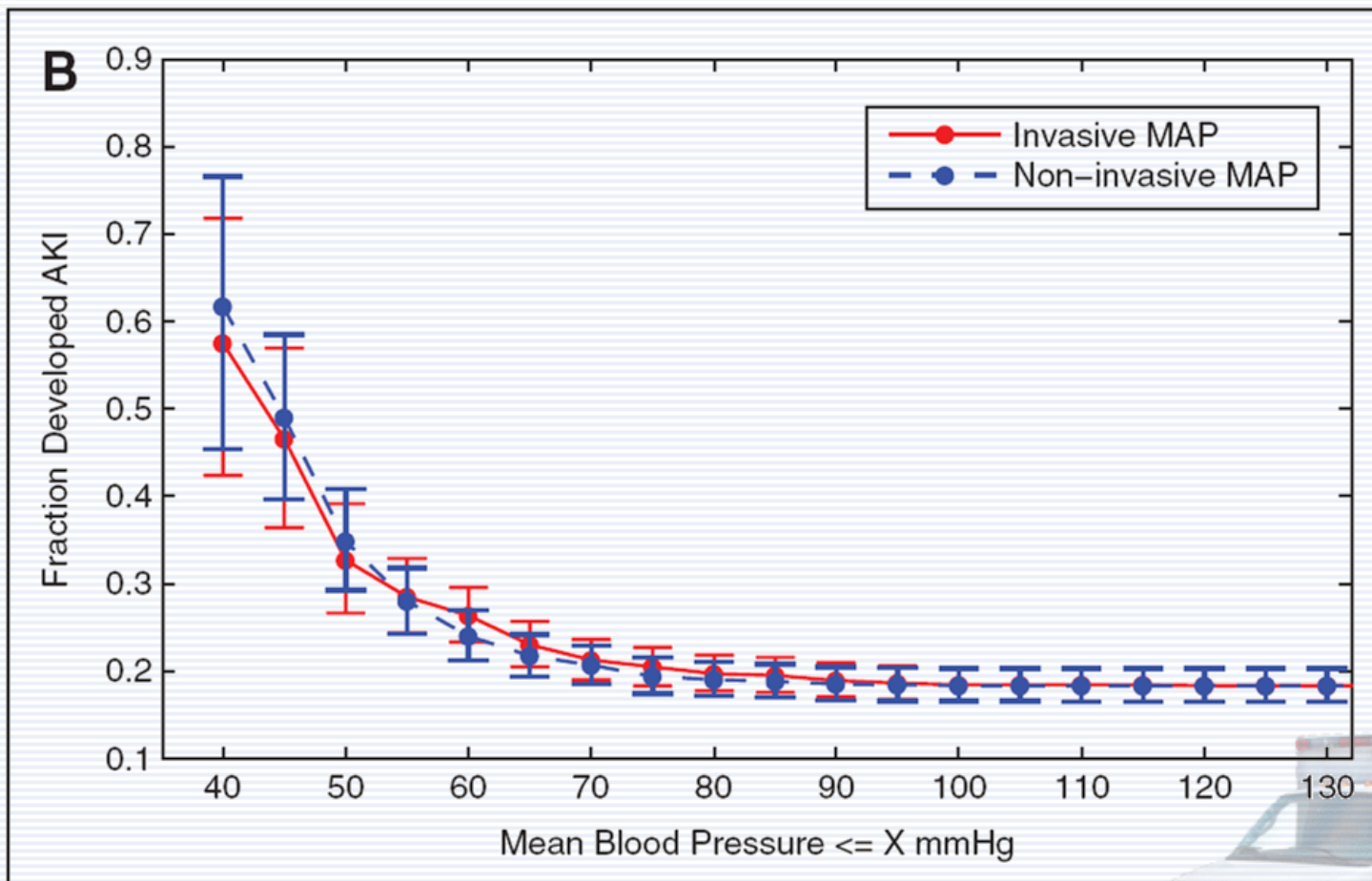
- * As perfusion falls, so does etCO_2
- * Monitor etCO_2 trending
- * $\text{etCO}_2 \leq 25$ mmHg is strongly associated with lactate levels > 4 mmol/L.



AKI: Arterial Line vs NIBP



Acute Kidney Injury: MAP



Plethysmography in Predicting Hypovolemia

- * Normal pleth waveform has evenly spaced, equally wide waves of equal amplitude
- * Studies have shown that as little as 8 to 10 percent reduction in total blood volume can be seen on the plethysmograph.
- * If, upon inspiration, the vertical amplitude of the pleth decreases, then increases during expiration, the patient might be hypovolemic.



PR: 0.12 QRS: 0.06 (s)

HR 139

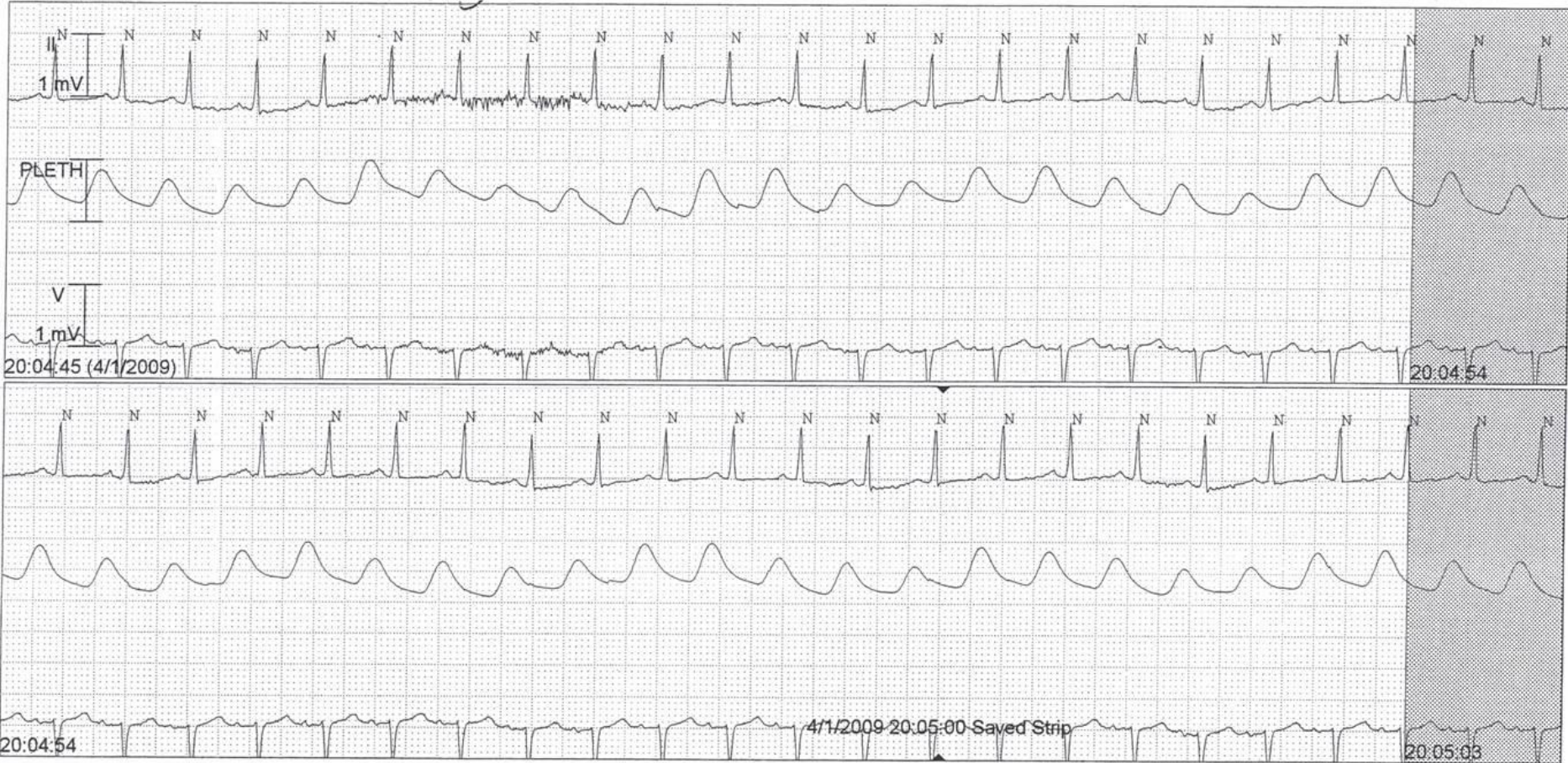
%SpO2 95

PVC 0

ST-II -0.3

ST-V 0.6

PULSE 139





97

95
%SpO₂

1.65^{8.0}

%SpMet

10¹²

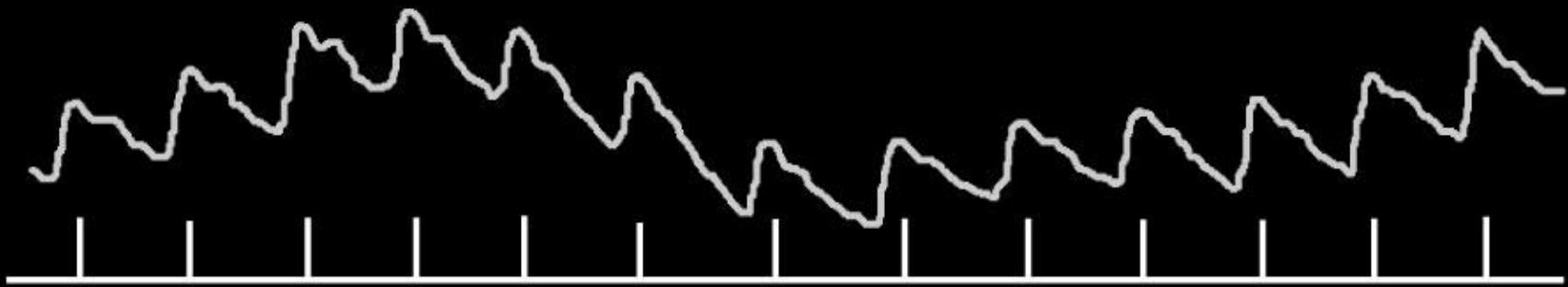
%SpCO

76

140
50
BPM

3.00
PI

60
PVI



FastSat

APOD

- Menu icon with right arrow
- Stack of documents icon
- MAX ↑ ↓ APOD
- TREND ↑ ↓ GRAPH



A PVI >14% before volume expansion discriminated between responders and non-responders with 81% sensitivity and 100% specificity.

Shock Indices

I wrote all this down in 1967.
WTF, people?

* Allgower's Shock Index = $\frac{\text{HR}}{\text{SBP}}$

* Modified Shock Index = $\frac{\text{HR}}{\text{MAP}}$



SI > 0.9

MSI < 0.7 or > 1.3

> 40% MORTALITY!



ASSESSMENT SEVERITY OF HYPOVOLEMIC SHOCK

Allgower's shock index

$$SI = HR \div SBP$$

0.5-0.6 = normal

0.8 = 10-20 %

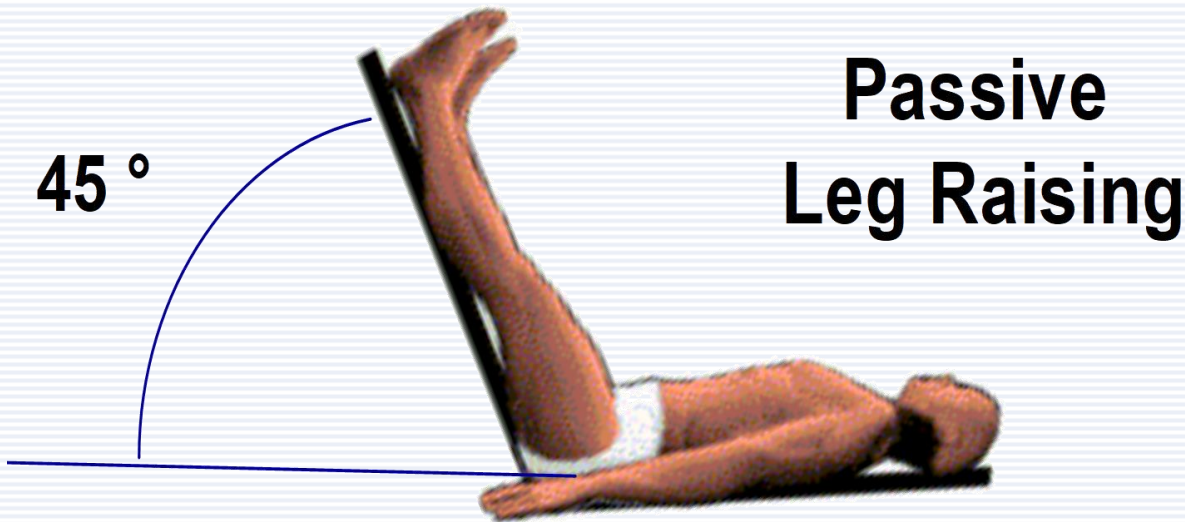
1.0 = 20-30 %

1.1 = 30-40 %

1.5-2.0 = 40-50 %

Passive Leg Raising

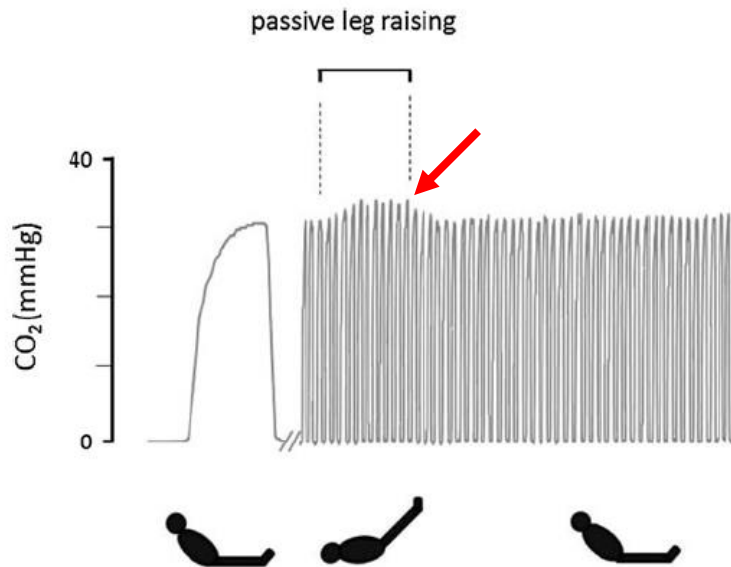
- * 150 – 300 ml volume
- * Effects < 30 seconds, not > than 4 minutes
- * Self-volume challenge
- * Reversible



Xavier Monnet
Aurélien Bataille
Eric Magalhaes
Jérôme Barrois
Marine Le Corre
Clément Gosset
Laurent Guerin
Christian Richard
Jean-Louis Teboul

End-tidal carbon dioxide is better than arterial pressure for predicting volume responsiveness by the passive leg raising test

Intensive Care Med. 2013 Jan;39(1):93-100



Still Paying Attention?

- * How might a clinician tell if a patient might be centrally hypovolemic and thus benefit from IV fluid boluses?
 - A. Waveform capnography and passive leg raise
 - B. Pleth variability index
 - C. Urinary output
 - D. Labs

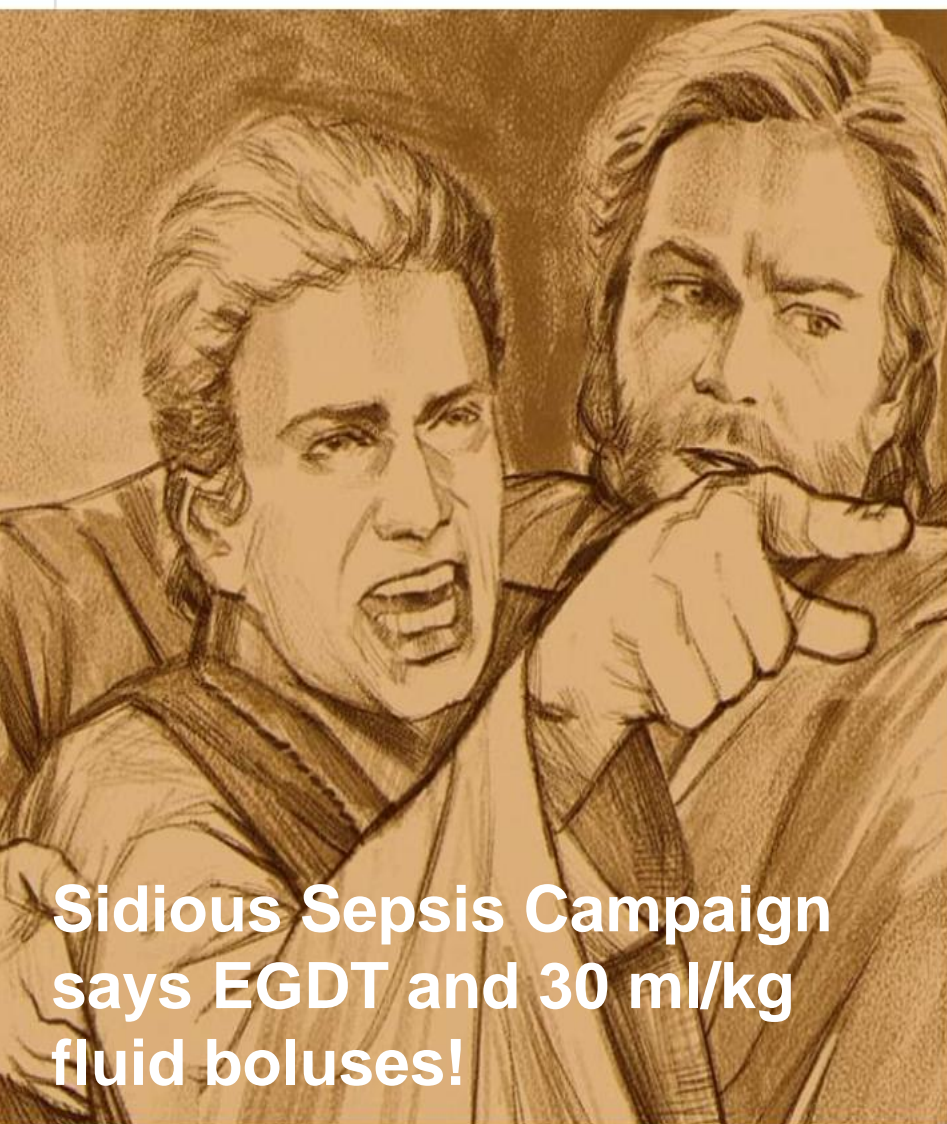


WARNING!

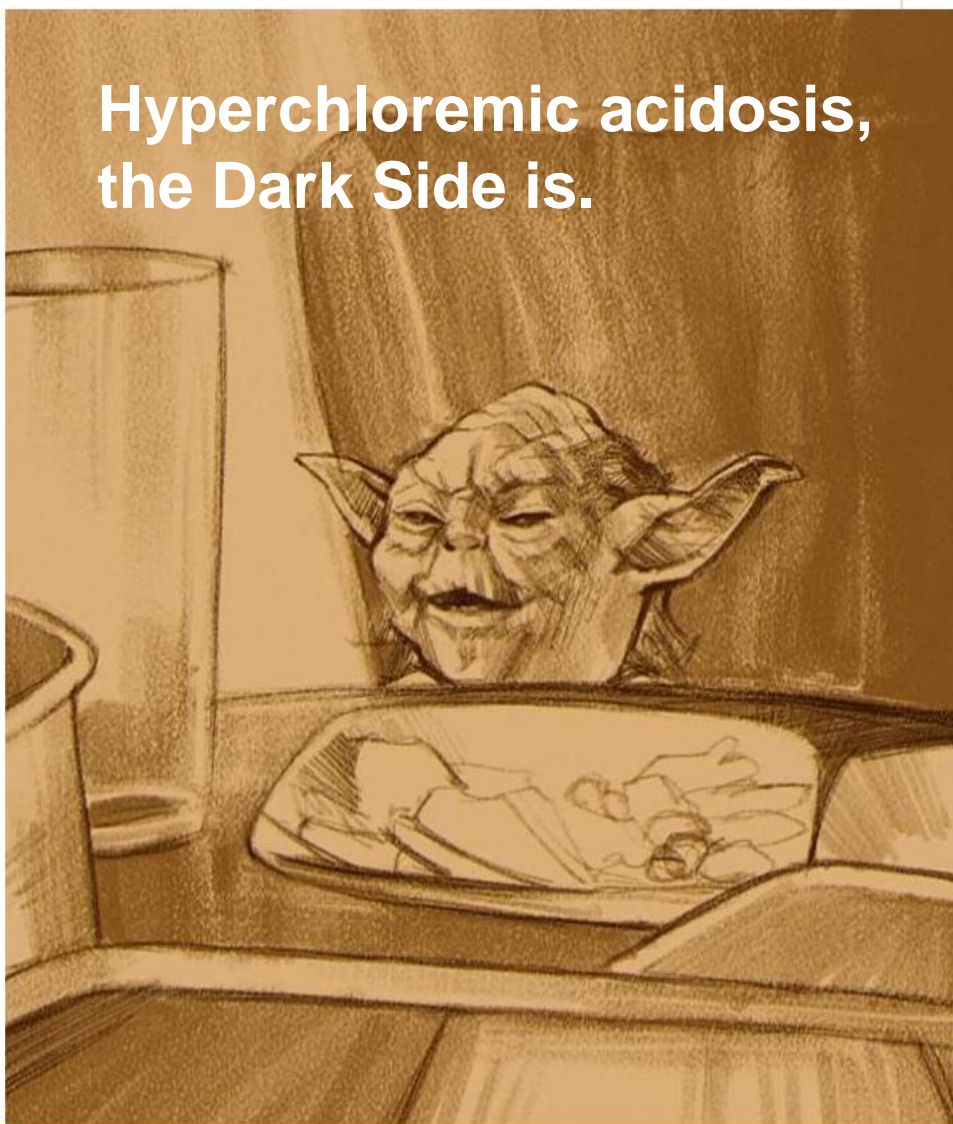


**MIXING OF MULTIPLE MEMES MAY RESULT IN COGNITIVE
DISSONANCE AND AUDIENCE CONFUSION.**

PROCEED WITH CAUTION!



**Sidious Sepsis Campaign
says EGDT and 30 ml/kg
fluid boluses!**



**Hyperchloremic acidosis,
the Dark Side is.**



One bag of this = 30 bags of this.

Inconvenient Facts

- * Roughly half of our hypoperfusing patients are incapable of raising their cardiac output with IV fluid boluses. These people are classified as “non-responders.”
- * For these people, IV pressors are better.
- * Try to determine early on which is which.



2012 Meta-Analysis of Fluid Bolus in Kids

Mortality after Fluid Bolus in Children with Shock Due to Sepsis or Severe Infection: A Systematic Review and Meta-Analysis

Nathan Ford^{1,2*}, Sally Hargreaves³, Leslie Shanks⁴

1 Médecins Sans Frontières, Geneva, Switzerland, 2 Centre for Infectious Disease Epidemiology and Research, University of Cape Town, Cape Town, South Africa, 3 The International Health Unit, Department of Infectious Diseases and Immunity, Hammersmith Hospital, Imperial College London, London, United Kingdom, 4 Médecins Sans Frontières, Amsterdam, The Netherlands

Conclusions: “...*fluid boluses were harmful compared to no bolus.* Simple algorithms are needed to...determine who could potentially be harmed by the provision of bolus fluids, and who will benefit.”



Prehospital Sepsis Treatment

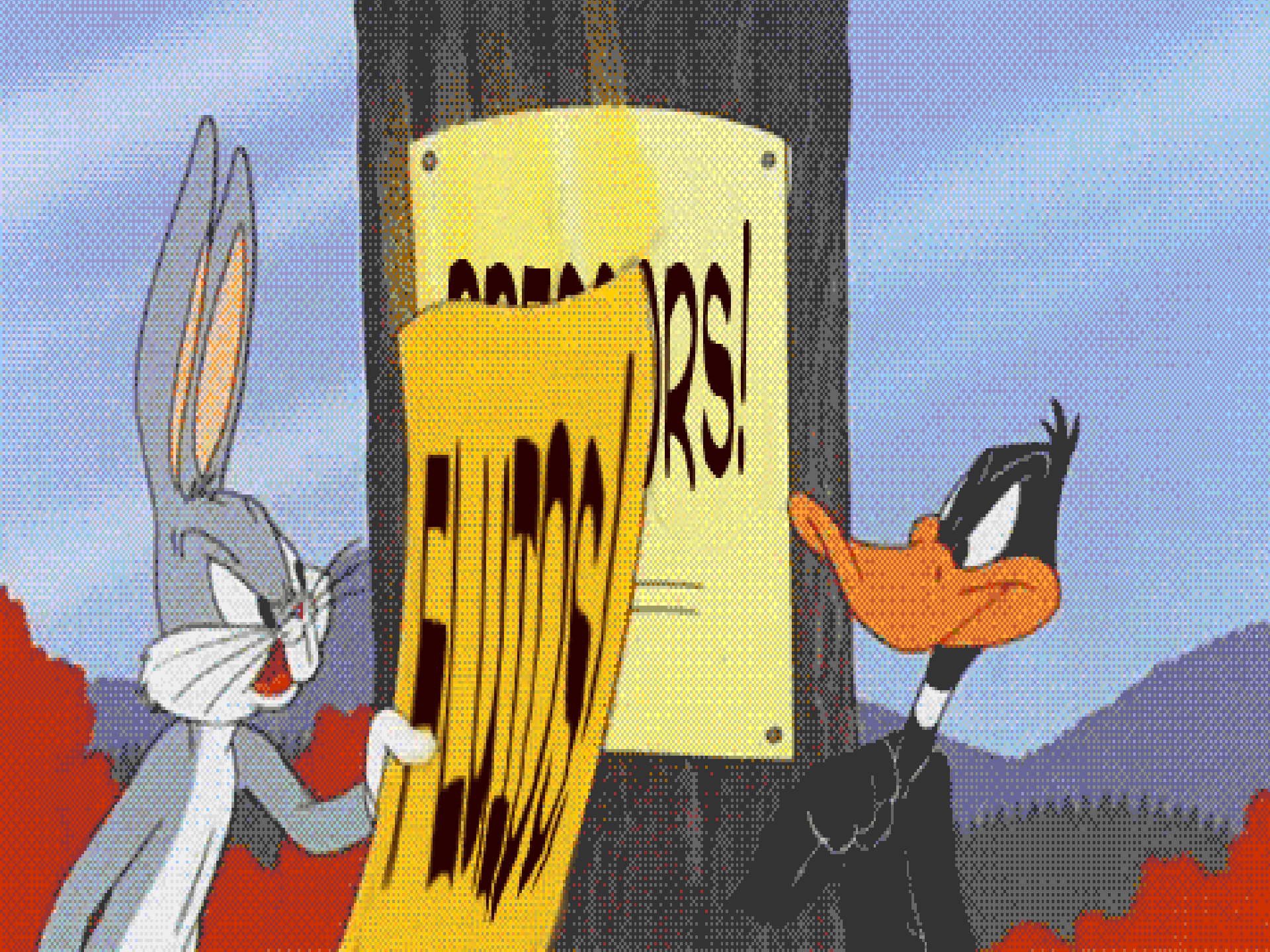
- * **EARLY RECOGNITION!**
- * **Supplemental oxygen**
- * **Bilateral large bore IV access, draw blood if possible**
- * **Fluid boluses**
 - * **30 ml/kg of a BALANCED fluid**
 - * **Large saline infusions contribute to hyperchloremic acidosis**
 - * **Reassess BP and lung sounds after each 500 ml.**
- * **Vasopressor support if unresponsive to fluid boluses and allowed by local protocol:**



Early Goal-Directed Therapy (EGDT)

- * In the presence of hypotension (SBP < 90 or MAP < 65) or serum lactate > 2 mmol/L:
 - * Bolus an initial minimum of 30 ml/kg balanced fluid or colloid equivalent.
 - * Administer vasopressors for refractory hypotension, titrated to MAP > 65, AND:
 - * Achieve central venous pressure (CVP) > 8 mm Hg.
 - * Achieve central venous oxygen saturation (ScvO₂) of > 70%.
- * **EGDT and fluid recommendations for sepsis are currently a source of great controversy among clinicians.**





Summary

- * Sepsis is a significant public health problem worldwide.
- * Prehospital recognition of sepsis can significantly improve outcomes.
- * Oxygenation and fluid replacement is critical.
- * qSOFA criteria can be easily adapted to Sepsis Alert Protocols.
- * Sepsis Alerts should be handled with all the urgency of STEMI alerts and stroke alerts.
- * Coordination with hospitals in formulating sepsis protocols can greatly improve patient outcomes.





Resources

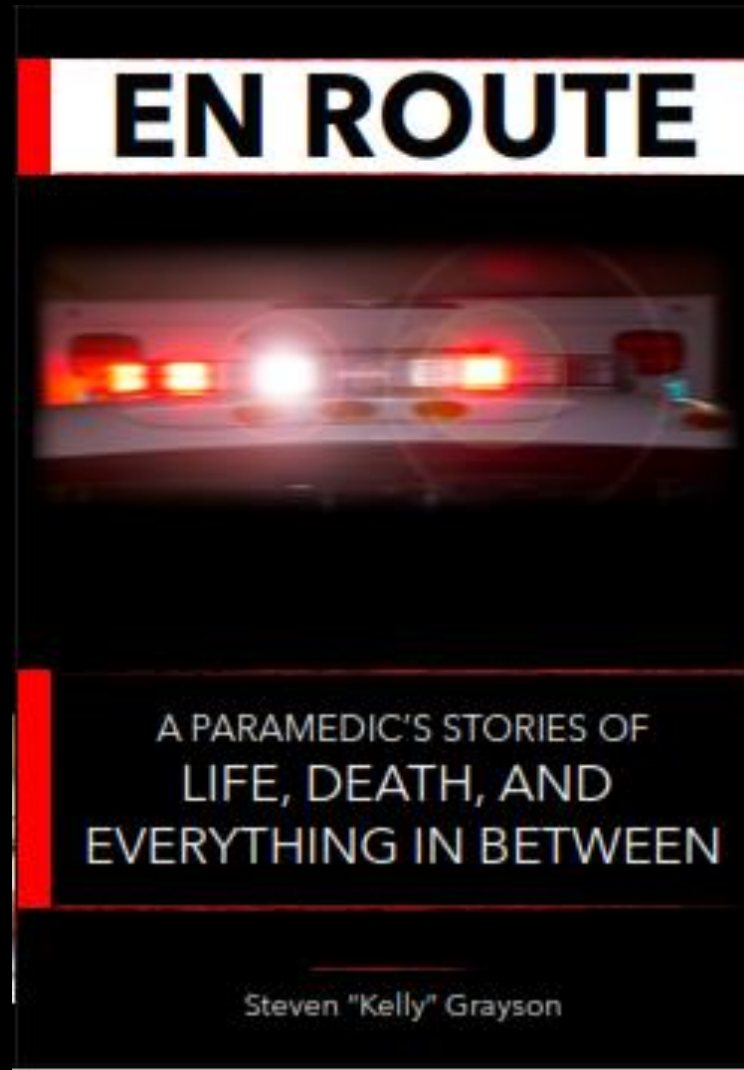
- * <http://jamanetwork.com/journals/jama/fullarticle/2654187>
- * <http://www.nejm.org/doi/full/10.1056/NEJMoa022139>
- * Margaret Jean Hall, Ph.D.; Sonja N. Williams, M.P.H.; Carol J. DeFrances, Ph.D.; and Aleksandr Golosinskiy, M.S. *Inpatient Care for Septicemia or Sepsis: A Challenge for Patients and Hospitals*. National Center for Health Statistics, Data Brief #62, June 2011
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Resources

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- * Seymour CW, et al., Crit Care Med 2017;45(5):759-765.
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<https://jamanetwork.com/journals/jama/fullarticle/2654187>





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