

# **Shock and septic shock .**

**Dr.Hosseini  
Tahmasbian.**

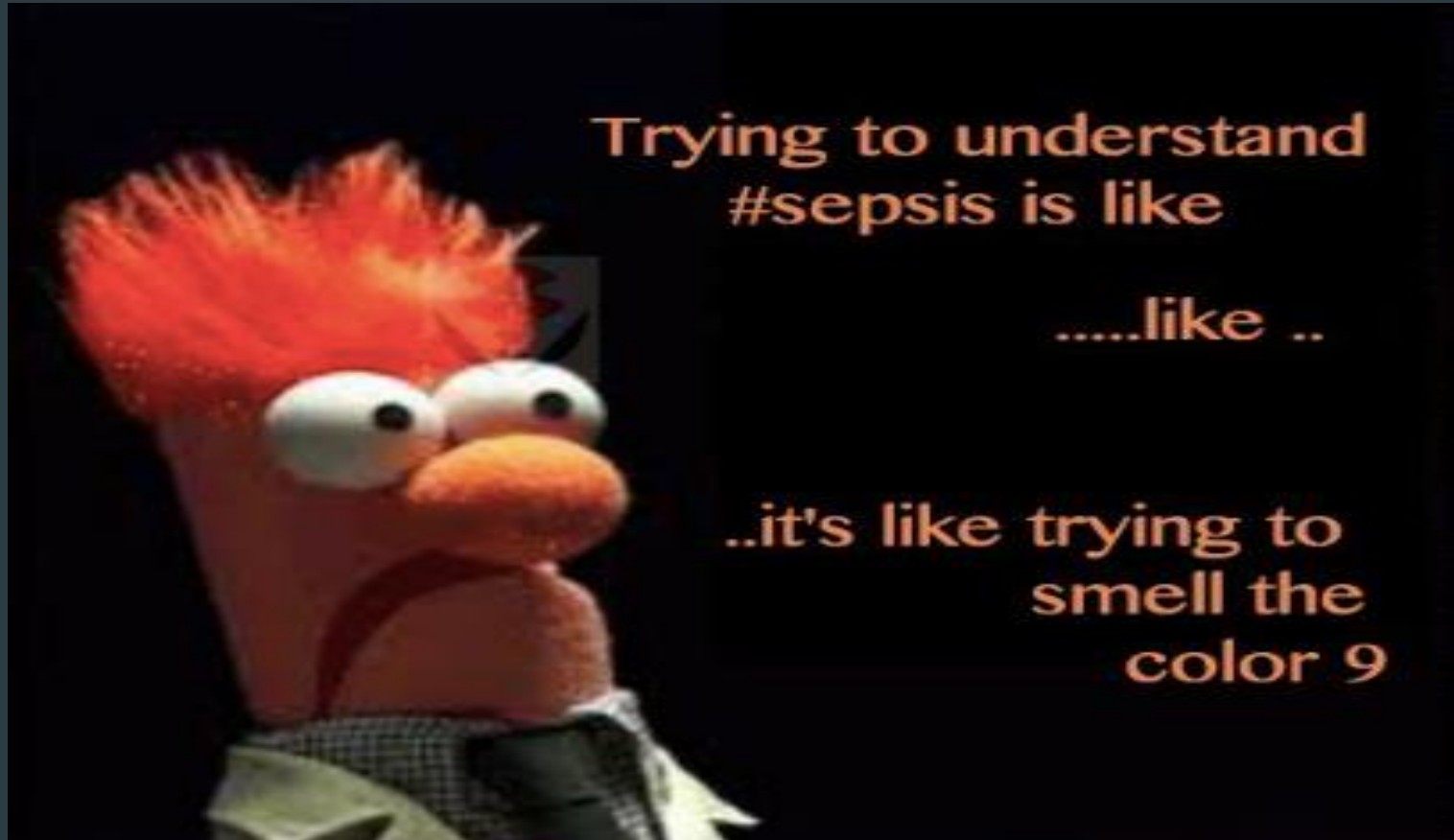
**Internist.**

# Identification and Management of Sepsis in the Prehospital Environment



# Objectives

- Define the different forms of sepsis
- Understand the pathophysiology of sepsis
- Understand the transformation of sepsis management
- Understand the key elements of sepsis management
- Understand the EMS role in sepsis identification and therapy initiation
- Understand Sepsis protocol



**“Sepsis is caused when the body’s immune system becomes overactive in response to an infection, causing inflammation which can affect how well other tissues and organs work.”**

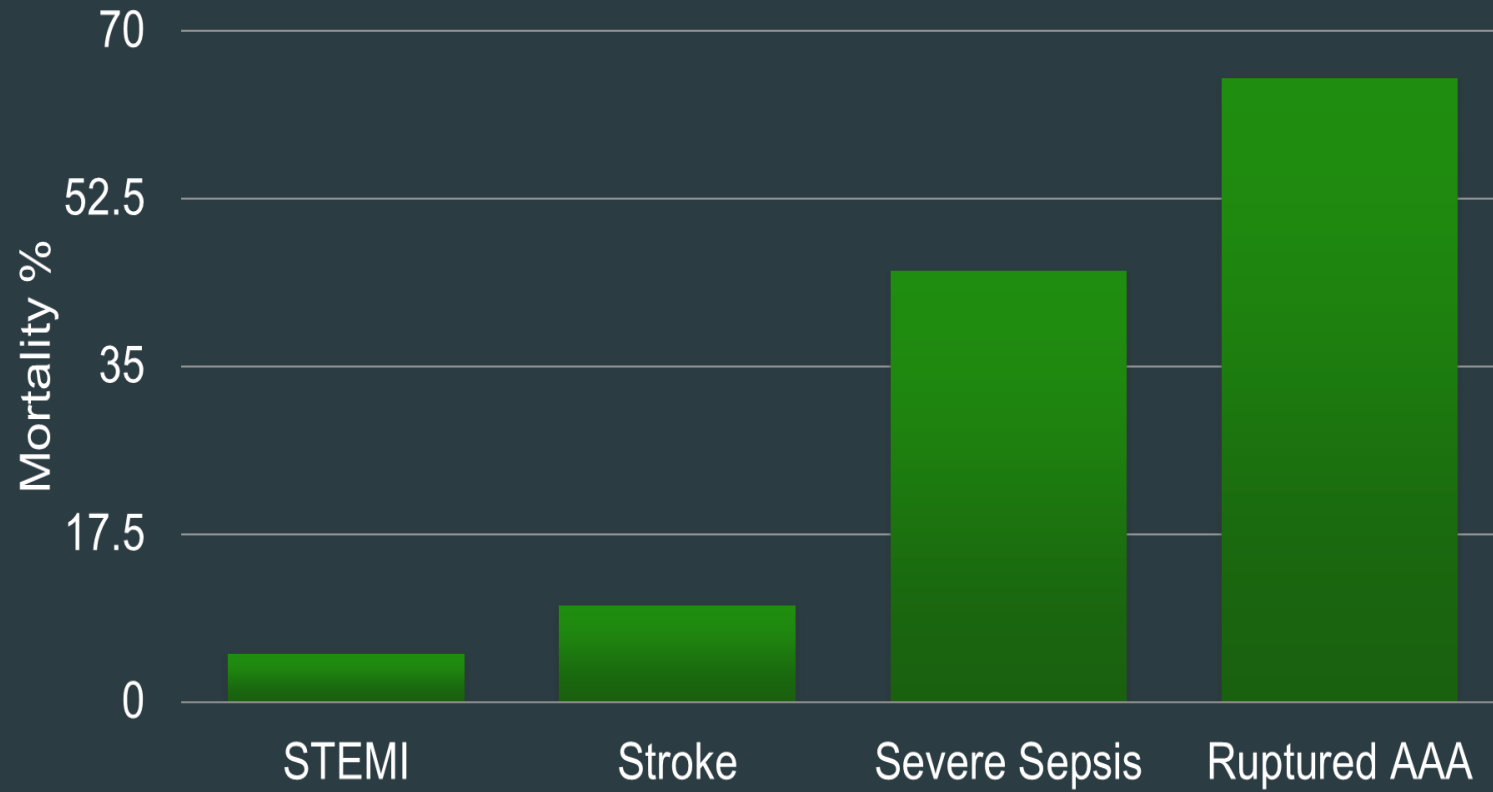
-National Institute for Health and Care Excellence  
Guidelines

# Defining Sepsis

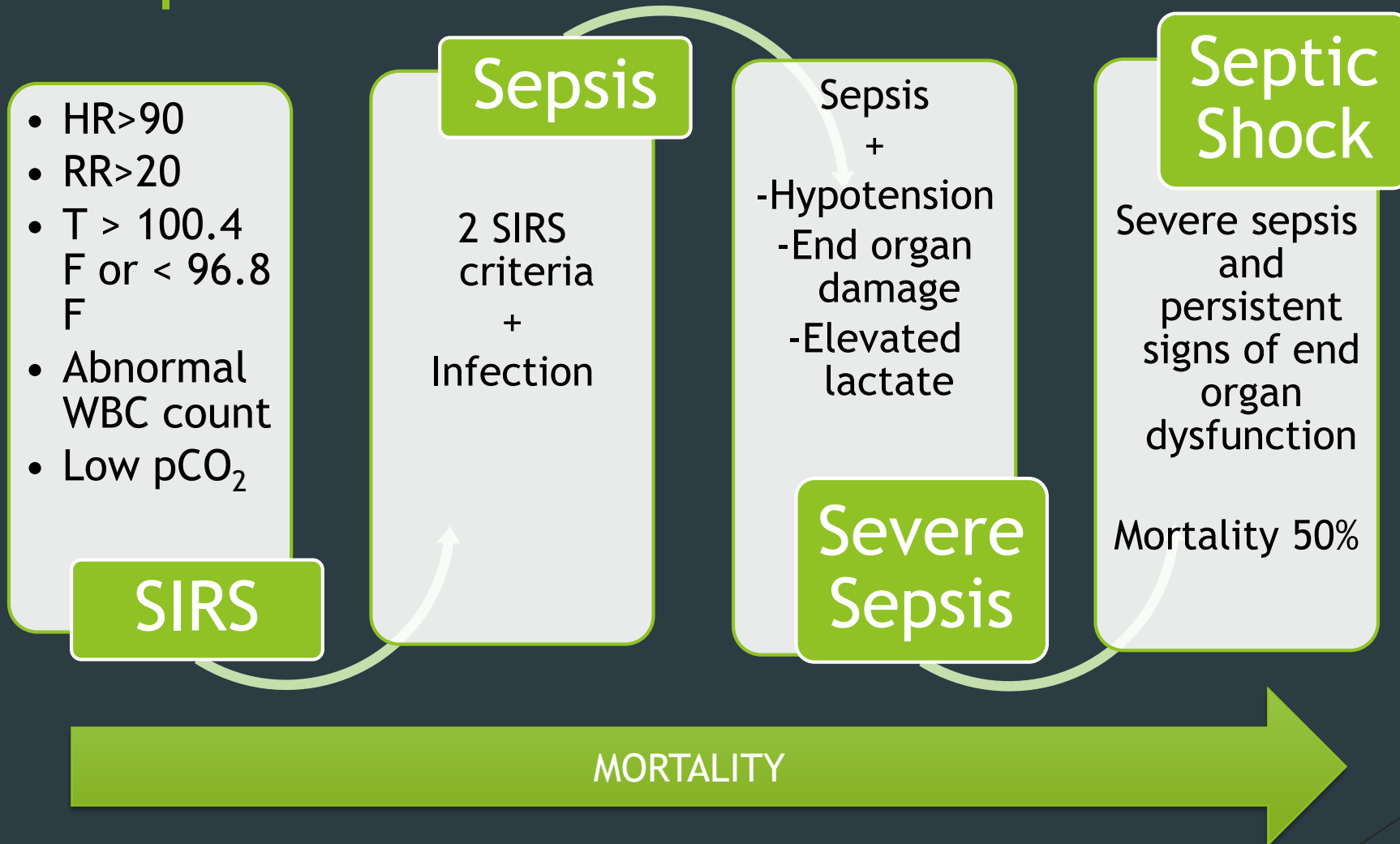
Sepsis is a syndrome

- A group of body dysfunctions found together
- Dysfunctions that progress together in a predictable way
- High mortality rate, variable clinical presentations

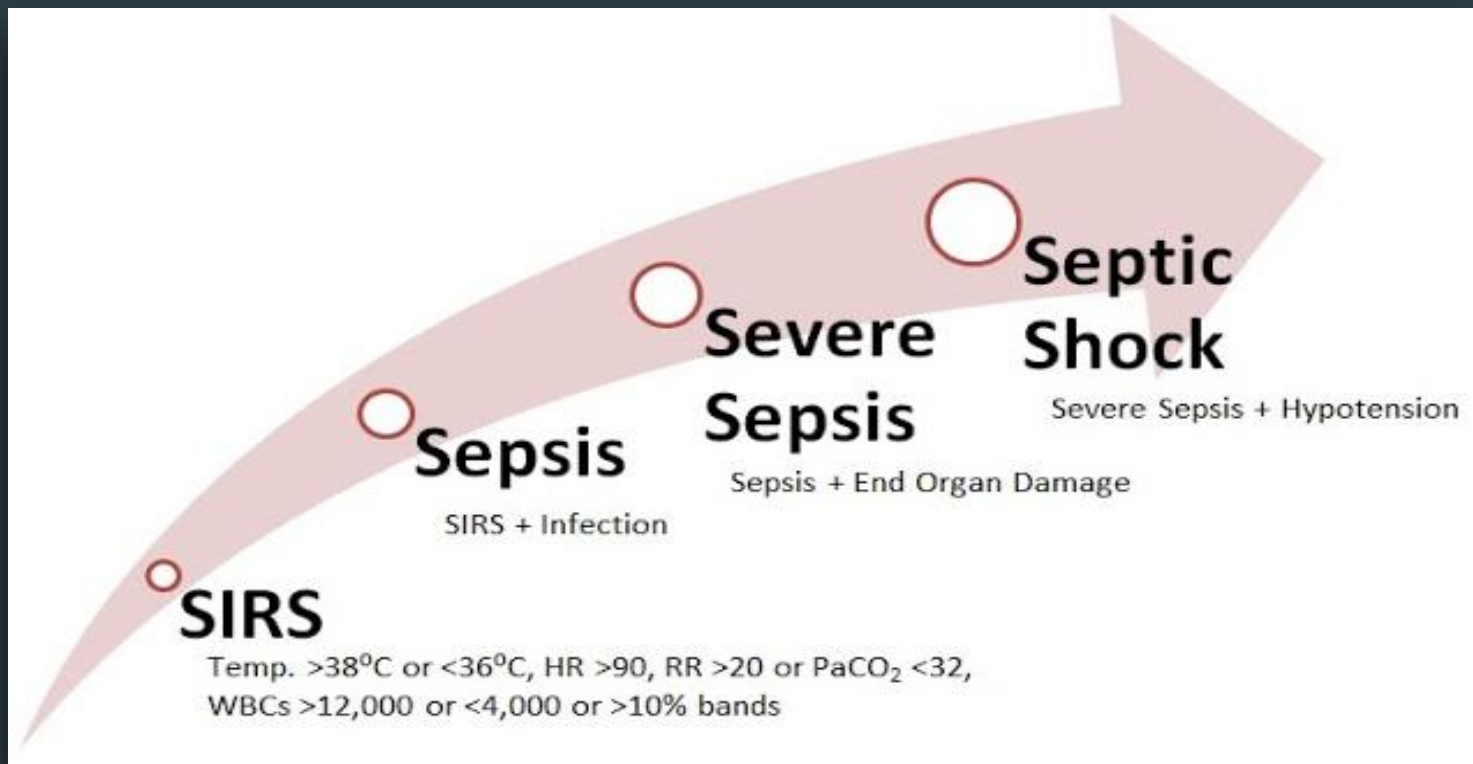
# Sepsis Mortality



# Sepsis Spectrum







# Normal Response to Infection

- Local infection
- Non-specific inflammatory response
- 3 phases
  - Vasodilation - increased blood flow to site, infusion of antibodies and cells to fight infection
  - Vessel permeability - antibodies and cells exit bloodstream and enter infected tissue
  - Once infection is controlled, tissue repairs itself

# Pathophysiology of Sepsis

- Uncontrolled, exaggerated immune response
- Endothelium damage, cell mediator activation, disruption of coagulation system homeostasis
- Vasodilation and capillary permeability
- Systemic inflammatory response
- End-organ damage, death



# Defining The Septic Picture

- **SIRS (Systemic inflammatory response syndrome):** The clinical syndrome that results from a deregulated inflammatory response or to a noninfectious insult.
- **Sepsis:** SIRS that is secondary to infection that has been diagnosed clinically. Positive cultures add to the validity but are not required for the diagnosis.
- **Severe Sepsis:** Sepsis plus at least one of the signs of hypoperfusion or organ dysfunction that is new, and not explained by other known etiology of organ dysfunction.
- **Septic Shock:** Severe sepsis associated with persistent hypotension (BP<90/60) despite adequate fluid resuscitation and/or a serum lactate level  $\geq 4.0$  mmol/L.



# Adult Severe Sepsis Criteria

All three of the following must be met within 6 hours of each other.

**A. Documentation of a suspected source of clinical infection**

**B. Two or more manifestations of systemic infection according to the SIRS criteria, which are:**

- Temperature > 38.3 C/101 F or < 36.0 C/96.8 F
- Heart rate > 90 bpm
- Respiration > 20 per min
- WBC > 12,000 or < 4,000 (k/uL) or > 10% bands

**C. Organ dysfunction, evidenced by any one of the following:**

- SBP < 90 (mmHg), or MAP < 65 (mmHg), or a SBP decrease of more than 40 pts (if documented by LIP as due to infection)
- Cr > 2.0 (mg/dL), or urine output < 0.5 mL/kg/hour for 2 hours
- Bilirubin > 2 mg/dL (34.2 mmol/L)
- Platelet count < 100,000 (k/uL)
- INR > 1.5 or a PTT > 60 sec
- Lactate > 2 mmol/L (18.0 mg/dL)
- Acute respiratory failure requiring a new need for invasive or non-invasive mechanical ventilation

**OR Physician/NP/PA documentation of severe sepsis**

# Septic Shock Criteria

- Patient meets Severe Sepsis criteria AND either:

- Lactic acid  $\geq 4$  mmol/L

OR

- Persistent Hypotension in the hour following crystalloid fluid bolus

OR

- Physician/Advanced Practitioner diagnosis

# Risk Factors for Sepsis

- Extremes of age (old and young)
  - Can't communicate, need careful assessment
  - Patients with developmental delay
  - Cerebral Palsy
- Recent surgery, invasive procedure, illness, childbirth/pregnancy termination/miscarriage
- Reduced immunity

# Increased Risk for Sepsis

- DIABETES
- Liver cirrhosis
- Autoimmune diseases (lupus, rheumatoid arthritis)
- HIV/AIDS
- Para/quadriplegics
- Sickle cell disease
- Splenectomy patients
- Compromised skin (chronic wounds, burns, ulcers)



# Increased Risk for Sepsis

- Chemotherapy
- Post-organ transplant (bone marrow, solid organ)
- Chronic steroid use
- Recent antibiotic use
- Indwelling catheters of any kind (dialysis, Foley, IV, PICC, PEG tubes, etc)

# Signs/Symptoms of Sepsis

- Symptoms of sepsis are often nonspecific and include the following:
  - Fever = most common (elderly patients often do NOT mount a febrile response)
  - Flu-like symptoms
  - Chills/shaking (mistaken for seizure)
  - Nausea/vomiting
  - Mental status changes/fatigue/lethargy

*Patient often does NOT appear acutely ill*

# Multiple Organ System Dysfunction

## CNS

Altered mental status

## Respiratory

Tachypnea

Hypoxia

## Hepatic

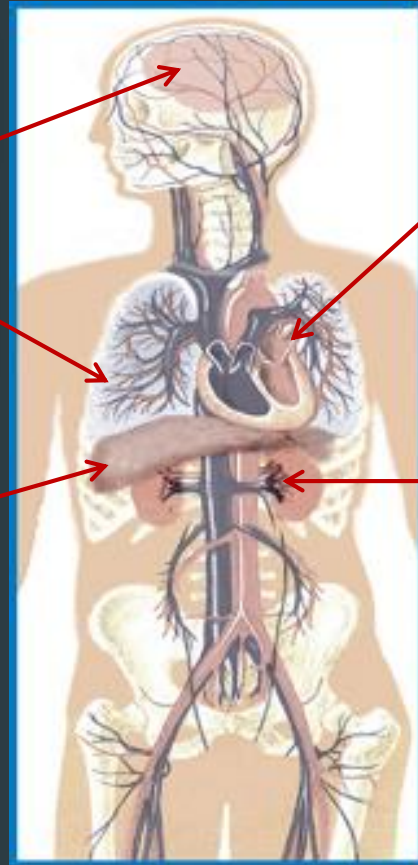
Jaundice

Liver inflammation

Coagulopathy

## Metabolic

Lactic acidosis



## Cardiovascular

Tachycardia

Hypotension

## Renal

Oliguria

Anuria

Renal failure

## Hematologic

Consumptive coagulopathy

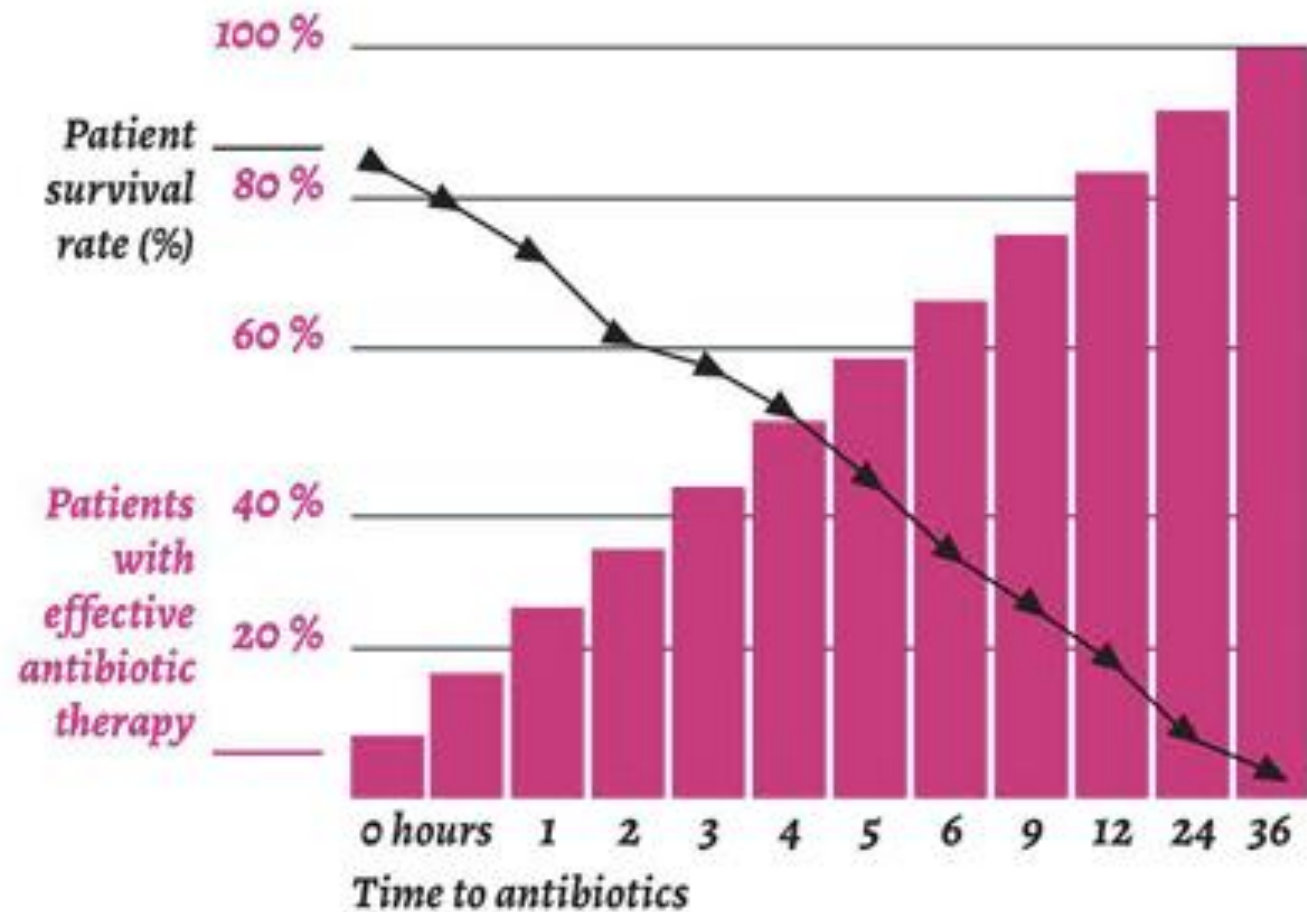
Petechiae

Purpura

# Causes of Sepsis

- Pneumonia
- Urinary tract infections
- Infection after abdominal surgery
- Skin infection (cellulitis, open wounds, MRSA abscess)
- C. Diff colitis
- Bacteremia from IV drug use

## Sepsis is a medical emergency<sup>8</sup>



(Crit Care Med 2006;34[6]:1589.)

# EMS and Sepsis



## Sepsis: a need for prehospital intervention?

W Robson,<sup>1</sup> T Nutbeam,<sup>2</sup> R Daniels<sup>3</sup>

*Emerg Med J. 2009*

- “In time critical conditions such as AMI or stroke, specific interventions by prehospital practitioners make a significant difference to mortality.”

# Epidemiology of Sepsis and Its Recognition by Emergency Medical Services Personnel in the Netherlands

Lena C. W. van der Wekken, Nadia Alam, Frits Holleman, Pieterneel van Exter,  
Mark H. H. Kramer & Prabath W. B. Nanayakkara



**RESEARCH**

**Open Access**

## Prehospital intravenous access and fluid resuscitation in severe sepsis: an observational cohort study

Christopher W Seymour<sup>1,2\*</sup>, Colin R Cooke<sup>3,4</sup>, Susan R Heckbert<sup>5</sup>, John A Spertus<sup>6</sup>, Clifton W Callaway<sup>7</sup>, Christian Martin-Gill<sup>7</sup>, Donald M Yealy<sup>7</sup>, Thomas D Rea<sup>8,9</sup> and Derek C Angus<sup>2,10</sup>

- 45,394 EMS encounters in King County, Washington
- 1350 met criteria for severe sepsis
- Administration of prehospital fluid was associated with decreased odds of hospital mortality



Contents lists available at ScienceDirect

Resuscitation

journal homepage: [www.elsevier.com/locate/resuscitation](http://www.elsevier.com/locate/resuscitation)



Clinical paper

## Opportunities for Emergency Medical Services care of sepsis<sup>☆</sup>

Henry E. Wang<sup>a,\*</sup>, Matthew D. Weaver<sup>b</sup>, Nathan I. Shapiro<sup>c</sup>, Donald M. Yealy<sup>b</sup>

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<sup>b</sup> Department of Emergency Medicine, University of Pittsburgh, Pittsburgh, PA, United States

<sup>c</sup> Department of Emergency Medicine, Beth Israel Deaconess Medical Center, Boston, Massachusetts, United States

- 34% of patients presenting to the ED with a serious infection arrived by EMS
- In these patients, mortality was higher for EMS patients (8%) than non-EMS patients (2%)
- EMS cares for the “sickest” sepsis patients



Original Contribution

## The impact of emergency medical services on the ED care of severe sepsis<sup>☆</sup>

Jonathan R. Studnek PhD<sup>a,b</sup>, Melanie R. Artho MD<sup>a</sup>,  
Craymon L. Garner Jr<sup>a</sup>, Alan E. Jones MD<sup>a,\*</sup>

<sup>a</sup>Department of Emergency Medicine, Carolinas Medical Center, Charlotte, NC 28203, USA

<sup>b</sup>Mecklenburg Emergency Medical Services Agency, USA

Received 19 July 2010; revised 8 September 2010; accepted 9 September 2010

- Compared severe sepsis patients arriving by EMS to those that did not
- 35 minute reduction to initiation of antibiotics
- 41 minute reduction to targeted sepsis resuscitation

## EARLY DETECTION AND TREATMENT OF PATIENTS WITH SEVERE SEPSIS BY PREHOSPITAL PERSONNEL

Wayne F. Guerra, MD, MBA, Thomas R. Mayfield, MS, NREMT-P, Mary S. Meyers, MS, EMT-P,  
Anne E. Clouatre, MHS, EMT-P, and John C. Riccio, MD

Centura Health Prehospital Emergency Services—South Denver Group, Denver, Colorado

*Reprint Address:* Thomas R. Mayfield, MS, NREMT-P, Centura Health Prehospital Emergency Services—South Denver Group, Stansbury Hall,  
2<sup>nd</sup> Floor, 980 East Harvard Avenue, Denver, CO 80210

S  
A  
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M



Academic Emergency Medicine

Official Journal of the Society for Academic Emergency Medicine

## Arriving by Emergency Medical Services Improves Time to Treatment Endpoints for Patients With Severe Sepsis or Septic Shock

Roger A. Band, MD, David F. Gaieski, MD, Julie H. Hylton, Frances S. Shofer, PhD,  
Munish Goyal, MD, and Zachary F. Meisel, MD, MPH

# EMS Role in Sepsis

- Decreased time to intravenous fluids
- Decreased time to antibiotics
- Decreased mortality
- Shorter hospital stay

# Identifying the Sepsis Patient

- Look for and ask about infection
  - Did you look at all the skin???
- Look for and ask about risk factors for infection
- Check a temperature accurately
  - $> 38^{\circ}\text{C}$  ( $100.4^{\circ}\text{F}$ )
  - $< 36^{\circ}\text{C}$  ( $96^{\circ}\text{F}$ ) **more dangerous**

# Identifying the Sepsis Patient

- Look for SIRS criteria in the vital signs
- Look for shock/dehydration
- Check end-tidal CO<sub>2</sub>




# Treating the Sepsis Patient

- Airway/breathing
  - Get sats > 92%
  - NRB, CPAP, invasive airway
- Circulation
  - 2 large bore IV, consider IO
  - 20 cc/kg NS bolus
  - May repeat if lungs remain clear



# Sepsis Alert

- Communicate your suspicion early!
- It doesn't matter if accepting facility has a formal sepsis alert response process
- Explicitly communicate abnormal vitals (especially temp) just as you would in trauma

Includes: patients meeting sepsis criteria (Elements from Boxes 1 and 2) as well as severe sepsis or septic shock (Elements from Boxes 1, 2, and 3).					
1	<ul style="list-style-type: none"><li>Suspected Infection or immunosuppression</li><li>Open wounds, sores, cellulitis</li><li>UTI</li><li>Pneumonia</li><li>Meningitis</li><li>Indwelling medical device</li><li>Vomiting, diarrhea</li><li>Recent surgery/procedure</li><li>Chemotherapy &lt; 6 weeks</li><li>Chronic steroid use</li></ul>	<u>Suspected Infection</u> <ul style="list-style-type: none"><li>Temperature abnormality on assessment or within 4 hours of assessment</li><li>Open wounds, sores, cellulitis</li><li>UTI or Pneumonia</li><li>Meningitis</li></ul>  <u>High-Risk Criteria</u> <ul style="list-style-type: none"><li>Malignancy</li><li>Asplenia or sickle cell disease</li><li>Bone marrow transplant</li><li>Indwelling medical device</li><li>Solid organ transplant</li><li>Severe intellectual disability or cerebral palsy</li><li>Immunocompromise, chronic steroid use</li></ul>			
		<u>Exam Criteria</u> 	0-2 y	≥ 2-10 y	≥ 10-14 y
2	<u>Two or more markers of Systemic Inflammatory Response Syndrome (SIRS)</u> <ul style="list-style-type: none"><li>Temp ≥ 100 or ≤ 97</li><li>HR ≥ 90</li><li>RR ≥ 20</li><li>Glucose &gt; 140 in non-diabetic</li><li>Altered mental status</li></ul>	HR	>190	>140	>100
		RR	>50	>34	>30
		Pulses	Decreased, weak, or bounding		
		Cap refill	Delayed (> 2 sec) or flash (<1 sec)		
		Skin	Mottled, ruddy, petechiae		
		Mental status	Decreased, irritability, confusion, inappropriate crying, poor interaction, diminished arousability		
3	<u>Findings of Shock</u> <ul style="list-style-type: none"><li>SBP &lt; 90 or MAP &lt; 65 or SBP drop of 40 mmHg from prior baseline</li><li>EtCO<sub>2</sub> ≤ 25</li><li>O<sub>2</sub> sat ≤ 92% on RA</li><li>Mottled or cold extremities</li><li>Central cap refill ≥ 3 seconds</li><li>Purpuric rash</li><li>No radial pulse</li></ul>	<ul style="list-style-type: none"><li>SBP &lt; 70 + (age in yr X 2).</li><li>3 or more exam criteria.</li><li>2 or more exam criteria in patient meeting high-risk criteria.</li></ul> 			
EMT					
<ul style="list-style-type: none"><li>Initiate <u>Universal Care</u>.</li></ul>					
AEMT					
<ul style="list-style-type: none"><li>Administer 20 mL/kg IV/IO fluid bolus, refer to treatment for <u>Shock</u> as indicated.</li><li>2 large bore IVs preferred for IV fluids. Consider IO placement early.</li><li>Do not delay transport if unsuccessful.</li></ul>					
EMT-I/Paramedic					

## Sepsis: Adult & Pediatric

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[TOC](#)

**Includes:** patients meeting sepsis criteria (Elements from Boxes 1 and 2) as well as severe sepsis or septic shock (Elements from Boxes 1, 2, and 3).

1

- Suspected Infection or immunosuppression
- Open wounds, sores, cellulitis
- UTI
- Pneumonia
- Meningitis
- Indwelling medical device
- Vomiting, diarrhea
- Recent surgery/procedure
- Chemotherapy < 6 weeks
- Chronic steroid use

### Suspected Infection

- Temperature abnormality on assessment or within 4 hours of assessment
- Open wounds, sores, cellulitis
- UTI or Pneumonia
- Meningitis



### High-Risk Criteria

- Malignancy
- Asplenia or sickle cell disease
- Bone marrow transplant
- Indwelling medical device
- Solid organ transplant
- Severe intellectual disability or cerebral palsy
- Immunocompromise, chronic steroid use

# 2

## Two or more markers of Systemic Inflammatory Response Syndrome (SIRS)

- Temp  $\geq 100$  or  $\leq 97$
- HR  $\geq 90$
- RR  $\geq 20$
- Glucose  $> 140$  in non-diabetic
- Altered mental status

### Exam Criteria



0-2 y

$\geq 2-10$  y

$\geq 10-14$  y

HR

$>190$

$>140$

$>100$

RR

$>50$

$>34$

$>30$

Pulses

Decreased, weak, or bounding

Cap refill

Delayed ( $> 2$  sec) or flash ( $< 1$  sec)

Skin

Mottled, ruddy, petechiae

Mental status

Decreased, irritability, confusion, inappropriate crying, poor interaction, diminished arousability

# 3

## Findings of [Shock](#)

- SBP < 90 or MAP < 65 or SBP drop of 40 mmHg from prior baseline
- EtCO<sub>2</sub> ≤ 25
- O<sub>2</sub> sat ≤ 92% on RA
- Mottled or cold extremities
- Central cap refill ≥ 3 seconds
- Purpuric rash
- No radial pulse

- SBP < 70 + (age in yr X 2).
- 3 or more exam criteria.
- 2 or more exam criteria in patient meeting high-risk criteria.



## EMT

- Initiate [Universal Care](#).

## AEMT

- Administer 20 mL/kg IV/IO fluid bolus, refer to treatment for [Shock](#) as indicated.
- 2 large bore IVs preferred for IV fluids. Consider IO placement early.
- Do not delay transport if unsuccessful.

## EMT-I/Paramedic

For shock due to suspected trauma, refer to [General Trauma Management](#) section guidelines. For shock due to anaphylaxis, refer to [Anaphylaxis and Allergic Reaction](#).

Emergency medical conditions can trigger signs of poor perfusion such as these:

- Tachycardia out of proportion to temperature
- Altered mental status
- Delayed/flash capillary refill >2 seconds
- Hypoxia
- Decreased urine output
- Tachypnea
- Hypotension for age, refer to [Abnormal Vital Signs](#)
- Weak, decreased or bounding pulses
- Cool/mottled or flushed/ruddy skin

## EMT

- Initiate [Universal Care](#).
- Check blood glucose, treat per [Hypoglycemia](#) or [Hyperglycemia](#) as indicated.
- If pregnant, place in left lateral recumbent position.

## AEMT

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Administer 30 mL/kg, max 1 L, IV/IO fluid bolus over &lt; 15 minutes.</li> <li>• May repeat up to 3 times until either:                             <ul style="list-style-type: none"> <li>- Vital signs/perfusion normal (or)</li> <li>- Rales, crackles or respiratory distress.</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Administer 30 mL/kg, max 1 L, IV/IO fluid bolus over &lt;15 minutes, <b>using push-pull methods</b>.</li> <li>• May repeat up to 3 times until either:                             <ul style="list-style-type: none"> <li>- Vital signs/perfusion normal (or)</li> <li>- Rales, crackles or respiratory distress or hepatomegaly.</li> </ul> </li> </ul> |
|--|---|
- Reassess after each IVF bolus.
  - If history of adrenal insufficiency (congenital adrenal hyperplasia, daily steroid use) refer to Adrenal Insufficiency treatment under EMT-I/Paramedic below. Assist with patient's own hydrocortisone.



## EMT-I/Paramedic

- For shock unresponsive to IV fluids, or cardiogenic shock with signs of fluid overload, consider vasopressors, refer to [appendix drip calculations](#):
  - **Epinephrine:** 0.05-0.3 mcg/kg/min IV/IO
  - **Norepinephrine:** 0.05-0.5 mcg/kg/min IV/IO (Paramedic Only) (Pump Only)
  - **Dopamine:** 2-20 mcg/kg/min IV/IO (Paramedic Only)



### Adrenal Insufficiency Treatment:

- Patient's hydrocortisone (Solu-Cortef): is preferred:
  - ≥ 12 years: 100 mg IM.
- **Methylprednisolone:**
  - 2 mg/kg IV/IO, max 125 mg.

### Adrenal Insufficiency Treatment:

- Patient's hydrocortisone (Solu-Cortef): is preferred:
  - 0-3 years: 25 mg IM.
  - 3-12 years: 50 mg IM.
  - ≥ 12 years: 100 mg IM.
- **Methylprednisolone:**
  - 2 mg/kg IV/IO, max 125 mg.



EMT	
<ul style="list-style-type: none"> <li>Initiate <a href="#">Universal Care</a>.</li> <li>Check blood glucose, treat per <a href="#">Hypoglycemia</a> or <a href="#">Hyperglycemia</a> as indicated.</li> <li>If pregnant, place in left lateral recumbent position.</li> </ul>	
AEMT	
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# What about Dopamine?

- Dopamine traditionally used for shock in EMS
- Studies show that **survival is worse when dopamine is used to treat septic shock**
- Probably better to stick with fluids and rapid transport
- Hospitals and other EMS use norepinephrine for best survival in septic shock



# Respiratory Component of Sepsis

- Mismatch of oxygen availability to changing needs of organs (ie. Increased oxygen demand)
- Keep sats  $\geq 92\%$  (NRB, CPAP, intubation)
- Respiratory failure can happen quickly
- Acute Respiratory Distress Syndrome

# Severe Sepsis/Septic Shock

A story of imbalance...

Oxygen  
Consumption



Oxygen  
Delivery

As sepsis progresses, circulatory abnormalities lead to an imbalance of systemic oxygen delivery and demand, resulting in global tissue hypoxia.

Global tissue hypoxia is a key development preceding multi-organ failure and death.

# Sepsis Pitfalls

- Beta blockers block tachycardia response
- Altered mentation not recognized as “end-organ failure”
- Temperatures not checked
- EtCO<sub>2</sub> not checked or recognized
- Discouragement due to hospital response

# EtCO<sub>2</sub> and Lactate

- Low EtCO<sub>2</sub> associated with high lactic acid
- Low EtCO<sub>2</sub> predicts mortality
- EtCO<sub>2</sub> of 25 mmHg = lactate up to 6.1 mm/L





**Thanks for Your Attention**