

# Before we start, consider this.

- Called for “weakness”
- 67 y/o male, Hx of COPD.
- 3-4 day onset of oliguria and fever
- Has not urinated for 24 hrs.
- Pale, hot and dry
- CAO x 4
- “I called because I just can’t get out of bed anymore.”
- The house smells really bad.



# What else do you want to know?

- On home O<sub>2</sub>, SaO<sub>2</sub> = 91%
- Vital Signs
  - Pulse = 110 weak and regular
  - BP = 100/40
  - Respiratory Rate = 24 and shallow
  - BGL = 167 mg/dL
    - No Hx of diabetes
- What do you think? Sick or Not Sick?



# Treatment?

- More oxygen?
- IV?
- Fluid Bolus?
- Transport?
  - Emergent?
  - Non-Emergent?
  - Local or Anchorage?





PESTR

Pre-hospital Emergent  
Sepsis Treatment and  
Recognition

# Objectives

- Identify and explain the SIRS to MODS continuum
- Broaden and Deepen your understanding of Sepsis
- Discuss the Pathophysiology of the Sepsis Cascade
- Clarify the role of EMS in Sepsis



# First, we need to speak the same language

- SIRS
  - Systemic Inflammatory Response Syndrome
    - A group of signs and values
    - Very broad
    - 2 or more = SIRS

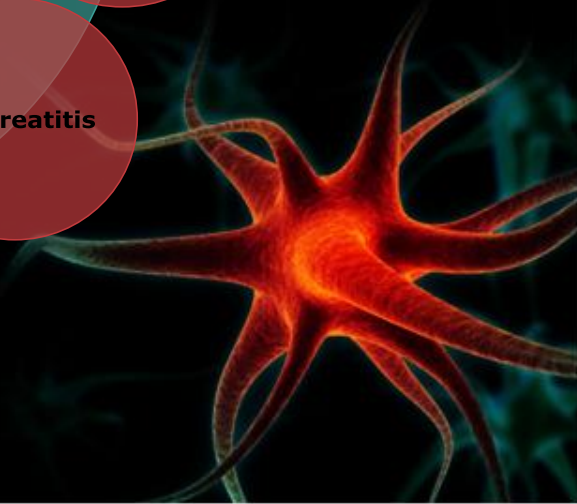
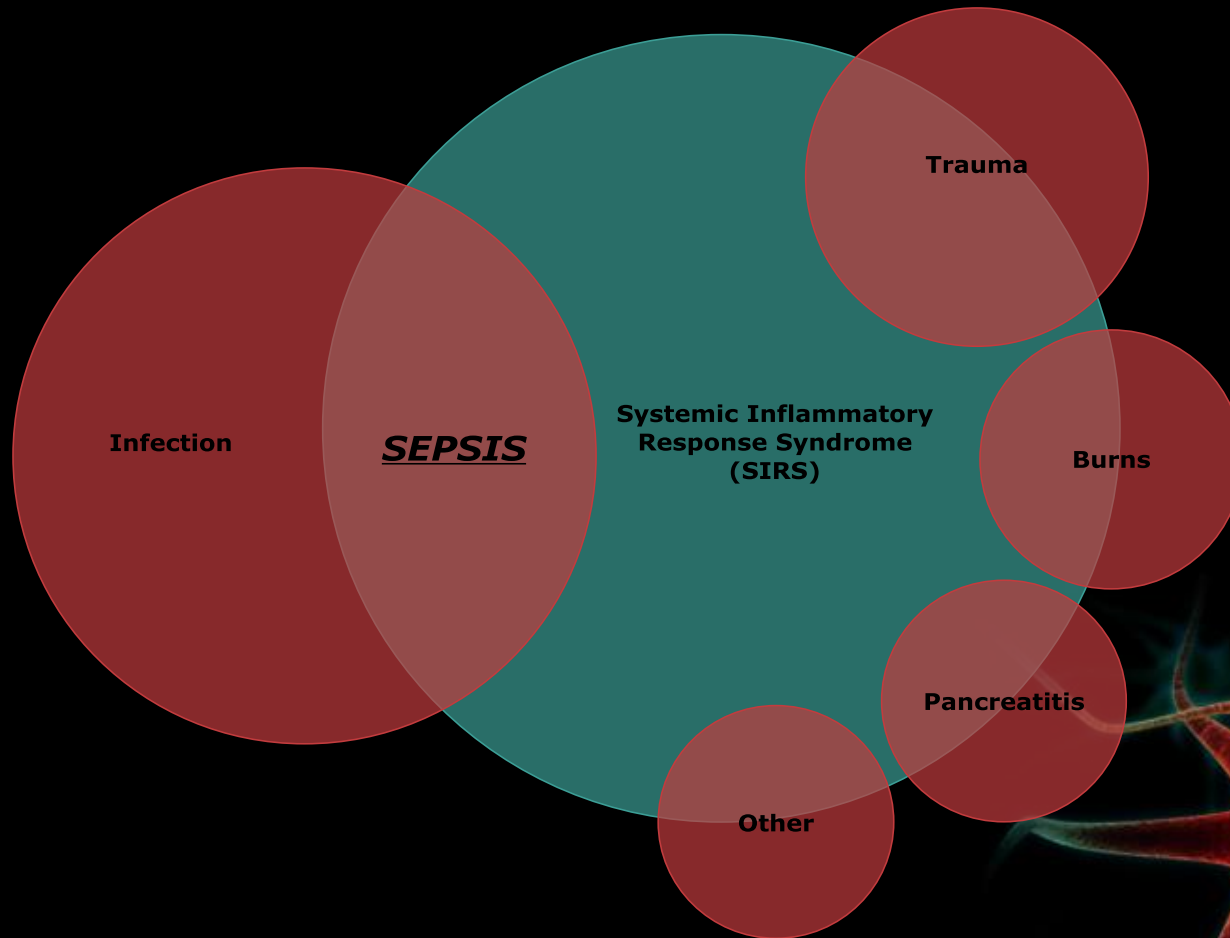


# But **WHATTT** are these signs and values?

- **W**BC Count  $<4,000$  or  $>12,000$
- **H**yperglycemia  $>120\text{mg/dL}$ 
  - Without history of Diabetes
- **A**cute AMS
- **T**emperature
  - Greater than  $101^{\circ}\text{F}$  ( $38.3^{\circ}\text{C}$ )
  - Less than  $96.8^{\circ}\text{F}$  ( $36^{\circ}\text{C}$ )
- **T**achycardia  $>90$  bpm
- **T**achypnea  $>20$  rpm



# What is Sepsis?



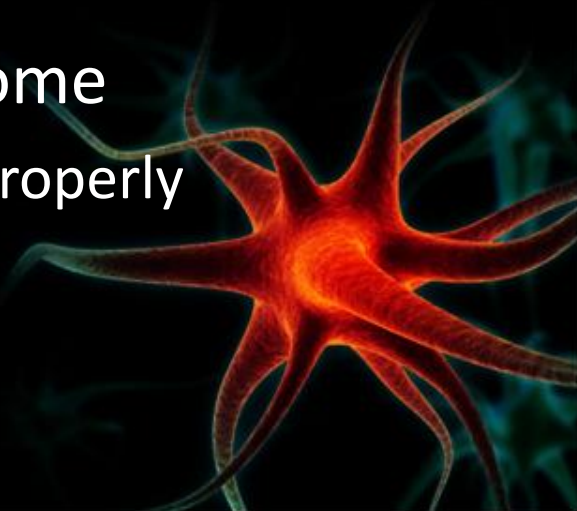
# Sepsis Defined

- Sepsis
  - Simply put, sepsis is SIRS + a vector of infection.
  - Technically it is a systemic response to infection.



# Definitions

- ARDS
  - Acute Respiratory Distress Syndrome
    - Widespread collapse of the pulmonary structures resulting in micro bleeding, atelectasis and death
- MODS
  - Multiple Organ Dysfunction Syndrome
    - 2 or more organs failing to function properly
    - Very, very low survival rates



# Definitions

- DIC
  - Disseminated Intravascular Coagulation
    - Over-activation of the clotting cascade that results in clotting and bleeding at the same time
- Cytokines
  - Protein signals released by many different cells.
    - Cytokines either increase or decrease the inflammatory response

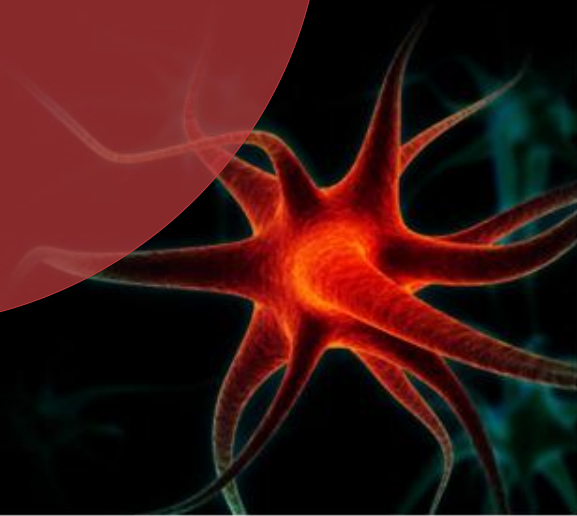
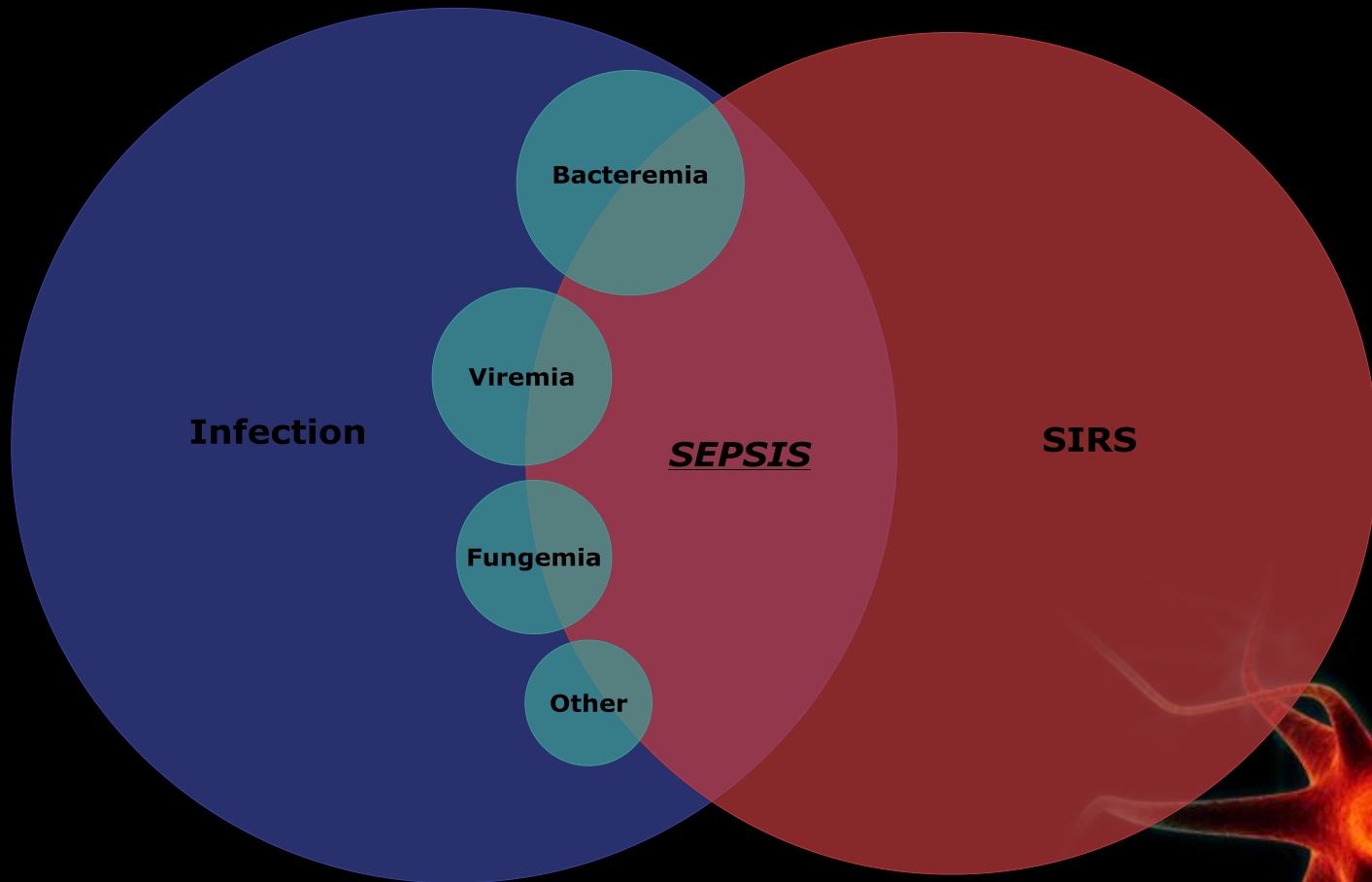


# Definitions

- Prostaglandins
  - Lipid compound that is a chemical messenger
    - Made throughout the body but act locally
- Leukotrienes
  - Another lipid compound, chemical messenger
    - Bronchoconstriction
    - Vascular Permeability



# Sepsis Specifics



# Why is Sepsis so BAD?

- Sepsis is a cascade of events that occurs systemically
- Several other life-threatening pathways are kicked off by the sepsis cascade
- Progression of sepsis and the secondary pathways are often accelerated by other diseases



Surprise Slide!



# What did we learn here?

## ↑ Clotting and ↑ chance of DIC

- Cytokines +
- Platelet Activating Factor ++
- Thromboxanes +++
- Complement ++
- Activation of the Clotting Cascade ++++
- If bacteremic, endotoxin ++
- Stasis from being sick ++

## Pulmonary damage and ↑ chance of ARDS

- Cytokines +
- Leukotriene ++++
- Prostaglandins ++
- Nitric oxide +++
- Everything from that other list!!!



# SIRS to MODS

## SIRS

+ Vector of infection

## Sepsis

+ Hypotension or Hypoperfusion

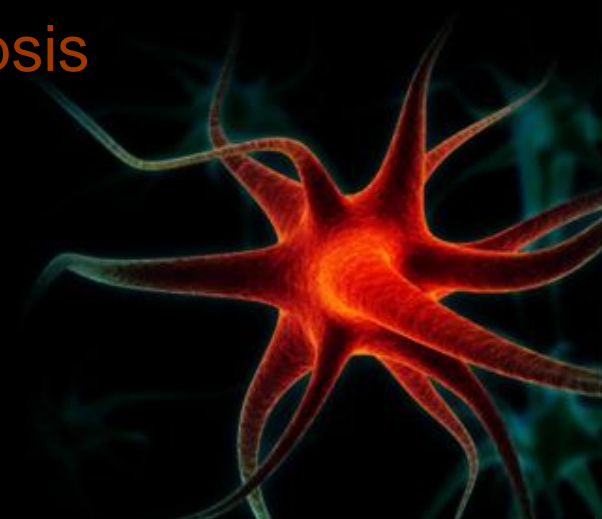
## Septic Shock

+ Refractory to fluids

## Septic Shock Syndrome or Severe Sepsis

+ End organ dysfunctions

## MODS



# Let's revisit our patient from earlier.

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- CAO x 4
- “I called because I just can't get out of bed anymore.”
- The house smells really bad.



# Nervous yet?

- On home O<sub>2</sub>, SaO<sub>2</sub> = 91%
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  - BP = 100/40
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  - BGL = 167 mg/dL
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# Treatment

- More oxygen?
- IV?
- Fluid Bolus?
- Transport?
  - Emergent?
  - Non-Emergent?
  - Local or Anchorage?



# Fomenting agitation

- How quickly can a patient progress through the steps?
  - It depends
    - What is the patient's baseline
    - What are the comorbidities
    - How far into the process are they?
- How do I know if my patient is going to crash?
  - You don't, you can only guess



# But I don't want to guess

- HISTORY, HISTORY, HISTORY!!!!

- Excellent and accurate vitals

- MAP

- Mean Arterial Pressure
- Pressure needed for end organ perfusion

- $(2 \times \text{Diastolic}) + \text{Systolic}$

3

If below 65, bad news!

- Or  $(2 \times \text{DBP}) + \text{SPB} < 195$



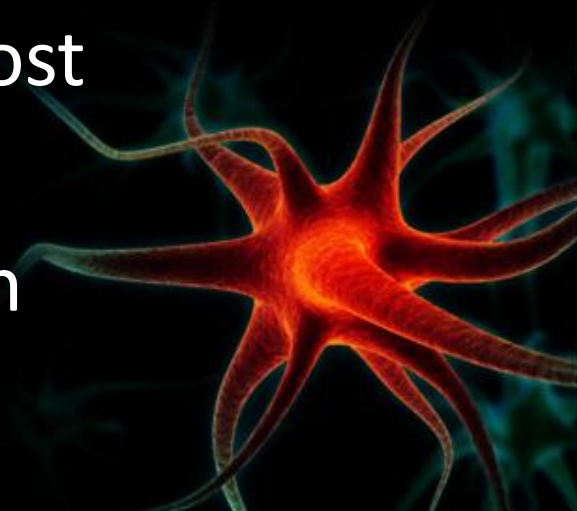
# Removing the Guesswork

- Since we are in the field, a lot of the diagnostic tools are not available to us
- Drawing solid line between cause and effect is sometimes difficult
- Play the odds and listen to your gut



# How do I treat it?

- First, it's up to your Medical Director
- Supportive therapy
  - Combat hypotension aggressively
  - Ensure adequate oxygenation
  - Consider early pressors if you can
- By far, early recognition is the most important
- Followed by rapid transport to an appropriate facility



# How to not look like a nutbag

- All this recognition is great
- Communicating your findings is also critical
- Come up with a plan and have documentation



# PESTR Screening Tool

---

**1. Is the patient's history or presentation suggestive of a new infection?**

Yes  No

**If Yes, what type of new infection?**

- |  |   |
|--|---|
| <input type="checkbox"/> Pneumonia, empyema            | <input type="checkbox"/> Bone/joint Infection           |
| <input type="checkbox"/> Urinary Tract Infection       | <input type="checkbox"/> Wound infection                |
| <input type="checkbox"/> Acute Abdominal Infection     | <input type="checkbox"/> Bloodstream catheter infection |
| <input type="checkbox"/> Meningitis                    | <input type="checkbox"/> Endocarditis                   |
| <input type="checkbox"/> Skin or soft tissue infection | <input type="checkbox"/> Implantable device infection   |
| <input type="checkbox"/> Other _____                   |   |

**2. Are any two of the following findings present in your patient? (Transfer patients may have lab values available)**

Yes  No

**If Yes, which findings?**

- |  |  |
|--|--|
| <input type="checkbox"/> Hyperthermia > 38.3° C (101.0° F) | <input type="checkbox"/> Acutely Altered Mental Status                 |
| <input type="checkbox"/> Hypothermia < 36° C (96.8° F)     | <input type="checkbox"/> Hyperglycemia > 120 mg/dL without diabetes hx |
| <input type="checkbox"/> Tachycardia > 90 bpm              | <input type="checkbox"/> Leukocytosis, WBC > 12 x 10 <sup>9</sup> /L   |
| <input type="checkbox"/> Tachypnea > 20 rpm                | <input type="checkbox"/> Leukopenia, WBC < 4 x 10 <sup>9</sup> /L      |

## **STOP!**

IF the answers to 1 AND 2 is "Yes", there is a strong suspicion of Sepsis. Continue to Question 3.

If "No" is answered, there is a low suspicion of Sepsis, continue with patient assessment and consider other causes.

**3. Are any organ dysfunction criteria present at a site remote from the new infection discovered AND not a chronic condition? (Transfer patients may have lab values available)**

- SBP < 90 mmHg or MAP < 65 mmHg MAP = ((2 x DBP) + SBP)/3
- SBP decrease > 40 mmHg from baseline
- A new or increased O<sub>2</sub> requirement to maintain SpO<sub>2</sub> > 90% (with bilateral pulmonary infiltrates)
- Creatinine > 2.0 mg/dL or Urine Output < 0.5 ml/kg/hr for more than 2 hrs.
- Bilateral Pulmonary infiltrates with PaO<sub>2</sub>/FiO<sub>2</sub> ratio < 300
- Bilirubin > 2 mg/dL
- Platelet count < 100,000
- Coagulopathy: INR > 1.5 or PTT > 60 seconds
- Lactate > 2 mmol/L

If 1 or more Organ Dysfunction Criteria are present, the patient meets criteria for **Severe Sepsis**. Follow your local protocols for treatment and expedite transport to a critical care facility.

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# Most of the stuff in question 3, I don't know

- Creatinine is a measure of renal function – have they urinated?
- $\text{PaO}_2/\text{FiO}_2$  ratio  $< 300$ , learned from blood gasses
- Bilirubin – breakdown of heme, causes jaundice
- Platelet count – CBC
- INR or PTT – Coag times, do they bleed a lot?

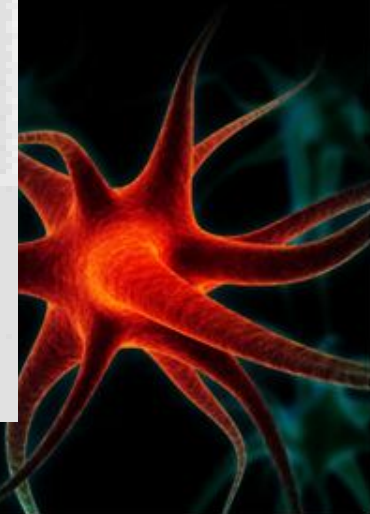


# Which brings us to Lactate

- Lactate is a product of cellular metabolism
- During anaerobic metabolism, Lactate levels increase dramatically and rapidly
- High Lactate and acidosis =
  - Lactic Acidosis
- Lactate is an outstanding marker of hypoxia at the cellular level



But I don't have a mobile lab



# Lactate levels are available!

- High end athletes use lactate levels to measure athletic performance
- CLIA
  - Clinical Laboratory Improvement Amendments
- Not so long ago BGL testing wasn't available on ambulances



# One last look

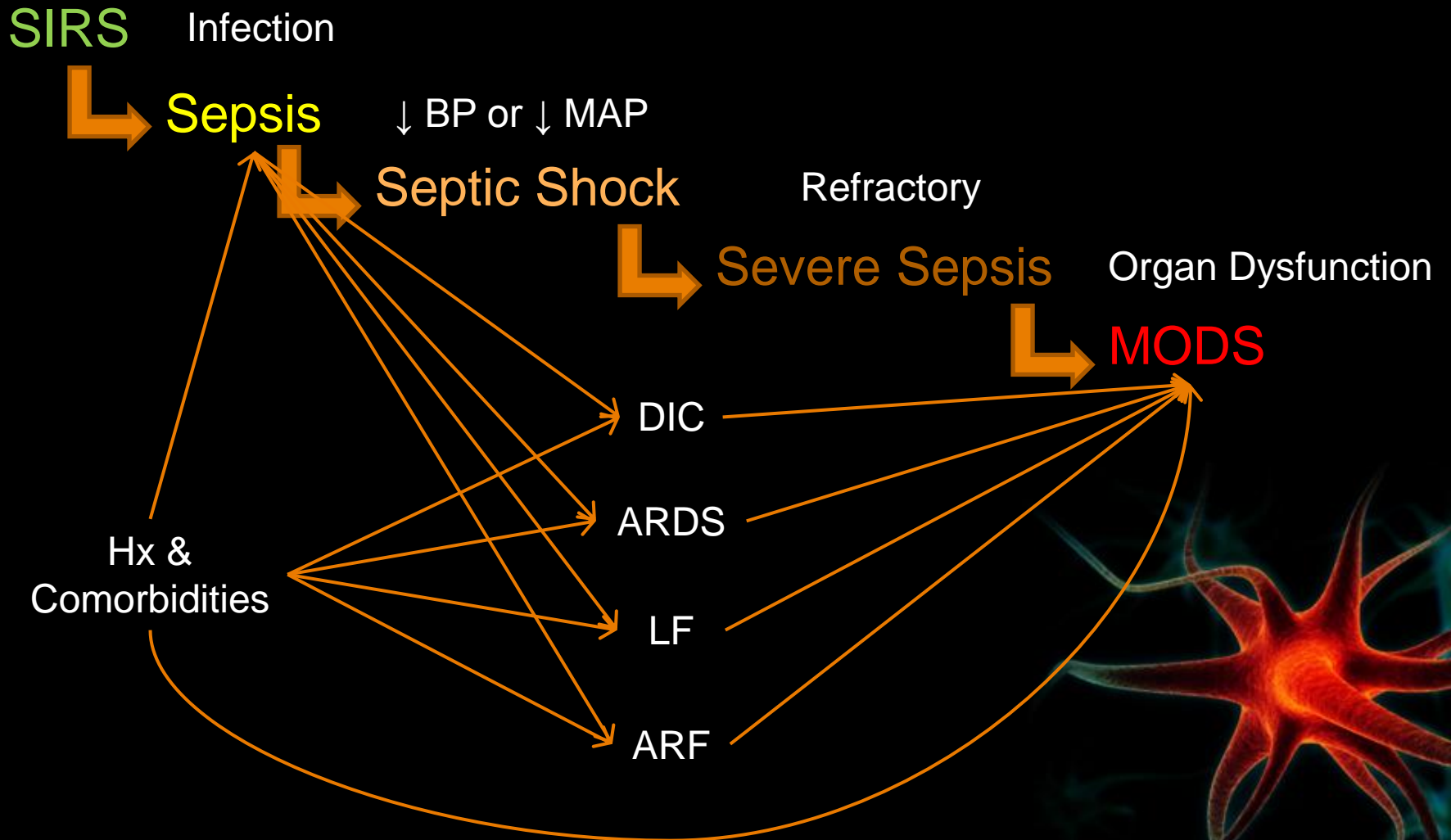
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# Remember, its insidious

- Once you have convinced yourself that the patient is Septic make sure you convince others
- Good radio report
- Better turnover report
- Supporting documentation



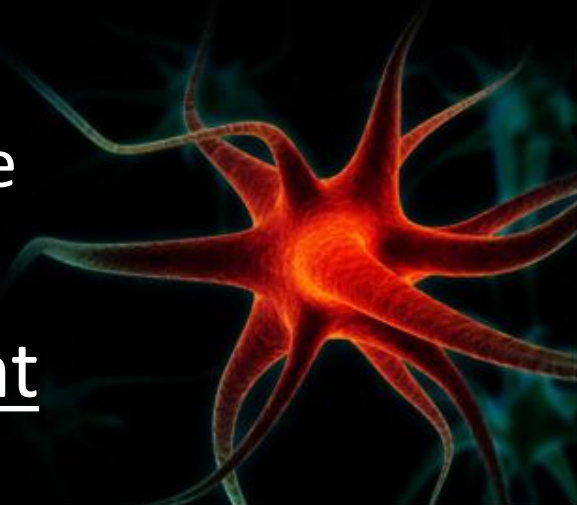
# Lets talk peds

- Pediatric compensatory mechanisms are much stronger than adults
- When peds crash, they crash bad and don't do well
- Focus on aggressive, early treatment and prevention of the crash



# SIRS is different in Kids

- Meeting SIRS in kids
  - Only 4(5) criteria
    - Fever
    - Tachycardia (Bradycardia >1 y/o)
    - Tachypnea
    - WBC count
  - The fifth criteria is Altered Mental Status – can be very subtle in these patients
- One MUST be fever or WBC count

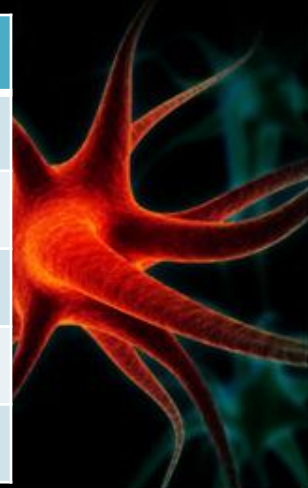


# I have a table if you want it

- The criteria for Tachycardia, Tachypnea, BP and MAP are different for kids

Age Group <sup>a</sup>	Heart Rate, Beats/Min <sup>b,c</sup>		Respiratory Rate, Breaths/Min <sup>d</sup>	Leukocyte Count, Leukocytes $\times 10^3/\text{mm}^3$ <sup>b,c</sup>	Systolic Blood Pressure, mm Hg <sup>b,c,e,f</sup>
	Tachycardia	Bradycardia			
0 days to 1 wk	>180	<100	>50	>34	<65
1 wk to 1 mo	>180	<100	>40	>19.5 or <5	<75
1 mo to 1 yr	>180	<90	>34	>17.5 or <5	<100
2-5 yrs	>140	NA	>22	>15.5 or <6	<94
6-12 yrs	>130	NA	>18	>13.5 or <4.5	<105
13 to <18 yrs	>110	NA	>14	>11 or <4.5	<117

Age Group	Goal MAP
<u>Neonate</u>	45 - 65 mmHg
<u>1-11 months</u>	50 - 70 mmHg
<u>1-5 years</u>	55 - 75 mmHg
<u>6-10 years</u>	60 - 80 mmHg
<u>11 years and older:</u>	65 - 85 mmHg



# Treating Kids

- Kids have strong hearts
- They handle fluids better than adults
- 3 x 20ml/kg boluses in the first 30 minutes
- Pressors aggressively
- O<sub>2</sub> is critical for these kids



# What happens after you drop them off?

- Each hospital has different standards
- Most suspected sepsis patients will get the following
  - CBC, CMP/BMP, troponin, lactate, ABG, PT/PTT or INR, Type and Hold, Blood cultures x 2, sputum cultures, UA, urine cultures, Chest x-ray and a 12-lead

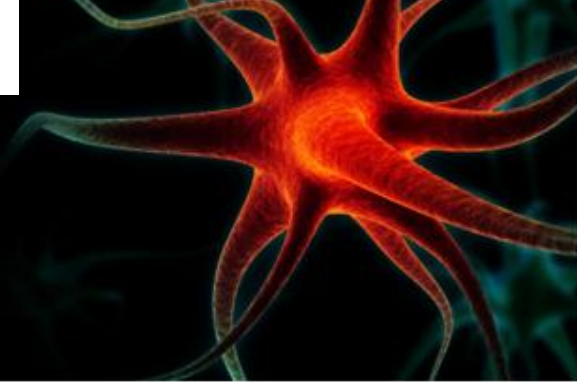
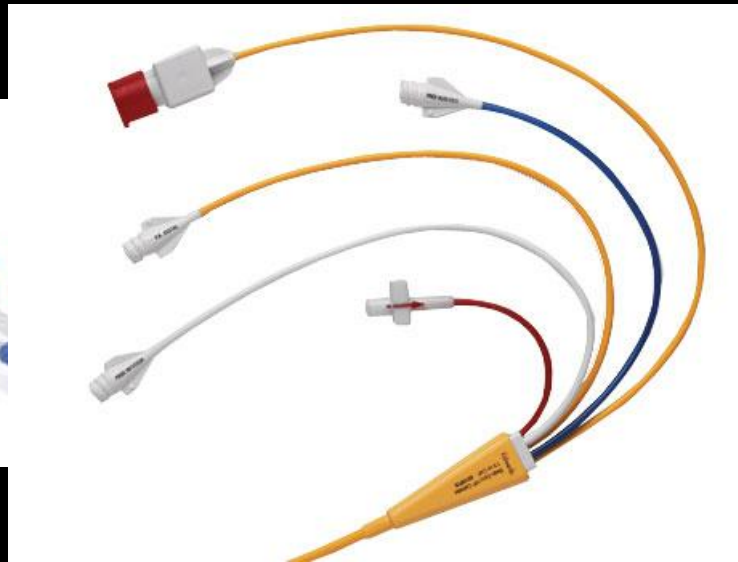


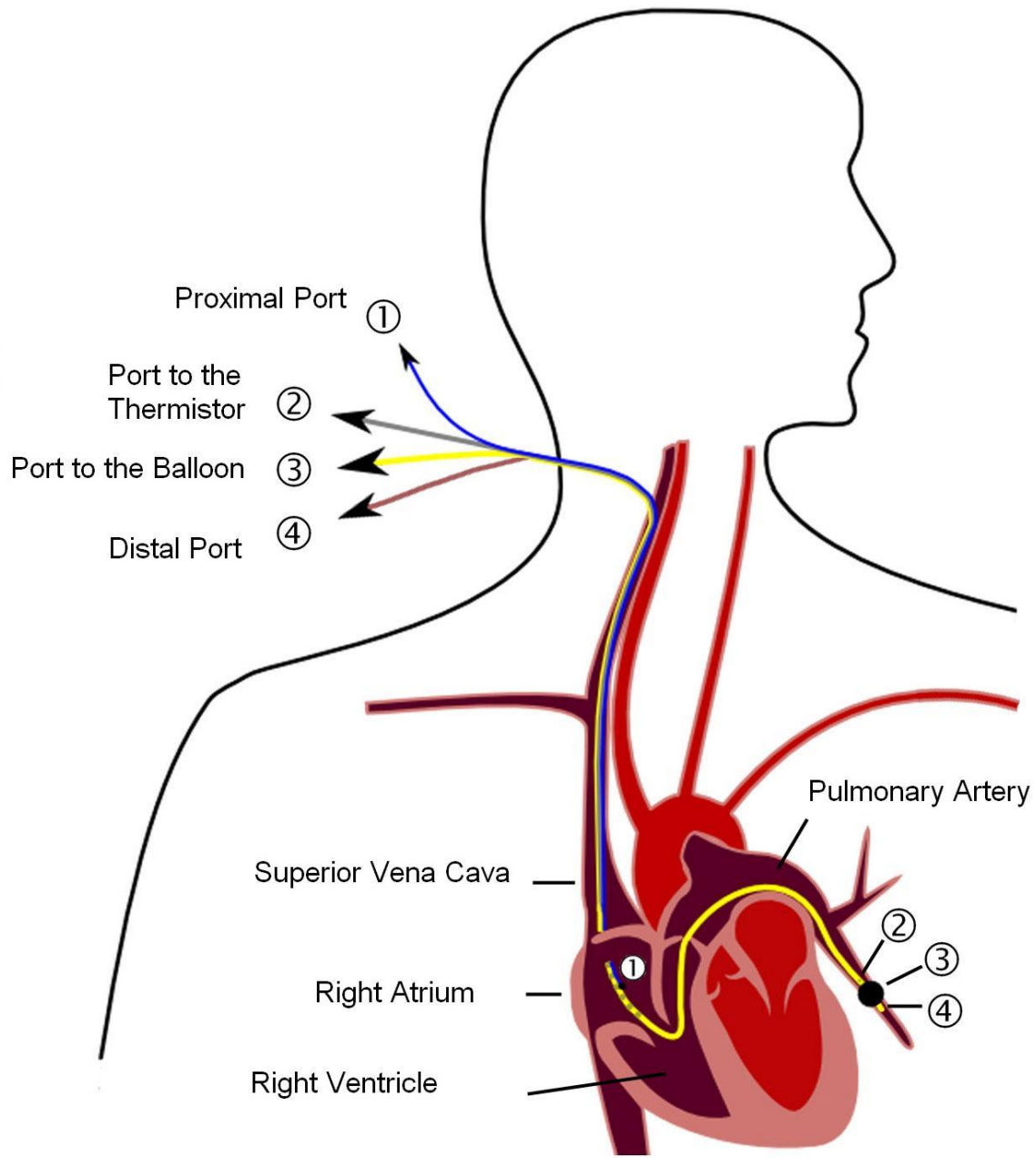
# Ventilators

- The oxygen demands on the septic patient are extremely high
- Many patients get intubated
- ALI/ARDS
  - Reverse ventilations
  - Can control  $FiO_2$
  - Easier to dial in  $O_2$  to meet demand
- Long times on the vent can worsen outcomes



One of these gets put in





# Why a Swan-Ganz?

- Several Measurements
  - SvO<sub>2</sub>
  - PAW
  - Temperature
  - Cardiac Output
  - CVP
- Carries a high risk, benefits are questionable



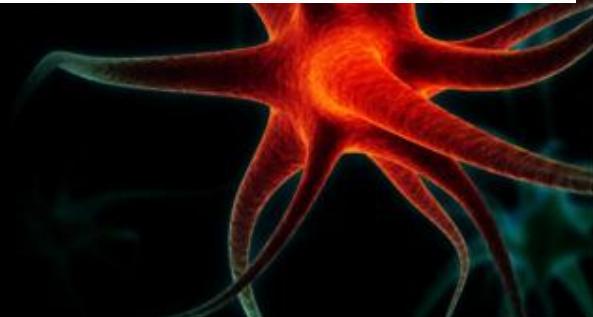
# Vasopressors

- Norepinephrine
  - Levophed – Leave 'em dead  $\alpha_1$  agonist
- Dopamine
  - Mainstay of EMS, dose dependent
- Dobutamine
  - Huge Inotrope and Chronotrope
- Milrinone
  - Primacor, Inotrope and Vasodilator



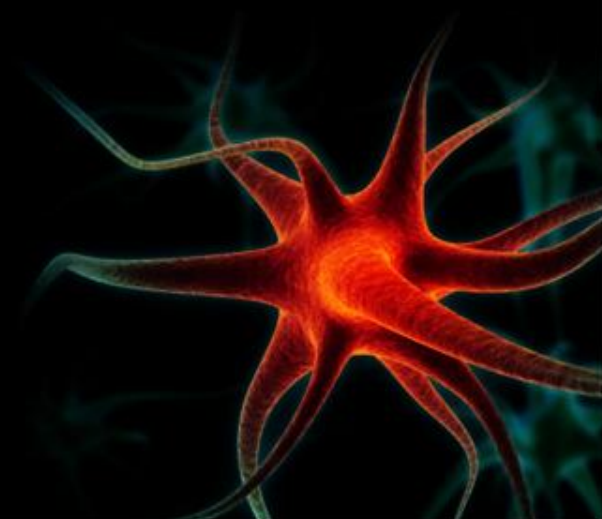
# Antibiotics

RESPIRATORY SOURCE	URINARY SOURCE	ABDOMINAL SOURCE	SKIN/SOFT TISSUE SOURCE
<p><b>Choose one:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Cefepime 2g IV x 1 NOW</li> <li><input type="checkbox"/> Piperacillin/Tazobactam 4.5g IV x 1 NOW</li> <li><input type="checkbox"/> Imipenem/Cilastatin 500 mg IV x 1 NOW</li> </ul> <hr/> <p><b>Plus choose one:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Gentamicin 4mg/kg IV x 1 NOW</li> <li><input type="checkbox"/> Moxifloxacin 400 mg IV x 1 NOW</li> </ul> <hr/> <p><b>Plus:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Vancomycin 1g IV x 1 NOW</li> </ul>	<p><b>Choose one:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Cefepime 2g IV x 1 NOW</li> <li><input type="checkbox"/> Ciprofloxacin 400 mg IV x 1 NOW</li> <li><input type="checkbox"/> Piperacillin/Tazobactam 3.375g IV x 1 NOW</li> <li><input type="checkbox"/> Gentamicin 4mg/kg IV x 1 NOW</li> </ul> <hr/> <p style="text-align: center;"><b>MENINGITIS</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Dexamethasone 10 mg IV <b><u>GIVEN BEFORE OR WITH 1<sup>ST</sup></u></b> dose of antibiotics <b><u>PLUS</u></b> Ceftriaxone 2 g IV <b><u>PLUS</u></b> Vancomycin 1 g IV</li> <li><input type="checkbox"/> <b><u>PLUS</u></b> If &gt;age 50 or immunocomprised give Ampicillin 2 g IV</li> </ul>	<p><b>Choose one regimen:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Ampicillin/Sulbactam 3 g IV x 1 NOW</li> </ul> <p style="text-align: center;"><b><u>OR</u></b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Imipenem/Cilastatin 500 mg IV x 1 NOW</li> </ul> <p style="text-align: center;"><b><u>OR</u></b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Metronidazole 500 mg IV x 1 NOW <b><u>PLUS</u></b> Ciprofloxacin 400 mg IV x 1 NOW <b><u>PLUS</u></b> Vancomycin 1 g IV x 1 NOW</li> </ul>	<p><b>Choose one:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Piperacillin/Tazobactam 3.375g IV x 1 NOW</li> <li><input type="checkbox"/> Imipenem/Cilastatin 500mg IV x 1 NOW</li> </ul> <hr/> <p><b>Plus:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Vancomycin 1g IV x 1 NOW</li> </ul> <hr/> <p><b>Plus:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Clindamycin 600 mg IV X 1 NOW</li> </ul>



# Other Meds

- Steroids
  - Reduce inflammation, increase infection
- Xigris
  - Controversial
    - Anti-inflammatory
    - Anti-thrombotic
    - Pro-Thrombolytic



# Summation

- Identify and explain the SIRS to MODS continuum
- Broaden and Deepen your understanding of Sepsis
- Discuss the Pathophysiology of the Sepsis Cascade
- Clarify the role of EMS in Sepsis



# Thank you for your time!

- References available upon request

Thomas P. Meyer, MICP, Southern Region EMS Council  
10/19/2011

