Early Recognition: What is Happening Physiologically to Cause the Signs and Symptoms of Sepsis

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ADVANCING NURSING THROUGH KNOWLEDGE & INNOVATION

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DISCLOSURES FOR KATHLEEN VOLLMAN

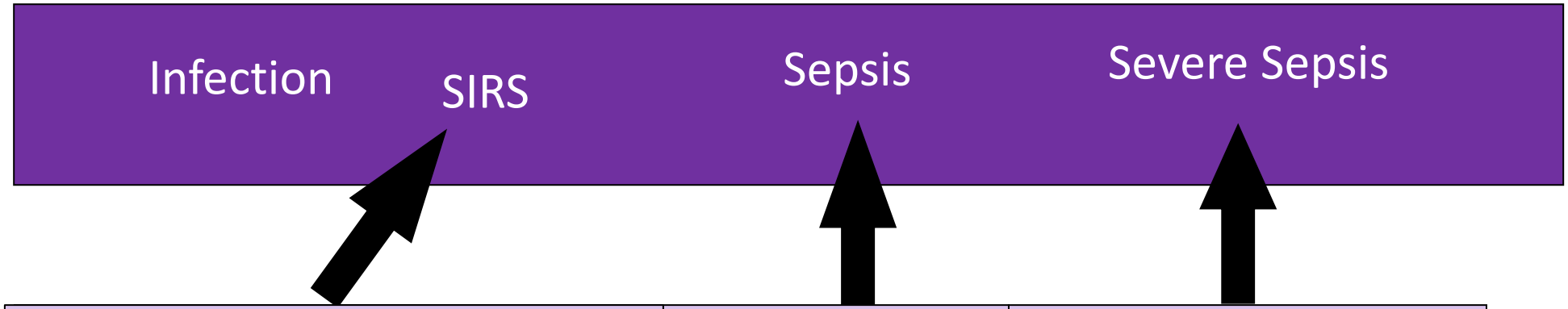
- Consultant-Michigan Hospital Association Keystone Center
- Subject matter expert HRET: CAUTI, CLABSI, HAPI, Sepsis, Safety culture for HRET
- Consultant and speaker bureau:
  - Stryker Sage
  - Potrero Medical
  - La Jolla Pharmaceutical
  - Baxter Healthcare

Objectives

- Explore the physiological derangements associated with sepsis and connected them to the signs and symptoms the patients display.
- Determine the strategies and tools that can help the nurse with early recognition of the septic patient.


Early Recognition is Key
A Priority Action Step

Severe Sepsis: Defining a Disease Continuum



Adult Criteria

A clinical response arising from a nonspecific insult, including ≥ 2 of the following:

Temperature:> 38°C or < 36°C
Heart Rate: > 90 beats/min
Respiration: > 20/min
WBC count: > 12,000/mm^3, or < 4,000/mm^3, or > 10% immature neutrophils
BG: < 140 ml/dl in non-diabetic

SIRS with a presumed or confirmed infectious process

Sepsis
with ≥1 sign of organ dysfunction, hypoperfusion or hypotension.

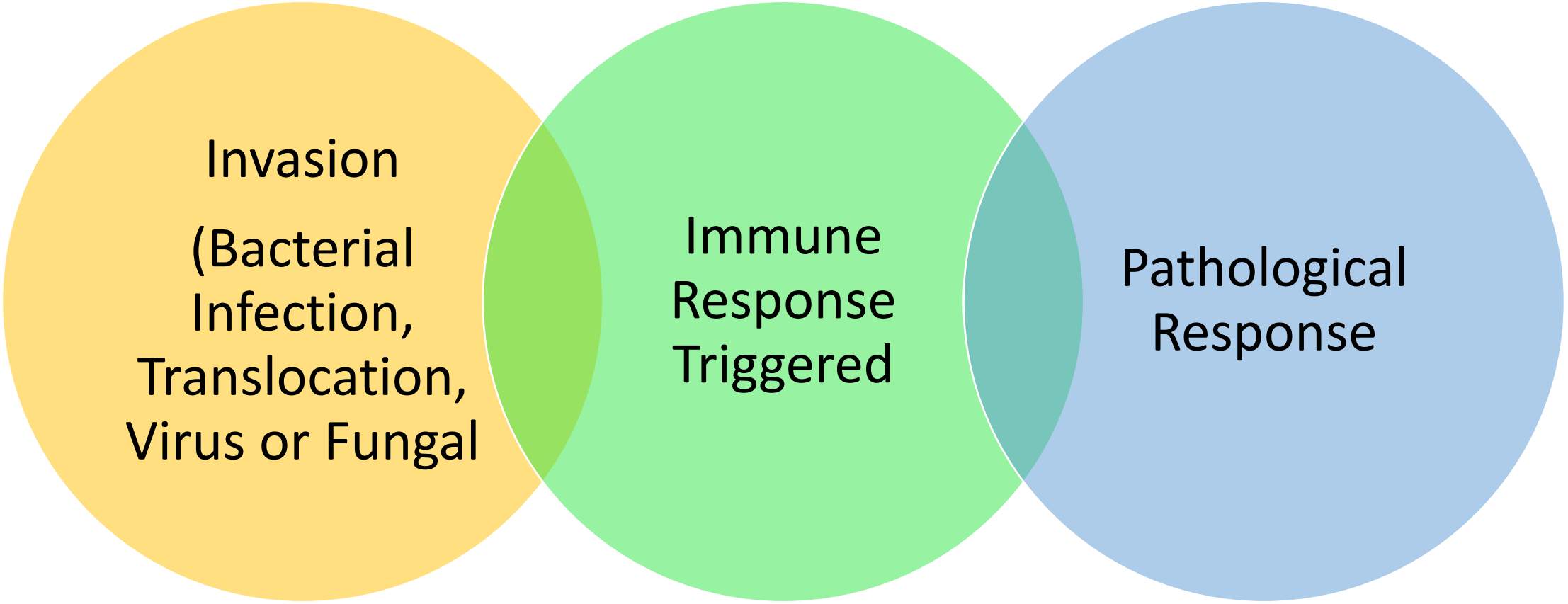
Examples:

- Cardiovascular (refractory hypotension)
- Renal
- Respiratory
- Hepatic
- Hematologic
- CNS
- Unexplained metabolic acidosis

Shock

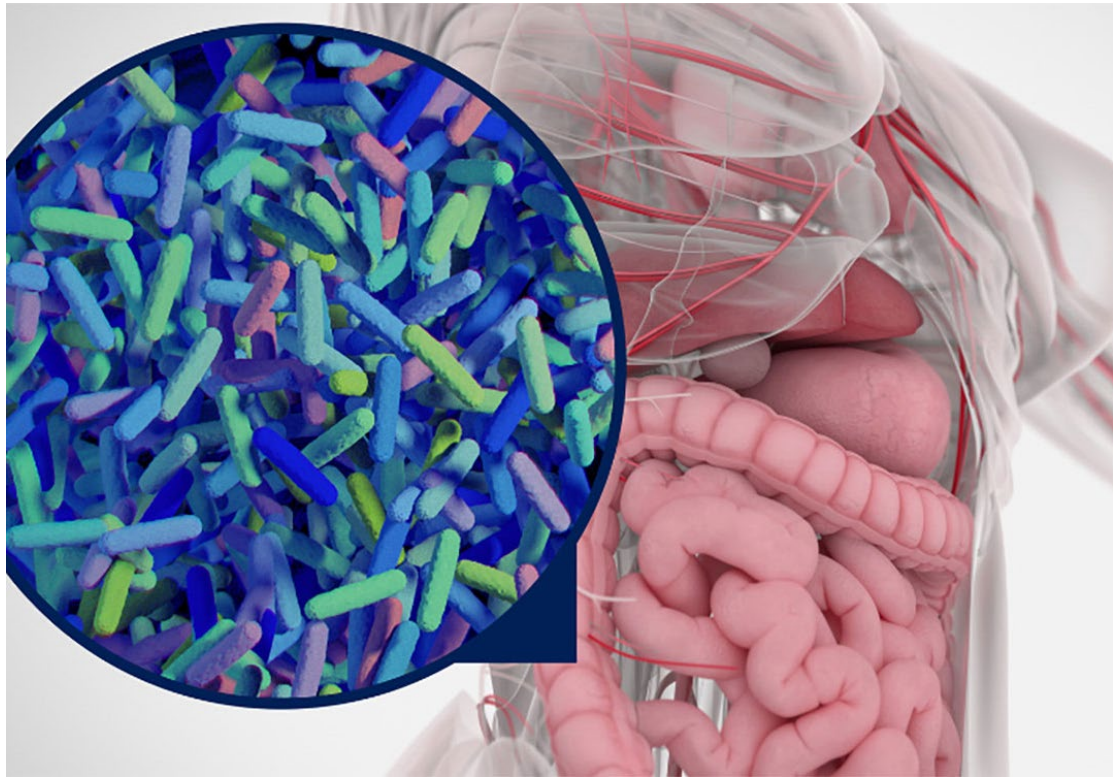
SIRS = Systemic Inflammatory Response Syndrome
Bone et al. *Chest.*1992;101:1644-1654.

The Process

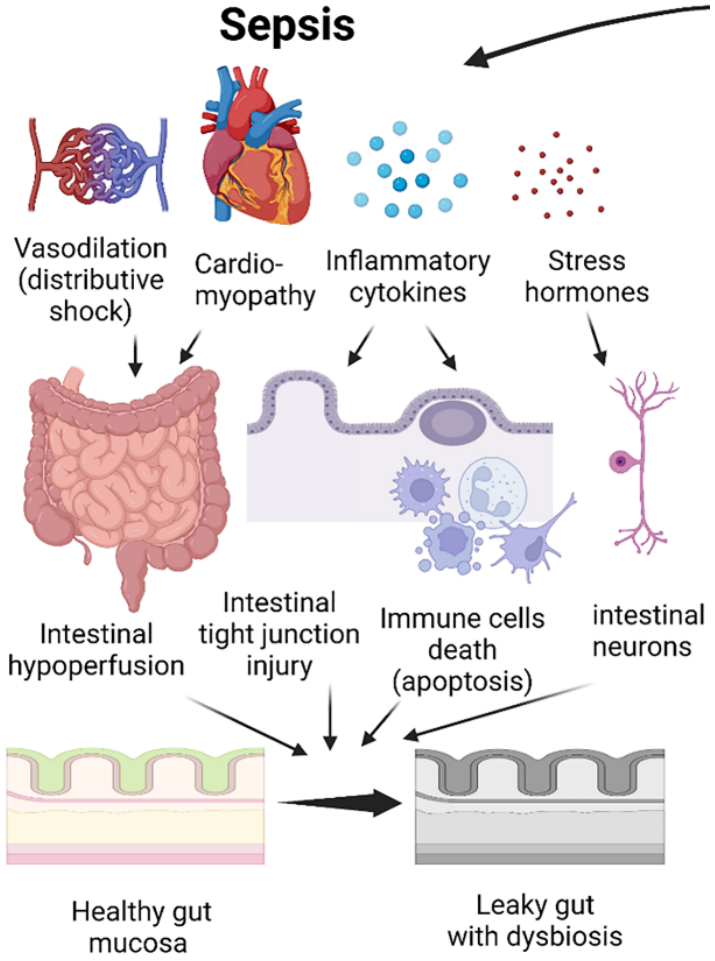

Invasion
(Bacterial Infection, Translocation, Virus or Fungal
Immune Response Triggered
Pathological Response

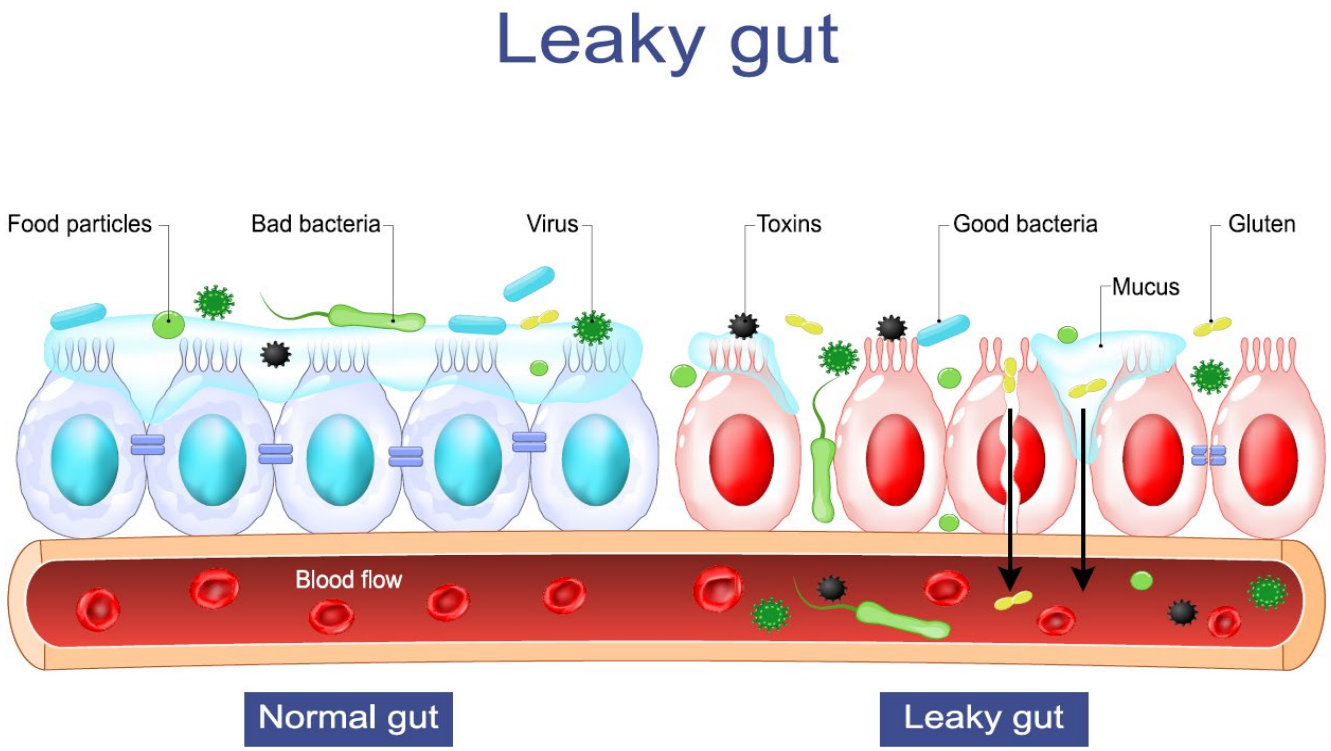
The Gut Microbiome

- Normally live in harmony
- Helps us regulate metabolic and immune functions
- Supports the barrier between the gut & blood stream
- 3 major bacteria
  - Firmicutes, Bacteroidetes, and Actinobacter.
- Care practices in critical illness disrupt the gut
  - Antibiotics (antianaerobic), PPI, enteral feeds make more aerobic changing the diversity
  - 90% of common organisms lost in first couple of hours of critical illness



https://extension.sdstate.edu/human-gut-microbiome





- The leaky gut syndrome refers to a status with which there is an increased intestinal permeability allowing the translocation of microbial molecules (endotoxins) from the gut into the blood circulation

Wiwat Chancharoenthana, et al. *Clin Sci (Lond)* 26 April 2023; 137 (8): 645–662. doi: https://doi.org/10.1042/CS20220777

Endotoxin

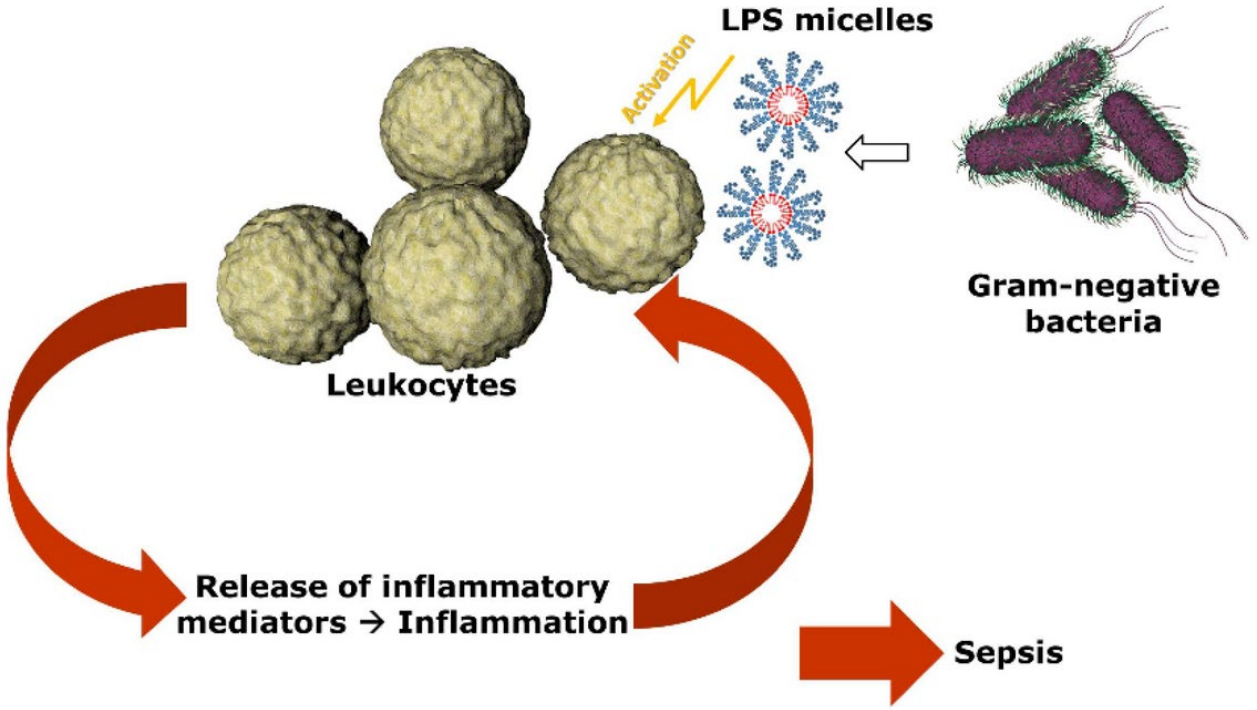
- Endotoxin is a lipopolysaccharide component of the outer cell membrane of Gram-negative bacteria which can trigger a brisk host response and multiple types of acute organ dysfunction

Sources of Endotoxin in the blood

External Bacteria
- **E-coli**
- **Pseudomonas aeruginosa**
- **Klebsiella**

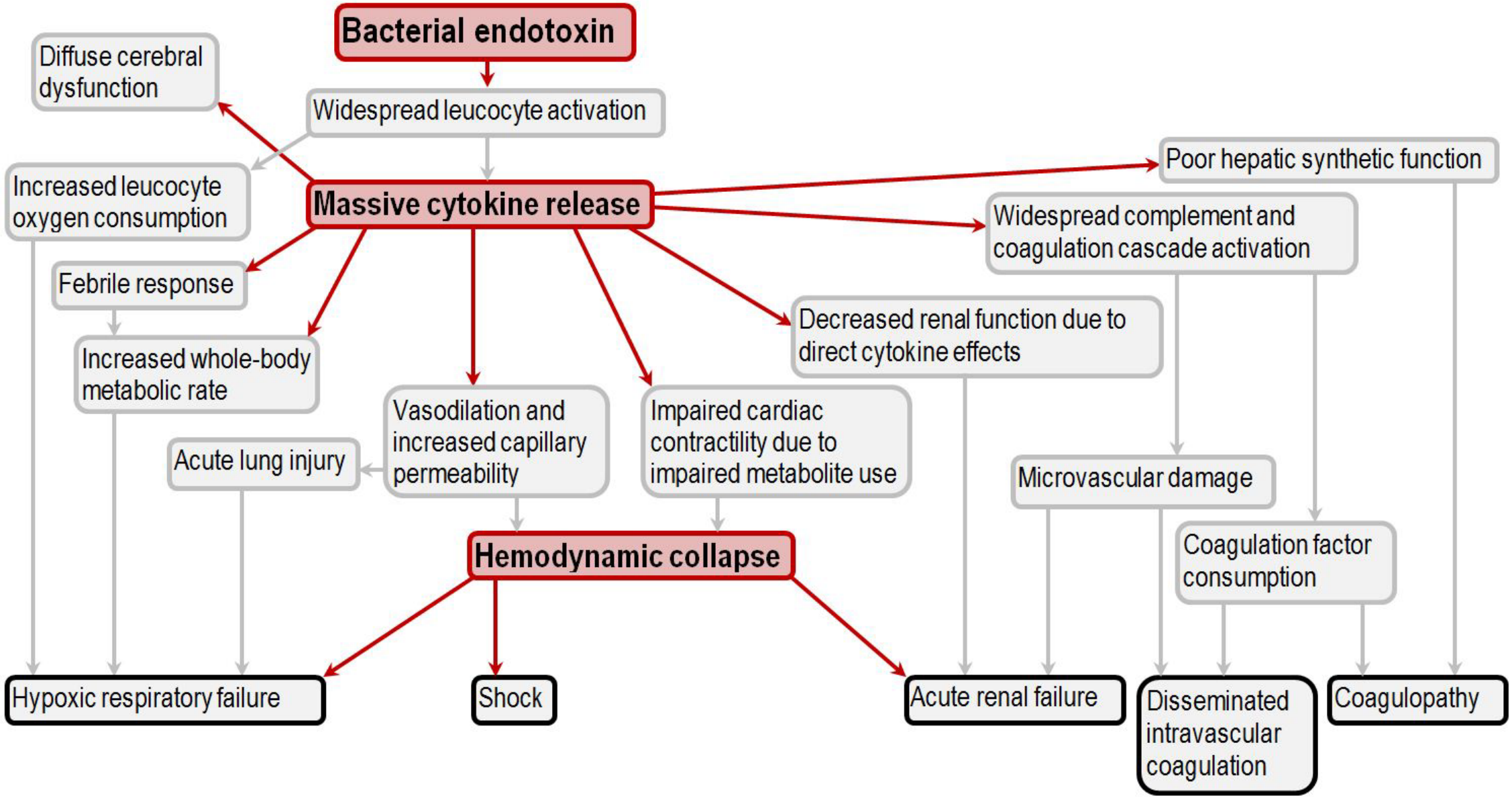
Gut translocation (70%)

Potent Trigger of Innate Immunity

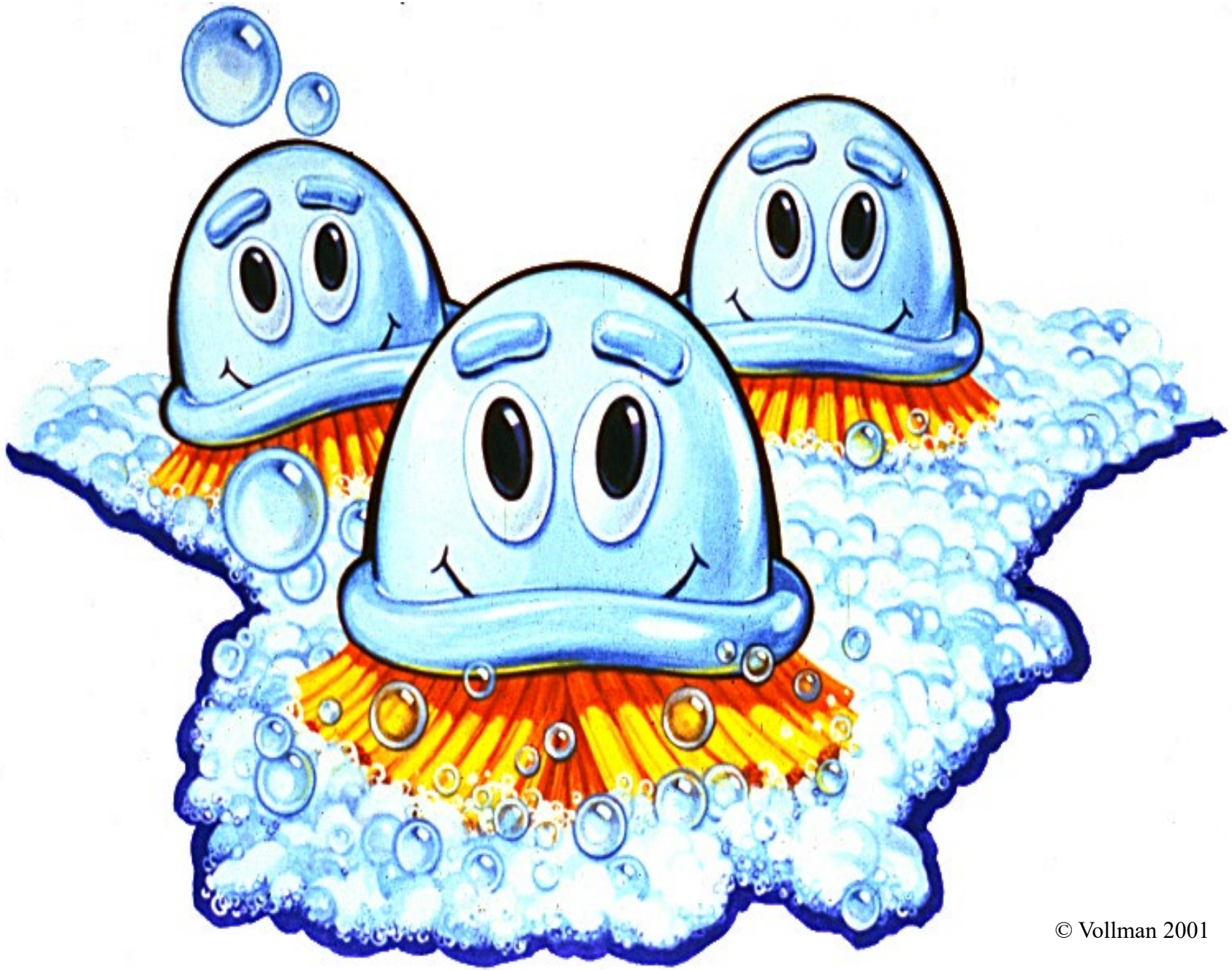


Kellum JA, et al. Critical Care; 2023:27:400

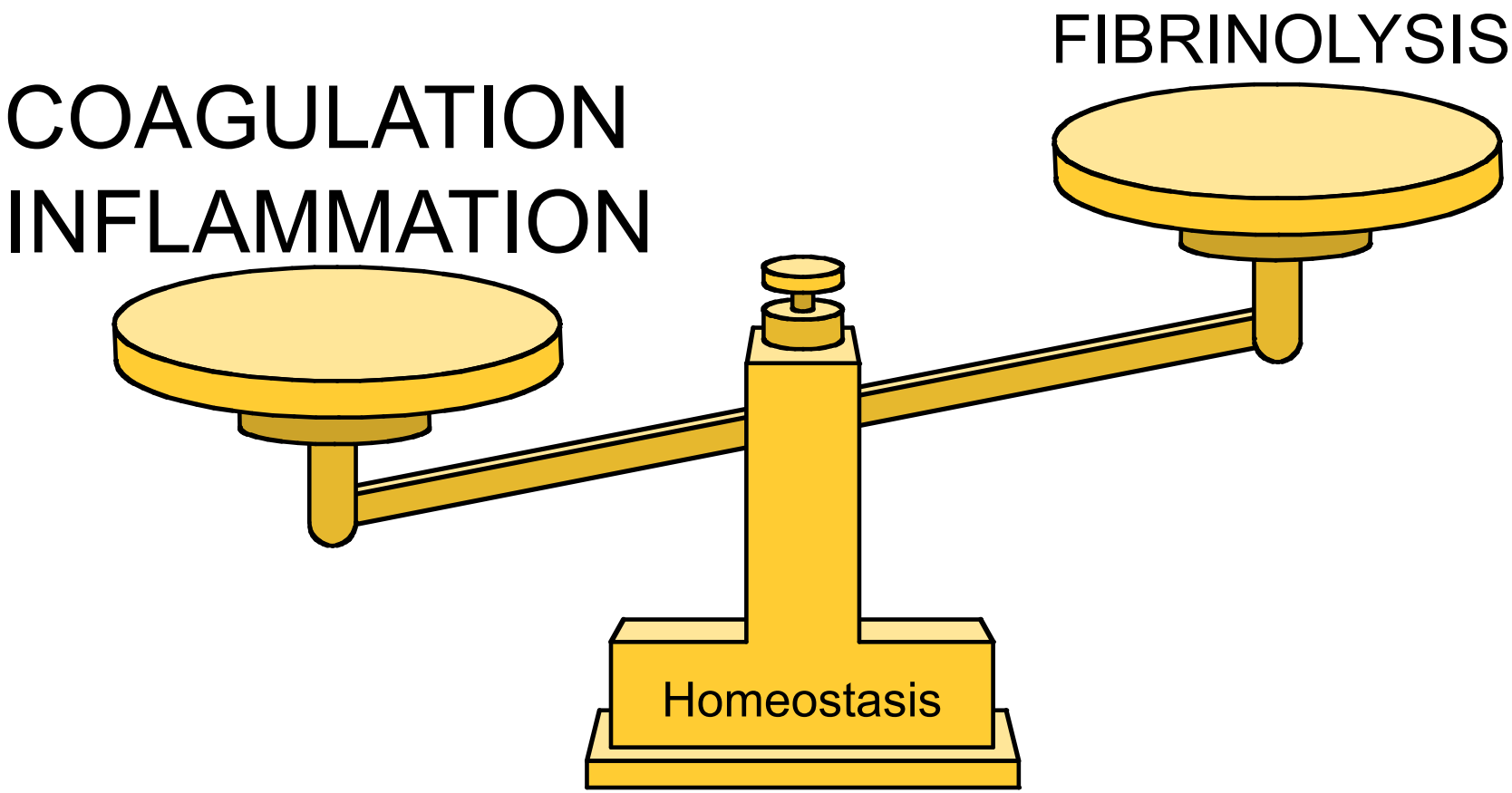
Harm, S., et al. *Sci Rep* **11**, 4192 (2021). https://doi.org/10.1038/s41598-021-83487-4



https://derangedphysiology.com/main/required-reading/sepsis-and-infections/Chapter-143/pathogenesis-multi-organ-system-failure-sepsis

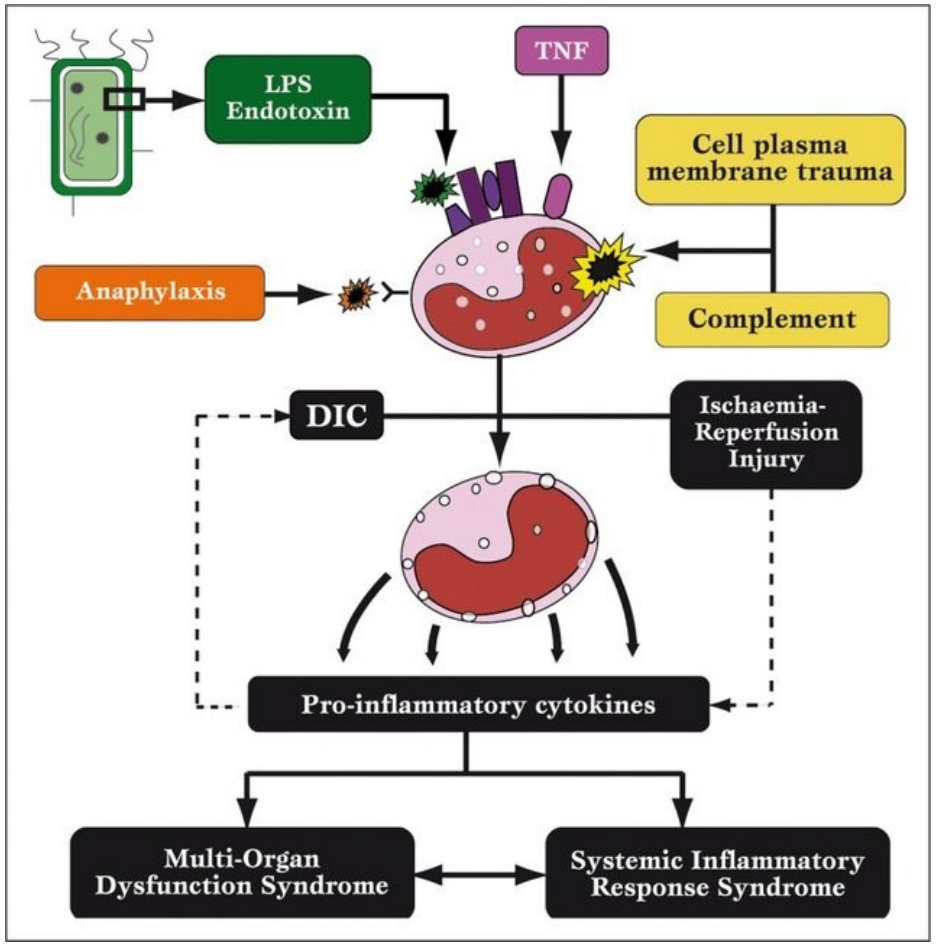


Homeostasis Is Unbalanced in Severe Sepsis



Carvalho AC, Freeman NJ. *J Crit Illness* 1994;9:51-75.
Kidokoro A, et al. *Shock* 1996;5:223-8.
Vervloet MG, et al. *Semin Thromb Hemost* 1998;24:33-44.

Pathophysiologic Characteristics in Severe Sepsis



Maldistribution of blood flow

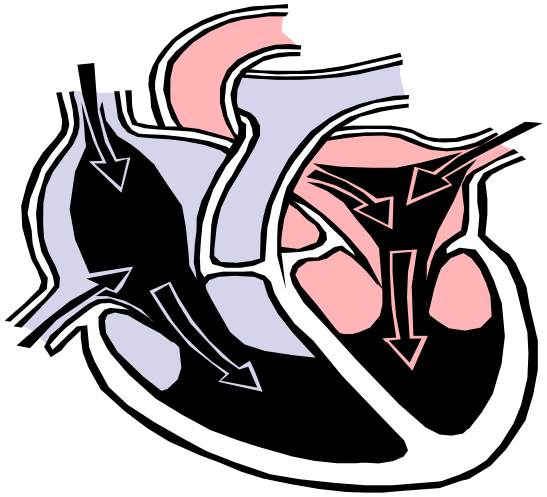
Imbalance of oxygen supply & demand

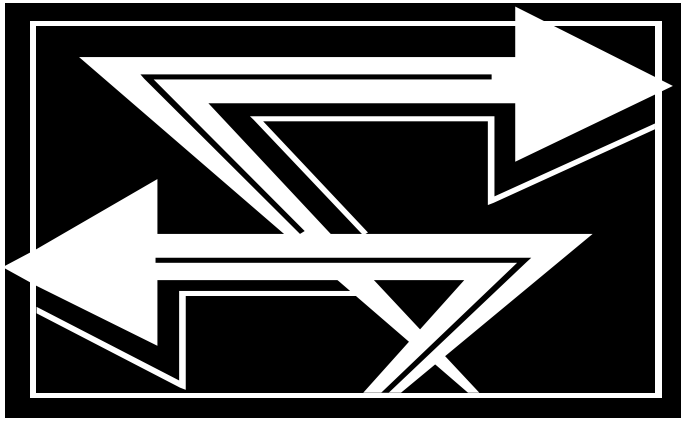
Metabolic alterations & activation of the stress response

Jaffer U, et al. HSR Proceedings in Intensive and Cardiovascular Anesthesia 2010;2;161-175

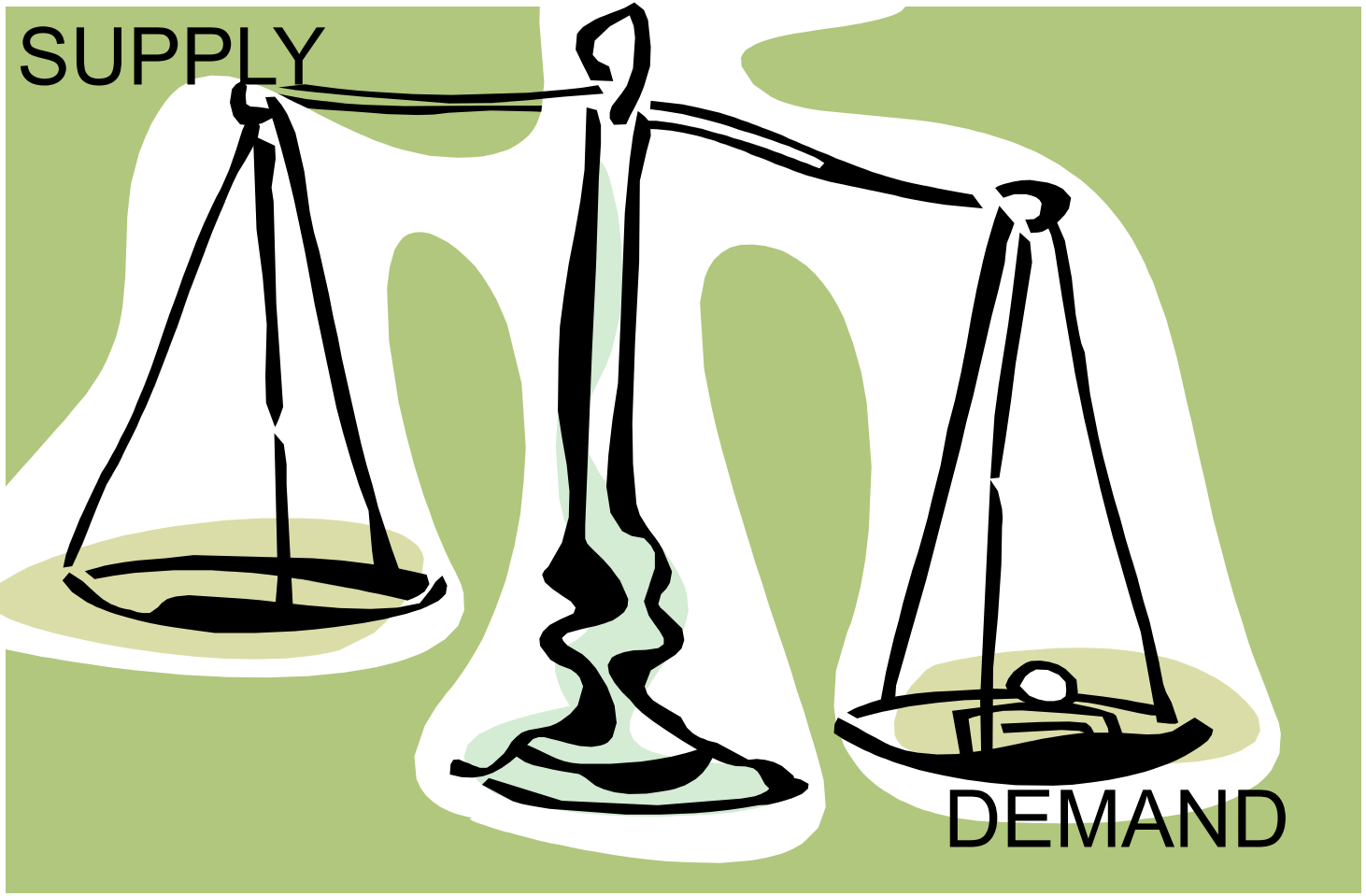
Maldistribution of Blood Flow

- Mechanical obstruction
  - Micro-emboli
  - Increased blood viscosity
- Systemic & local mediator & ion influence
  - Constriction vs. dilation
- Loss of regulatory activities/endothelial cell injury
  - Reactive hyperemia
  - Anticoagulation
  - Leaky membranes



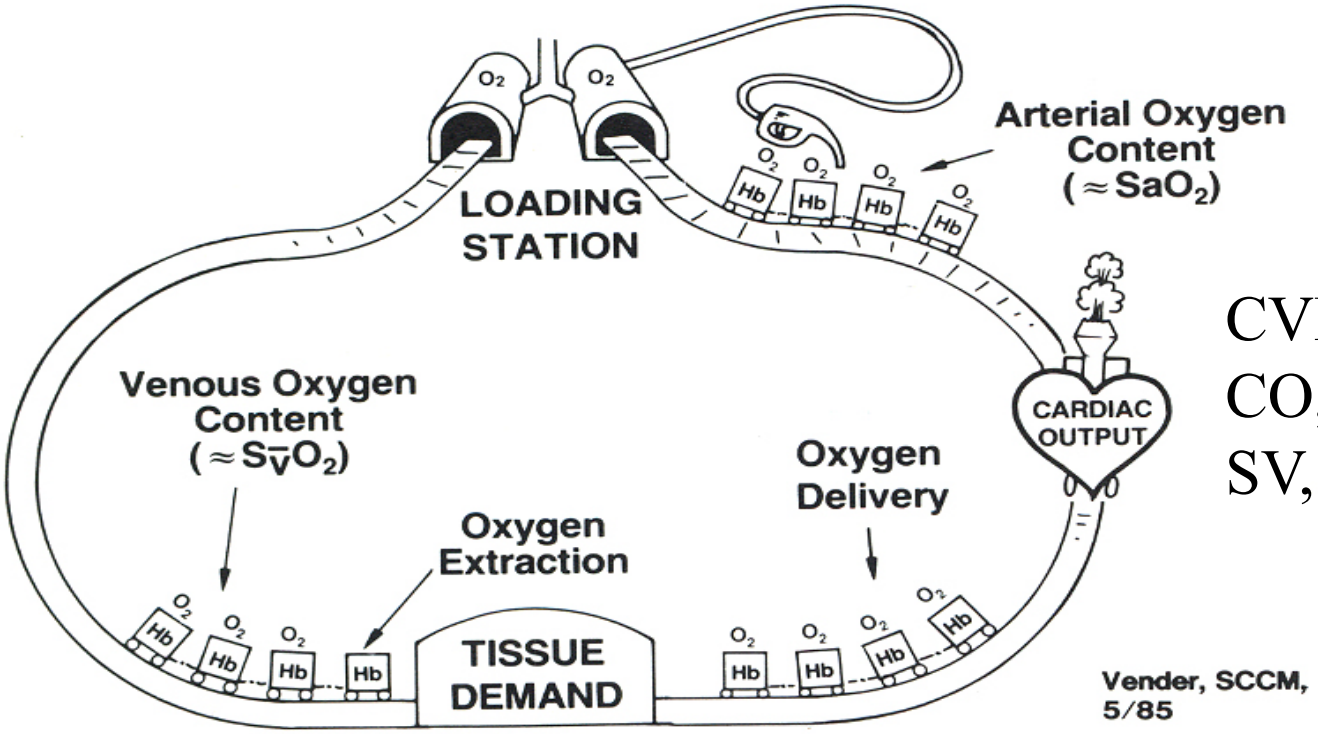


Imbalance of Oxygen Supply & Demand



OXYGEN SUPPLY/DEMAND DYNAMICS

- O_2 Supply
- O_2 Transport
  - Volume
  - Hgb
  - Cardiac performance
- O_2 Demand



CVP, CO, CI, SV, SVI

Figure 9d Mixed venous oxygen saturation.

O_2 Supply/Demand Compensatory Mechanisms

- Improve pulmonary gas exchange
- Increase oxygen delivery
- Alter the distribution of blood flow

O_2 Supply Debt

Metabolic Alterations & The Stress Response

Initiation of the Stress Response

Sympathetic Nervous System Activation

Hypothalamus Activation

Metabolic Alterations & The Stress Response

SNS Activation

- Gut translocation
- ↑ BMR
- Inhibition of insulin secretion
- Inhibition of glucose uptake by the tissues

Hypothalamus Activation

- Adrenal cortex stimulation
- Changes in carbohydrate, protein & fat metabolism resulting in ↑ glucose concentration

Pathologic Response

Infection

- Local diffuse inflammation
- Fever
- Immune cell dysfunction
- Early coagulopathy

Severe Sepsis

- Cytokine storm
- Coagulopathy & platelet dysfunction
- Organ Dysfunction

Septic Shock

- Hypotension/hypoperfusion
- Vasopressor dependent
- MODS/High SOFA score
- High mortality

Adapted from Endotoxin, the Phantom Menace of Sepsis Presented by Mark Tideswell & Debra Foster, Sepsis Alliance

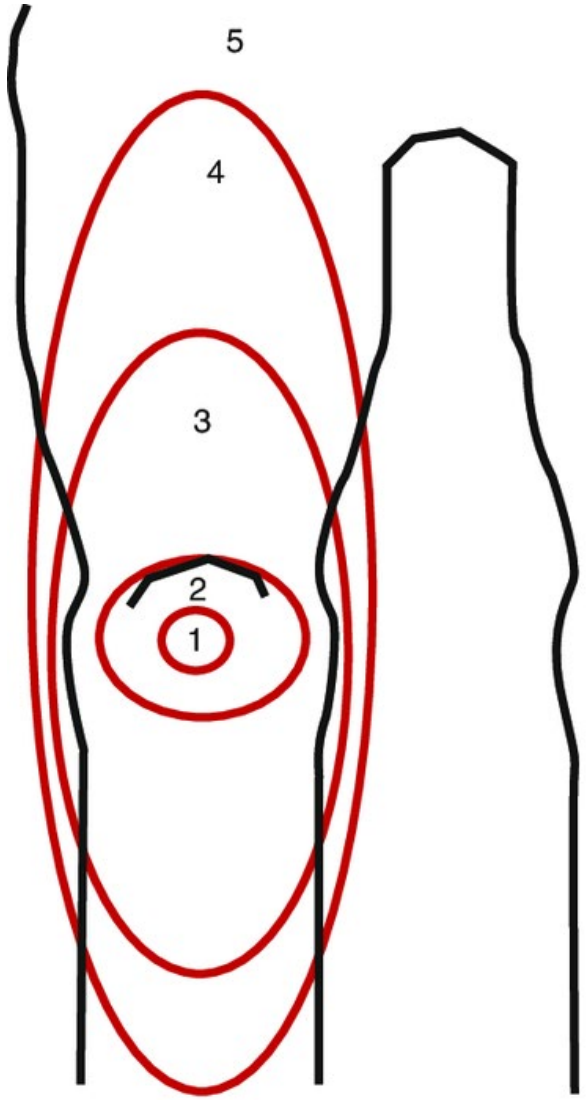
Signs & Symptoms of Sepsis

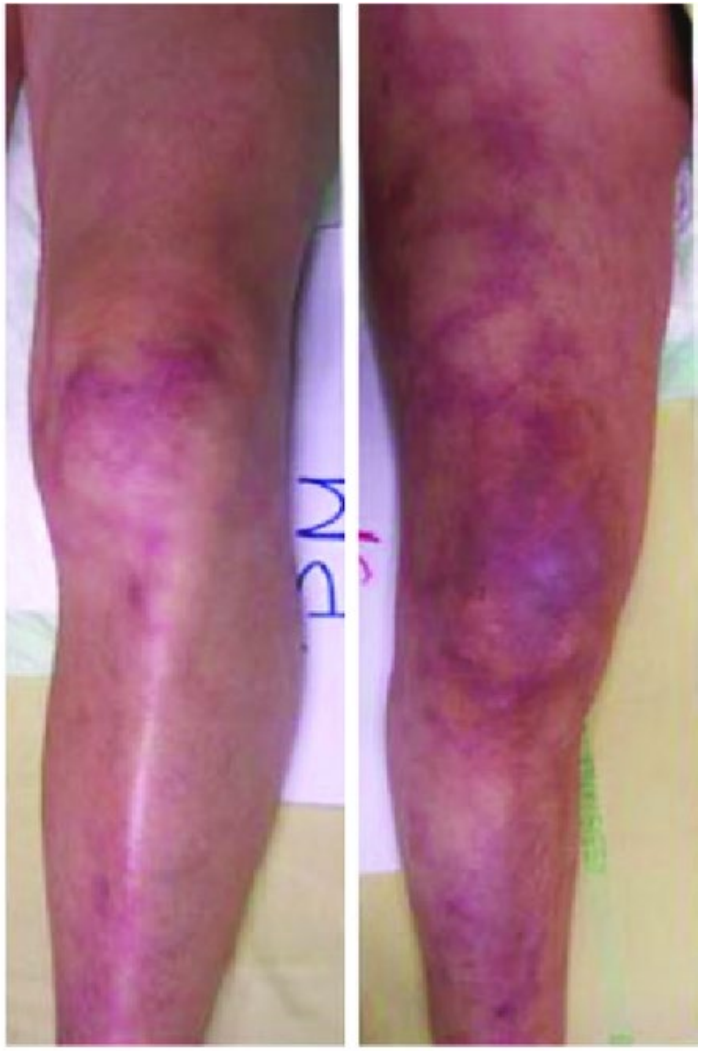
Chills
Alteration in LOC
Tachypnea
Unexplained metabolic acidosis
↑Heart rate
Altered blood pressure

↓Platelets
↑Bands
↓Skin perfusion
↓Urine output (adult > .5 ml/kg/hr)
Poor capillary refill
Hyperglycemia
Purpura/petechia
Skin mottling

Levy M, et al. *Crit Care Med* 2003;31:1250-6.

Mottling

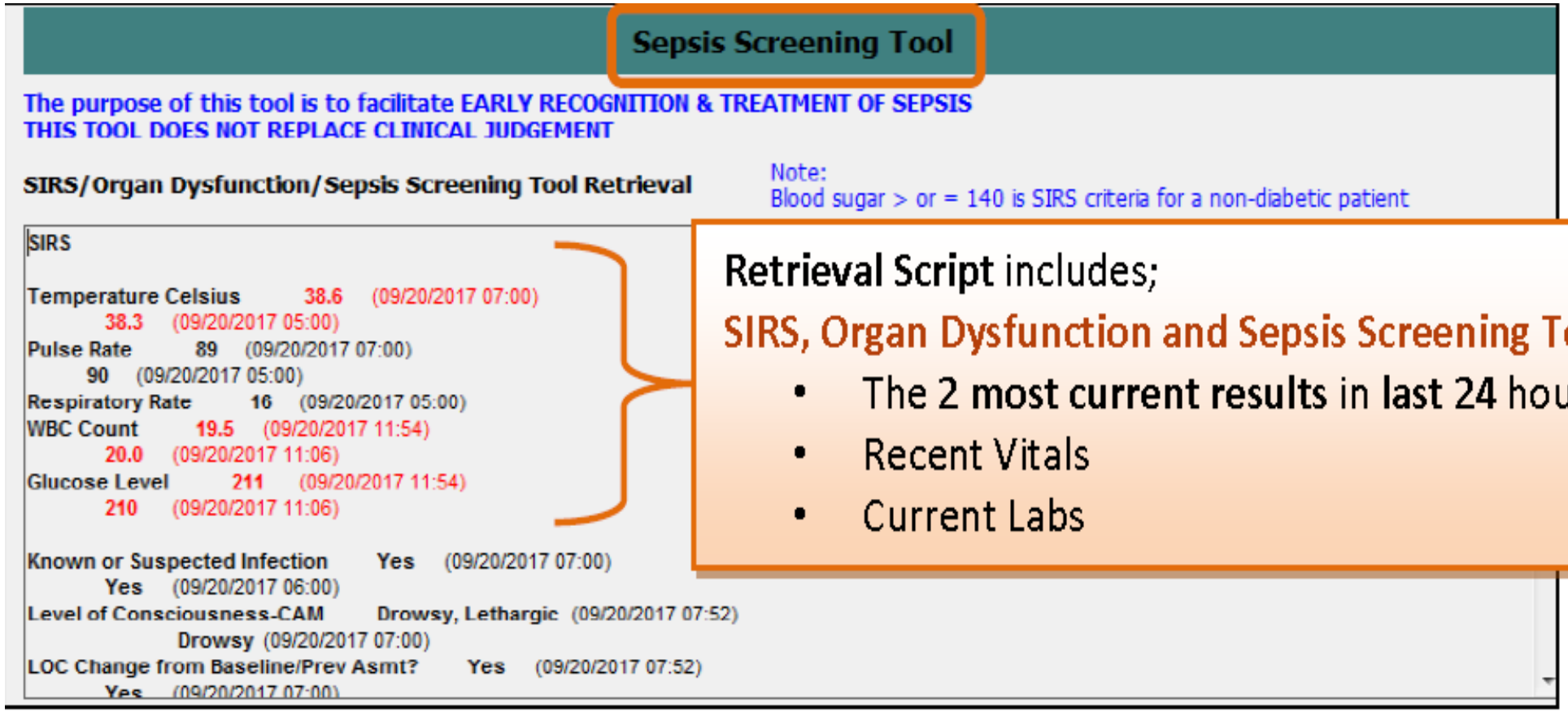




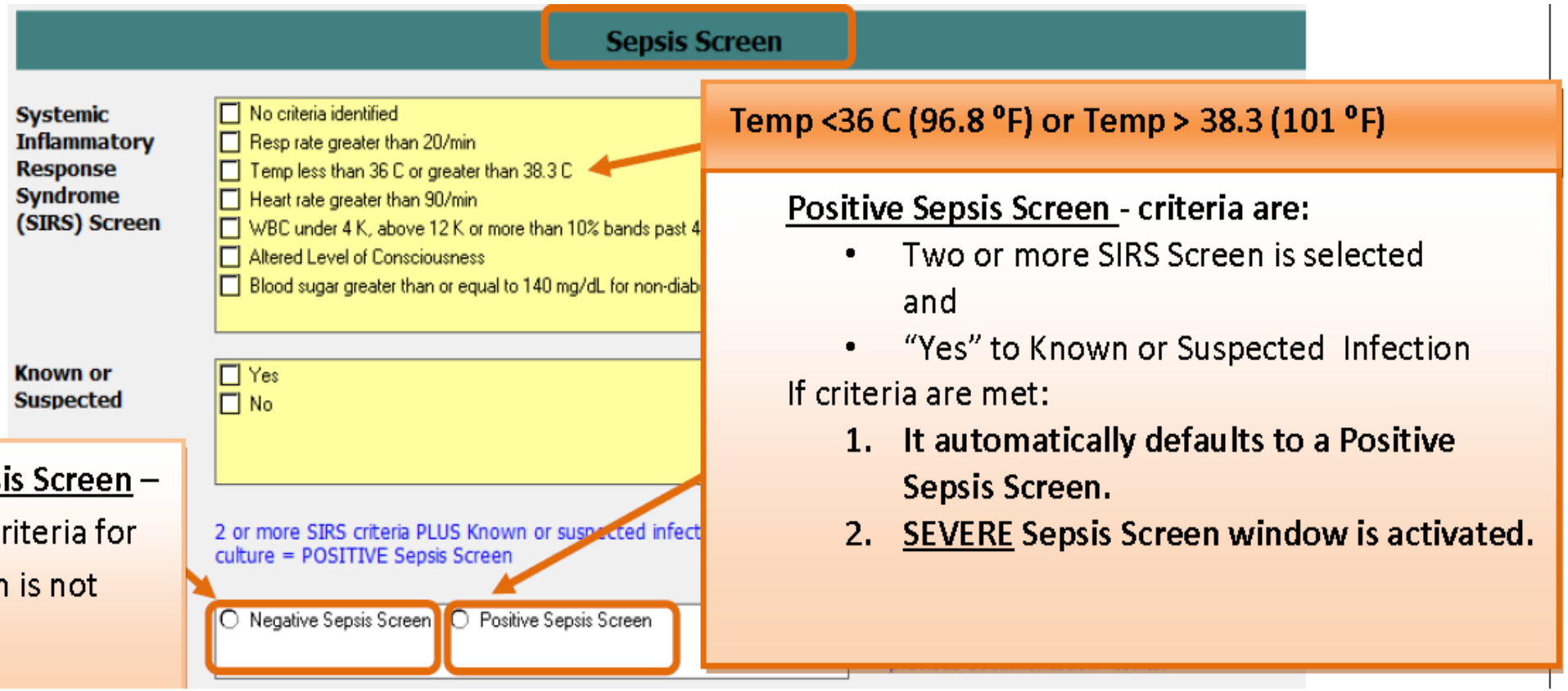
SCORE 2

SCORE 4

Electronic Routine Screening



Electronic Routine Screening



Temp <36 C (96.8 °F) or Temp > 38.3 (101 °F)

Positive Sepsis Screen - criteria are:

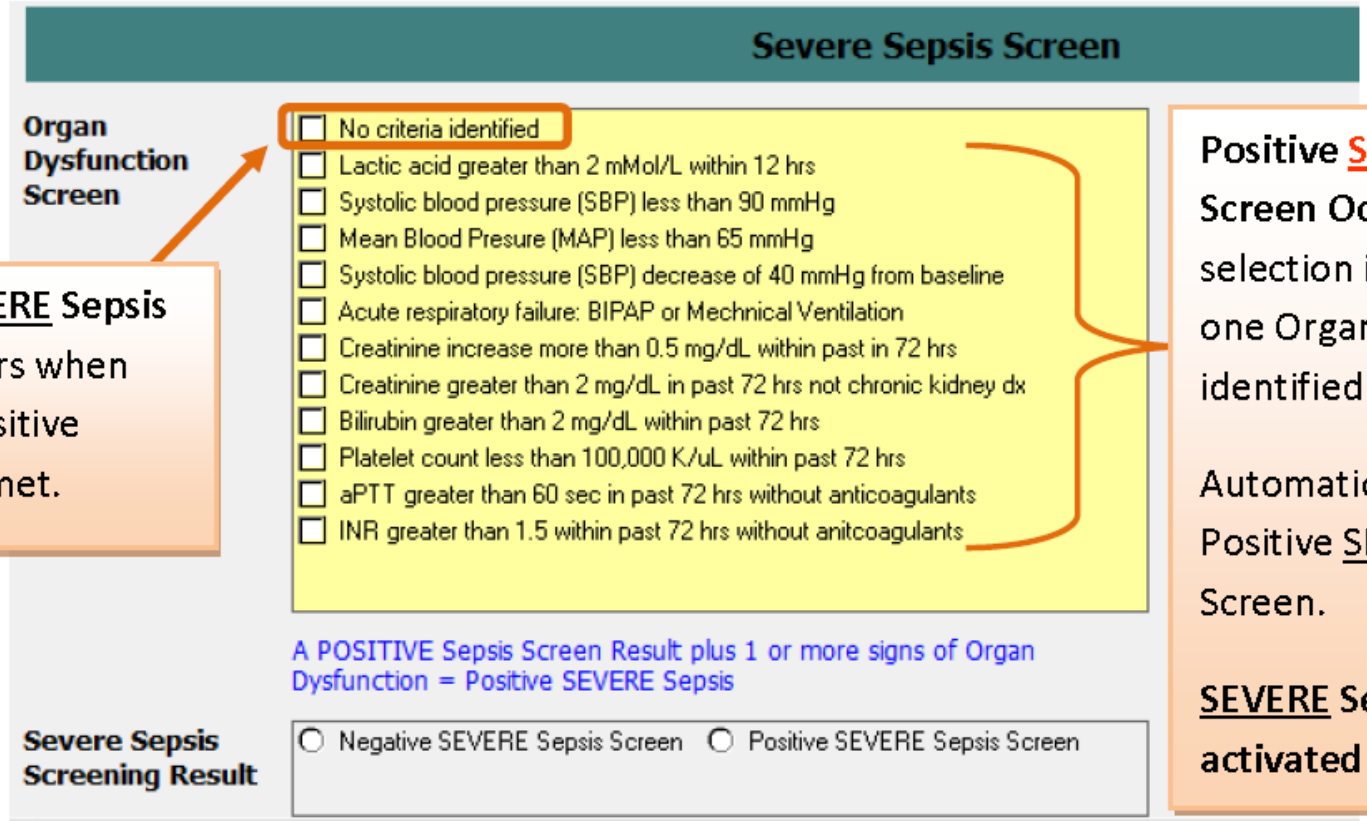
- Two or more SIRS Screen is selected and
- "Yes" to Known or Suspected Infection

If criteria are met:

1. **It automatically defaults to a Positive Sepsis Screen.**
2. **SEVERE Sepsis Screen window is activated.**

Negative Sepsis Screen – occurs when criteria for positive screen is not met.

Electronic Routine Screening



Negative SEVERE Sepsis Screen – occurs when criteria for positive screen is not met.

Positive SEVERE Sepsis Screen Occurs when one selection is chosen once one Organ Dysfunction is identified.

Automatically defaults to a Positive SEVERE Sepsis Screen.

SEVERE Sepsis Screen is activated

Effective Screening

- Develop screening process for ED, rapid response team, ICU & house wide
- Education beyond PowerPoint/case studies
- Develop audit process to evaluate compliance and effectiveness
- Ensure screening process has clear “next steps” defined for nursing staff

Dellinger RP, Levy MM, Carlet JM, et al. 2008. Crit Care Med. 2008;36:296-327.
Schorr C. et al Journal of Hospital Medicine, 2016;11:S32-S39