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Sr. Product Marketing Manager –POC Critical Care

"Utilizing Point of Care Testing for Lactate"

Objectives

- Understand Lactate and the role that it can play as a prognostic indicator for morbidity and mortality
- Identify the clinical value of lactate in a number of disease states
- Recognize the need for a Sepsis protocol

Lactate: What Increases Levels?

Lactate production occurs in all tissues, specifically:

- ✓ Skeletal muscle
- ✓ Brain
- ✓ Red blood cells
- ✓ Kidneys

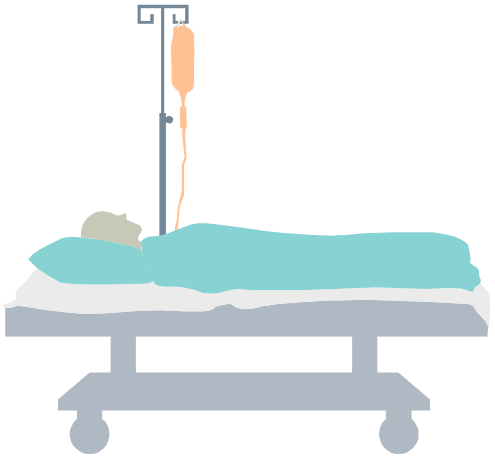
Lactate levels are elevated by:

- Tissue hypoperfusion
- Anaerobic metabolism
- Hepatic dysfunction
- Catecholamines
- Pyruvate-dehydrogenase impairment

Arnold RC, et al. *Shock*. 2009 Jul;32(1):35-9.

Schneider HG, et al. *Pathology*. 2007. 39(4):383-90.

Serum Lactate



The College of Emergency Medicine developed a Users Guide, noting:

- ✓ Lactate values are essential in identifying tissue hypoperfusion in patients who are not yet hypotensive, but at risk for septic shock
- ✓ A raised lactate level, especially the rate of clearance, has prognostic value for survival

Lactate in severe sepsis and septic shock - A quick user's guide. College of Emergency Medicine.

Serum Lactate

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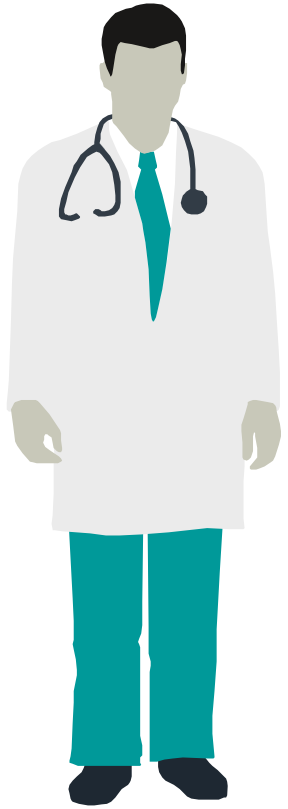
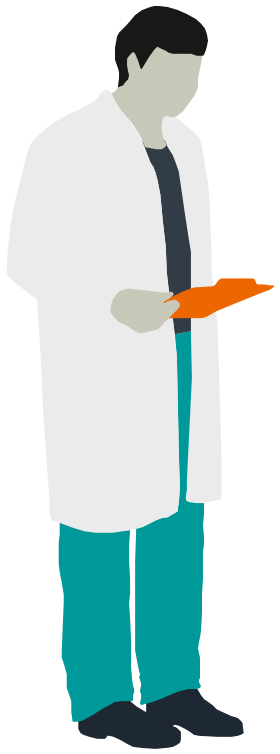


Initial Lactate		
	0 to 2 mmol/L	Normal
	> 2 mmol/L	If sepsis criteria are already met, this indicates Severe Sepsis
	> 4 mmol/L	If sepsis criteria are already met, this may indicate Septic Shock if the patient does not respond to fluids

Lactate levels should be repeated after the initial care duties have been performed

Lactate in severe sepsis and septic shock - A quick user's guide. College of Emergency Medicine.

Serum Lactate



Repeat Lactate		
	0 to 2 mmol/L	Normal
	> 2 mmol/L	If initial lactate was >2 and <4, this is Severe Sepsis unless the patient's BP is low (see below) If initial Lactate was >4, this indicates Severe Sepsis
	> 4 mmol/L	Septic Shock (If the BP was never low, this is called Cryptic Shock)

If, after initial resuscitation, the BP remains low, this is Septic Shock regardless of the Lactate levels.

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Disease States

Blood Lactate Levels

- Lactate is raised with significant tissue hypoxia -Type A lactic acidosis
- Also raised in other conditions not associated with tissue hypoxia- Type B lactic acidosis
- The lactic acid test is used as an indirect assessment of the oxygen level in tissues and to determine the cause and course of lactic acidosis.
- Also used as a prognostic indicator in Sepsis

Lactic Acidosis

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Type A Lactic Acidosis – Hypoxic

- ✓ Shock
- ✓ Carbon Monoxide intoxication
- ✓ Severe anemia
- ✓ Cardiac arrest
- ✓ Respiratory failure

Type B Lactic Acidosis – Non-Hypoxic

- ✓ Large doses of acetaminophen
- ✓ Alcohol intoxication
- ✓ IV infusion of epinephrine, glucagon, fructose, or sorbitol.
- ✓ Antifreeze poisoning
- ✓ Metformin (Glucophage), usually coincides with renal or liver impairment
- ✓ Theophylline, Cocaine, Salicylates
- ✓ Anti-retroviral Drugs (HIV patients)
- ✓ Malignancies, Sepsis, Seizures

Sepsis- Did You Know?

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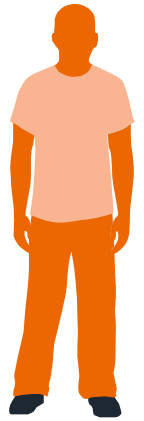
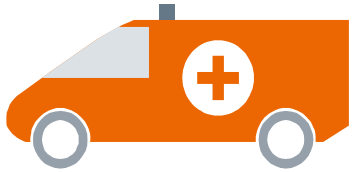
Every year, severe sepsis strikes more than a million Americans[1]



$20 Billion Spent in 2011[2]

Between 28-50% of patients die[3]

Sepsis contributed to 1 in every 2 to 3 deaths, and most of these patients had sepsis at admission[4]



1. Inpatient Care for Septicemia or Sepsis: A Challenge for Patients and Hospitals , NCHS Data Brief No. 62, June 2011
2. Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project Statistical Brief No. 160 August 2013. National inpatient hospital costs: the most expensive conditions by payer, 2011
3. Wood KA, Angus DC. Pharmacoeconomic implications of new therapies in sepsis. PharmacoEconomics. 2004;22(14):895-906
4. JAMA July 2, 2014 Volume 312, Number 1

Systemic Inflammatory Response Syndrome (SIRS)

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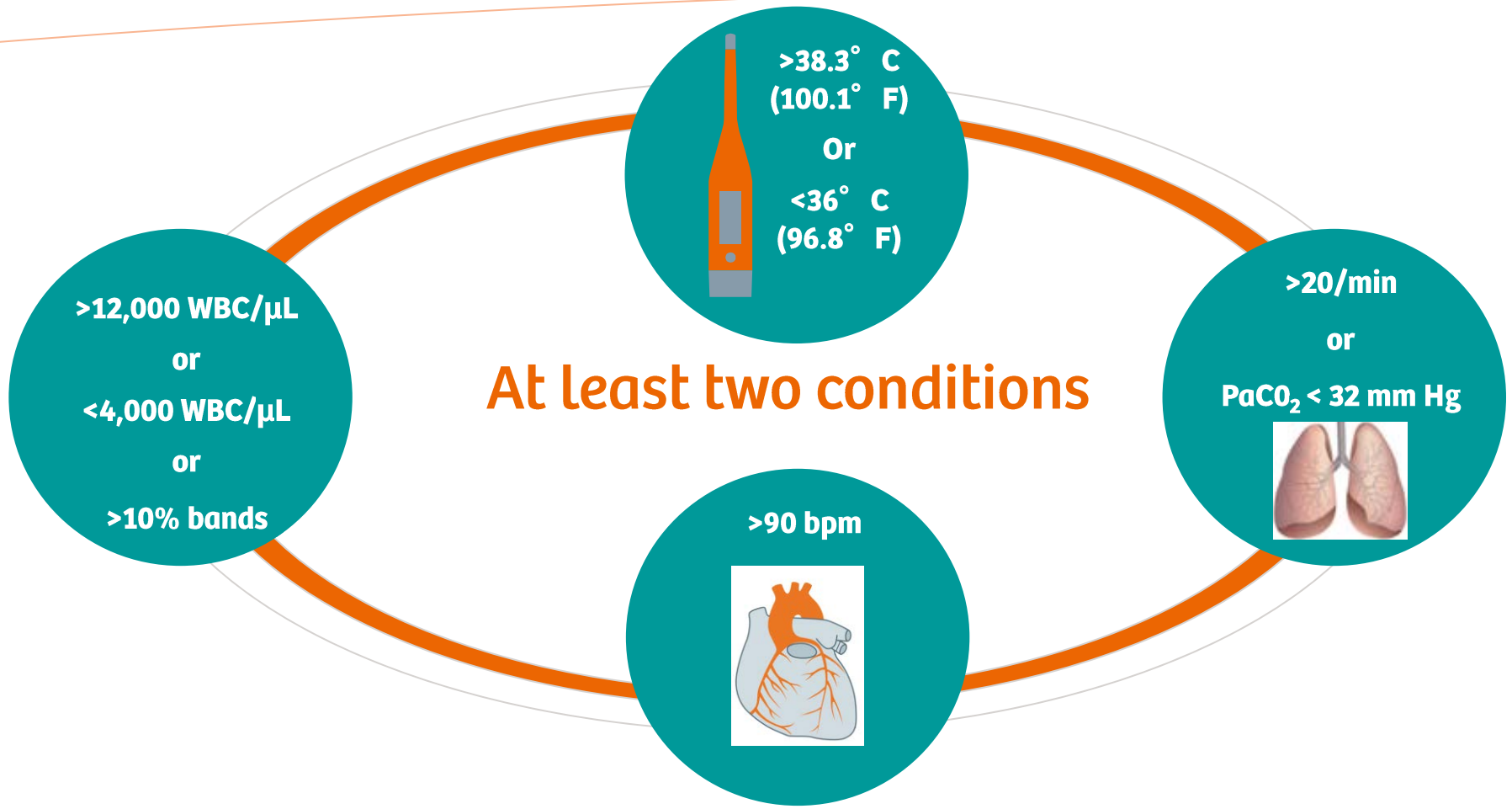

Levy et al. *Crit Care Med.* 2003;31(4):1250-56.

What is sepsis?

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Confirmed **or** Suspected Infection

+

Systemic

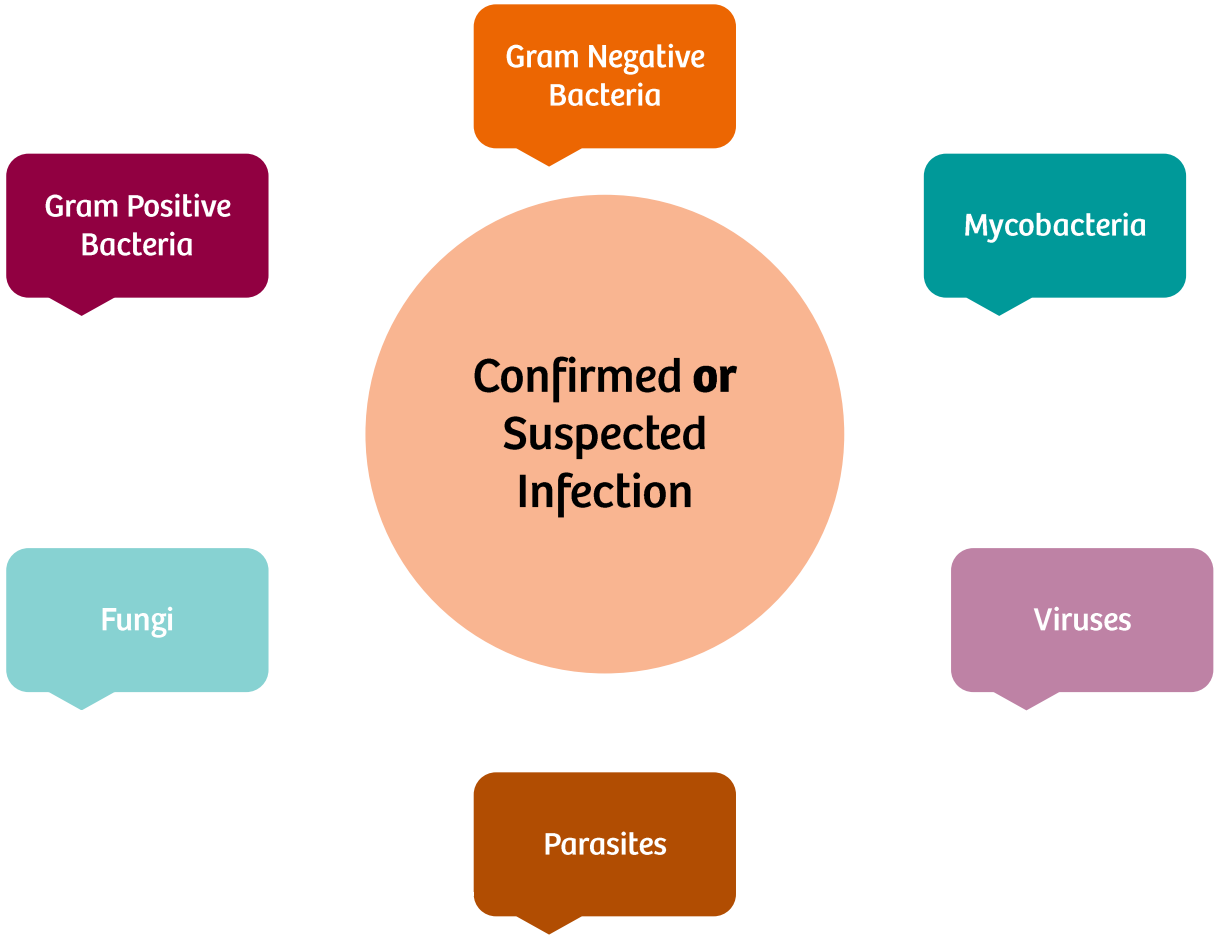
Inflammatory

Response

Syndrome

Martin GS et al. *NEJM*. 2003;348:1546-54

What is sepsis?



Systemic
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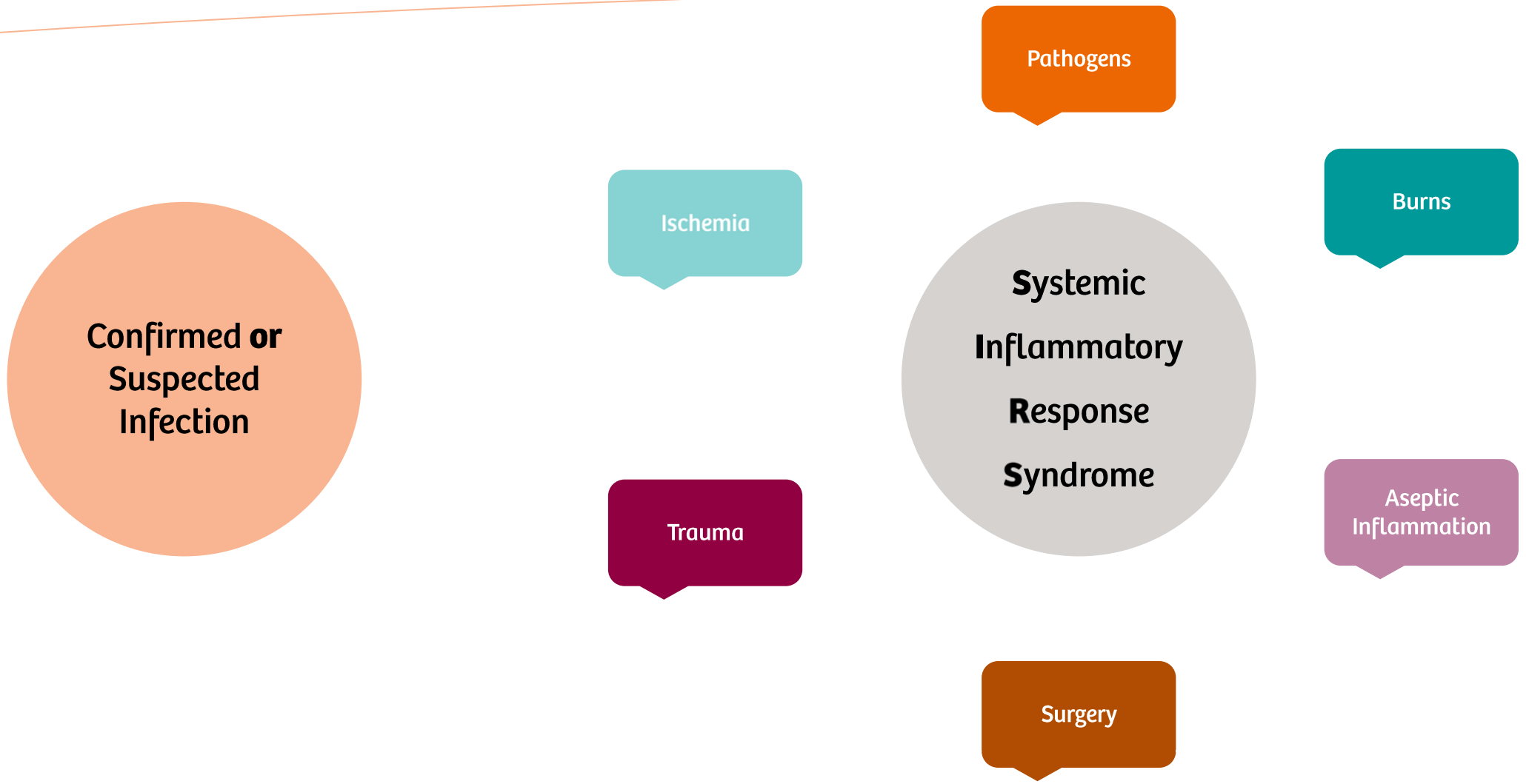
Martin GS et al. *NEJM*. 2003;348:1546-54

What is sepsis?



Martin GS et al. NEJM. 2003;348:1546-54

Severe Sepsis, and Septic Shock Definitions

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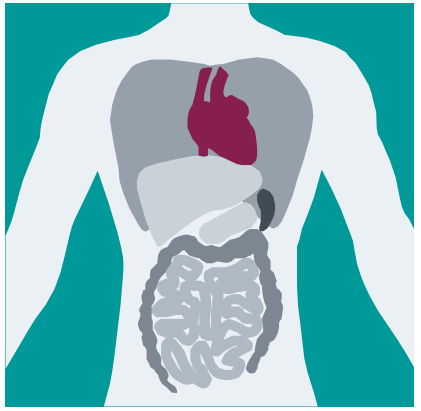
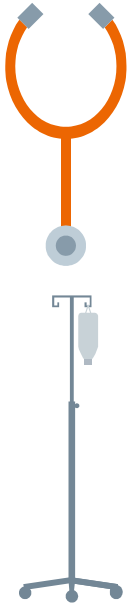
Infection:

Confirmed or Suspected





Hypotension

Fluid resuscitation

SIRS

Organ Dysfunction

Sepsis

Severe Sepsis

Septic Shock

Levy et al. Crit Care Med. 2003;31:1250.
Wheeler, et al. N Engl J Med. 1999;340:207.
Friedman et al. Crit Care Med. 1998; 26:2078.
Bone et al. Chest. 1992;101:1644.
Brun-Buisson C. Intensive Care Med. 2000;26:S64.

Basic mechanisms of the septic process

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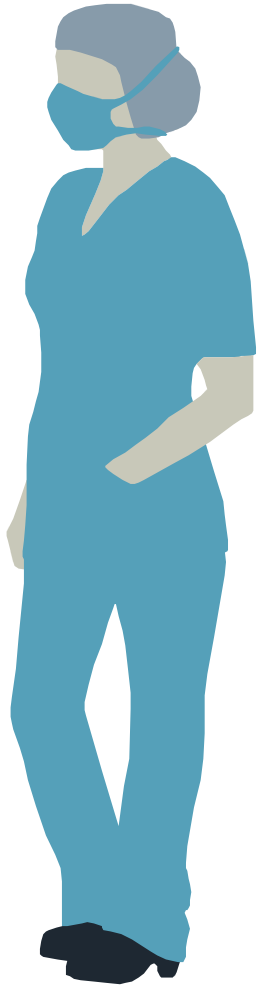
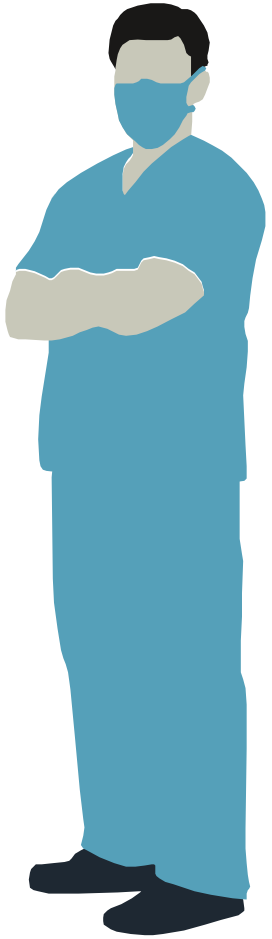
Heterogeneity is the theme

- Dysregulated coagulation
  - Altered hemostasis
  - Prolonged clotting times
- Aberrant mediator production
  - Hyper inflammatory
  - Blunted inflammatory response
  - Unknown inflammatory response



Remick DG. *Am J Pathol.* 2007;170(5): 1435-1444.

Basic mechanisms of the septic process



Heterogeneity is the theme

- Cellular dysfunction
  - Lymphocyte apoptosis
  - Neutrophil hyperactivity
  - Endothelial cell failure
  - Apoptosis in other cells
- Metabolic alterations
  - Hyperglycemia
  - Hypoglycemia
  - Adrenal failure

Remick DG. *Am J Pathol.* 2007;170(5): 1435-1444.

"Until a cure for sepsis is found, early detection is the surest hope for survival"

The Sepsis Alliance

Minutes matter–There is a need for a rapid indicator of morbidity and mortality

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- ✓ Pathogenesis can be rapid with death occurring in as little as 24 to 72 hours
- ✓ Early goal-directed therapy in patients with sepsis can decrease mortality by as much as 46%
- ✓ Every hour of delay lowers survival by nearly 8%
- ✓ The Global Sepsis Alliance urges the use of antibiotics and intravenous fluids within an hour of suspecting sepsis

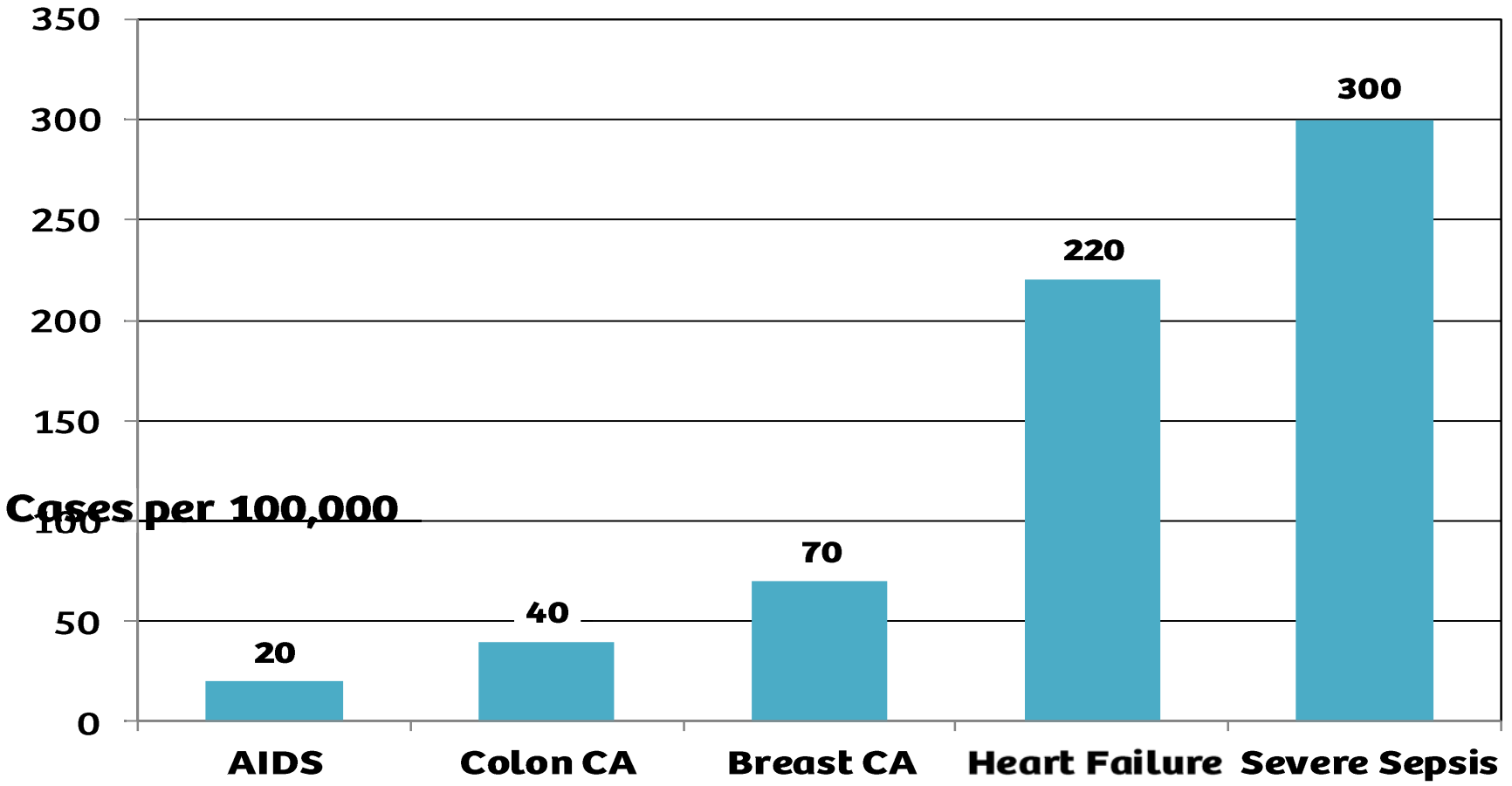
Blomkalns AL. Lactate- A marker for sepsis and trauma. www.emcreg.org. EMCREG International.
Journal Watch. Lactate Clearance measures the efficacy of goal-directed therapy in sepsis
The Associated Press New Clue to sepsis as more aggressive care urged. October 4, 2010.

Minutes matter–There is a need for a rapid indicator of morbidity and mortality

- ✓ Survivors of sepsis are at risk of developing mental and physical impairments late in life
- ✓ 60% of sepsis patients experienced worsening of cognitive or physical function or both after their infection
- ✓ Nearly 17% showed signs of moderate to severe cognitive impairment compared to 6% before the sepsis infection.
- ✓ Sepsis contributes to 20,000 new cases of cognitive impairment, such as dementia, per year

Iwashyna TJ, et al. JAMA. 2010; 304(16): 1787-1794.
Rettner R. Study: Sepsis has long-term impact on older adjlts. Health News. October 26, 2010.

Incidence of Severe Sepsis



Crit Care Med 2001;29)7):1303-1310

Case History: Septic Shock

Erin Flatley

www.sepsisalliance.org founded in her memory

- An otherwise healthy 23 year old female was experiencing pain due to hemorrhoids.
- April 24 (Wednesday): She develops a significant increase in pain (10/10), uncontrolled by Demerol. She had a outpatient hemorrhoidectomy which was uneventful.
  - Six hours after the procedure, the doctor said she was well enough to go home.
- April 27 (Saturday): She was unable to void for 3 days after surgery and was seen in the ER.
  - Temp: 101, BP: 101/47, HR: 129, RR: 21, WBC: ~23,000
  - At this point she met 4 of the SIRS criteria
  - She was discharged with a diagnosis "This is the expected course given the recent surgery"

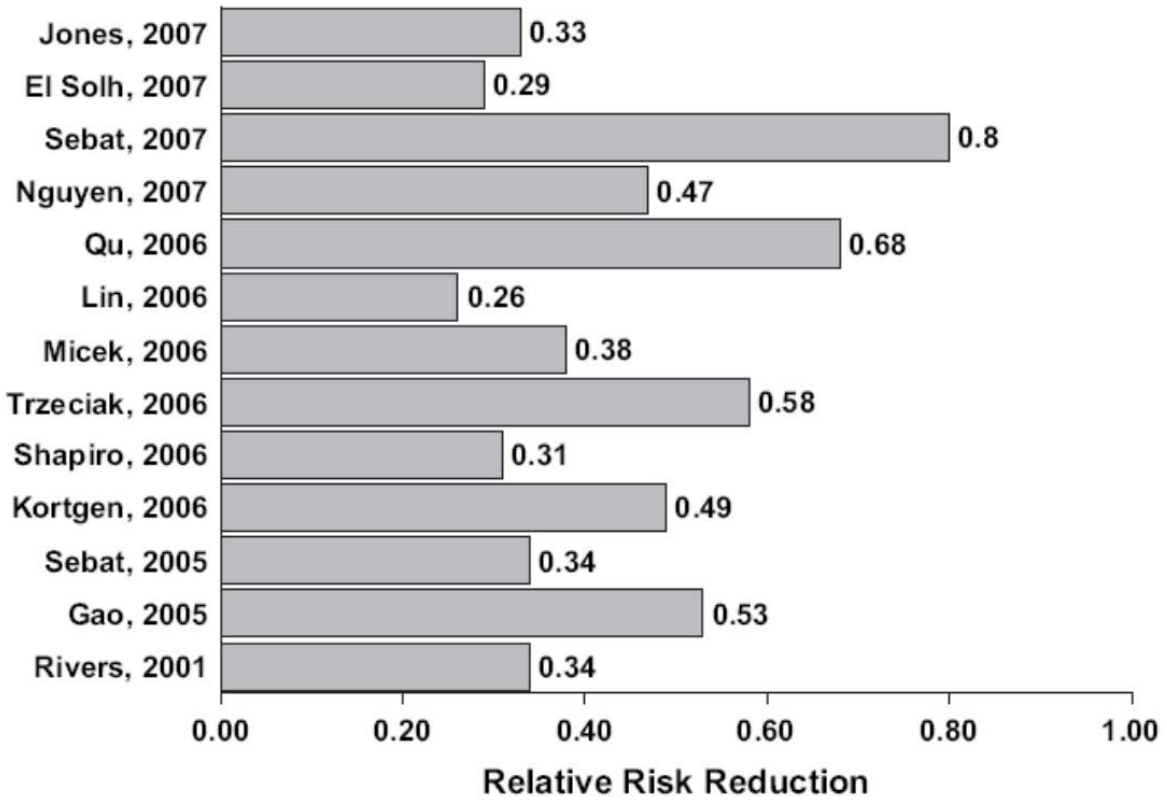
Case History: Septic Shock

Erin Flatley

www.sepsisalliance.org founded in her memory

- April 28 (Sunday): She returned to hospital with persistent, worsening symptoms and was admitted.
  - WBC: ~46,000 (doubled)
- April 29 (Monday)
  - 3:00 pm: She was diagnosed with an UTI
  - 5:30 pm: She is in septic shock and has not received any antibiotics or IV fluids
  - 10:00 pm: She was transferred to the ICU and antibiotics were started
- April 30 (Tuesday)
  - 7:30 am: Erin Flatley dies of septic shock 6 days after an outpatient surgical procedure

Decreased risk if sepsis protocols are implemented



Rivers E.P, et al. Crit Care Clin. 2008; 23: S1-47.

Traditional variables don't address the need

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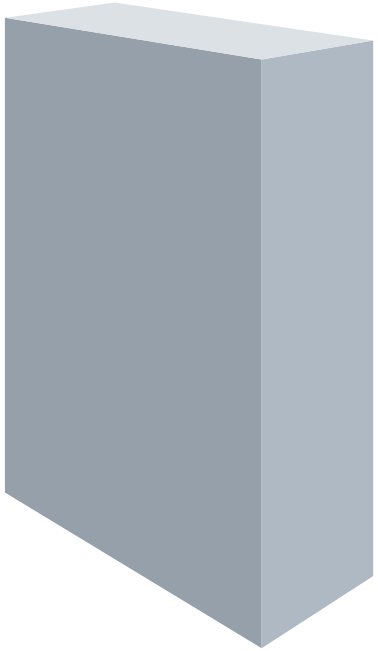
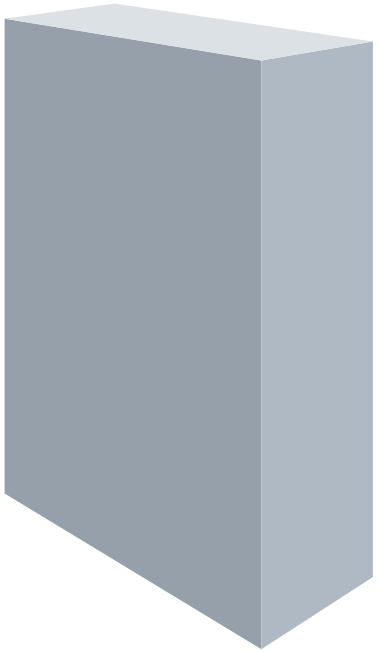


Physiological variables:

- Vital signs
- Heart rate
- Glasgow Coma Score
- Respiratory rate
- pH
- Base deficit



Testing Sent to Lab:

- Platelet count
- Prothrombin time
- Albumin
- Total bilirubin
- Hemoglobin
- Potassium
- Sodium
- Blood Urea Nitrogen
- PCO2
- PO2
- HCO3
- PCT
- Anion Gap
- IL-6
- Glucose
- Chloride

Baker J, et al. *Intensive Care Med.* 2007; 33(11): 1863-1865. Blomkalns AL. Lactate- A marker for sepsis and trauma. www.emcreg.org. EMCREG International.

Nguyen, HB et al. *Crit Care Med.* 2004; 32(8): 1637-1642. Billiter et al. *World J Surg.* 2009; 33:558-566. Rivers E, et al. *N Engl J Med.* 2001; 345(19):1368-1377. Institute for Healthcare Improvement: Serum Lactate Measured. http://www.ihi.org

Whole Blood versus Serum

Lactate is moderately unstable once it is collected:

Two samples were centrifuged for 15 min. The plasma and serum lactate levels were consistently higher than the whole blood values ($p<0.05$)

Centrifugation increases tech time and slightly delays reporting of results. This also allows for:

Lactate shifts to occur between the plasma and blood cell compartments

Ongoing lactate synthesis by blood cells

A delay by as much as 30 minutes may increase the lactate concentration by as much as 70%

Toffaletti J. Scand J Clin Lab Invest. 1996; 56(Suppl 224): 107-110
Wiese J et al. Crit Care Med. 1997; 11: 1780-1781.
Kruse JA, et al. Intensive Care Med. 1990; 16:1-2.

Point of Care Testing for Lactate levels

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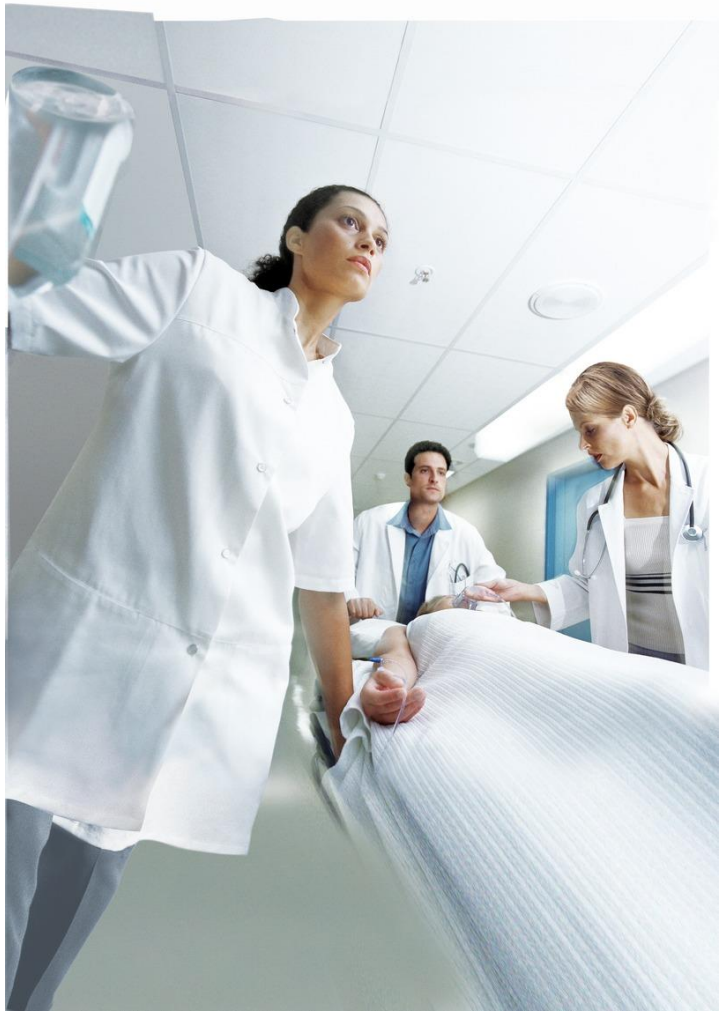
Utilizing a Point of Care Blood Gas Analyzer Allows for:

- ✓ Use of Whole blood
- ✓ Rapid time to result
- ✓ Small sample size
- ✓ Broad analytical measuring range



Summary

- Lactate measurement should be a standard of care in every institution
- It is critical to have equipment that makes rapid assessment possible
- Create standardized protocols that include the measurement of lactate levels
- Include physician order entry prompt to order lactate for suspected sepsis

Institute for Healthcare Improvement: Serum Lactate Measured. http://www.ihi.org

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Questions?

Contacts

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