



# Sepsis: The Silent Killer

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# Objectives

- ✱ **Understand the continuum of sepsis**
  - ✱ Identify patients with sepsis
- ✱ **Current treatments for sepsis**
- ✱ **Understand basic principles of shock**
  - ✱ What is “occult shock”
- ✱ **Why do I need to know this (pre-hospital care)**
- ✱ **Future trends for screening, triage, and treatment**



# VCU Medical Center



- Only level 1 Trauma Center in Central Virginia
- ED 70,000 visits/yr



- Construction of new ICU hospital
- Opened in fall 2008
- Over 120 ICU beds

# Who and What is VCURES



[www.vcures.com](http://www.vcures.com)

- Multidisciplinary Center of Excellence
- Focus: Acute Care Research, and Education
- 8 Colleges, 30 Departments, 50 Investigators
- Nontraditional Partnerships: Engineering, Physics, Chemistry, Computer Science
- Taking the Cancer Center Approach to Acute Injury and Illness

*Restoring life through innovation and collaboration*

**Turning the Golden Hour into the Silver Day**



# Current Trends in Emergency Medicine Critical Care



# Trends in ED Visits

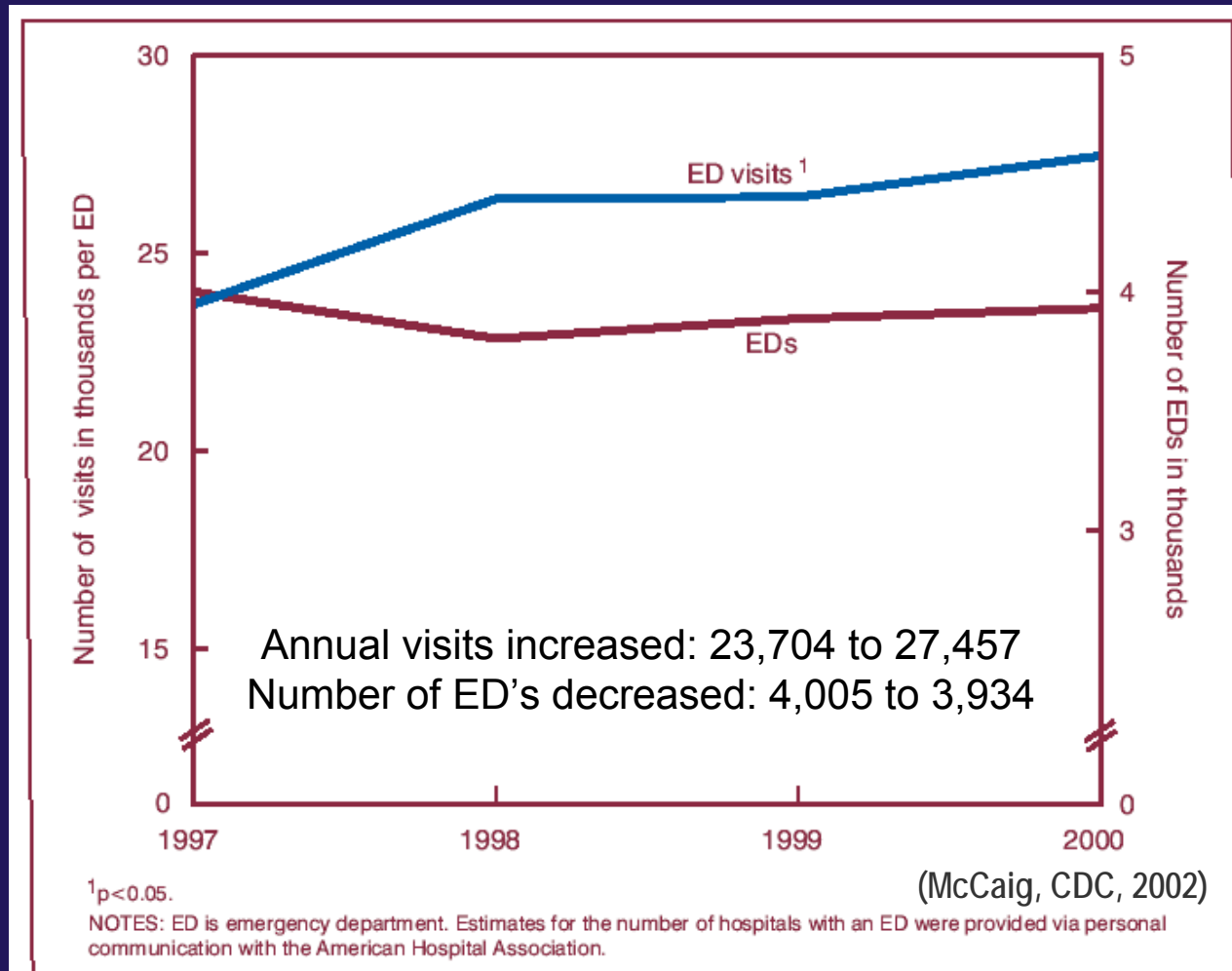


Figure 1. Trend in emergency department visits: United States, 1997–2000



# Patient Demographics – Age/Race

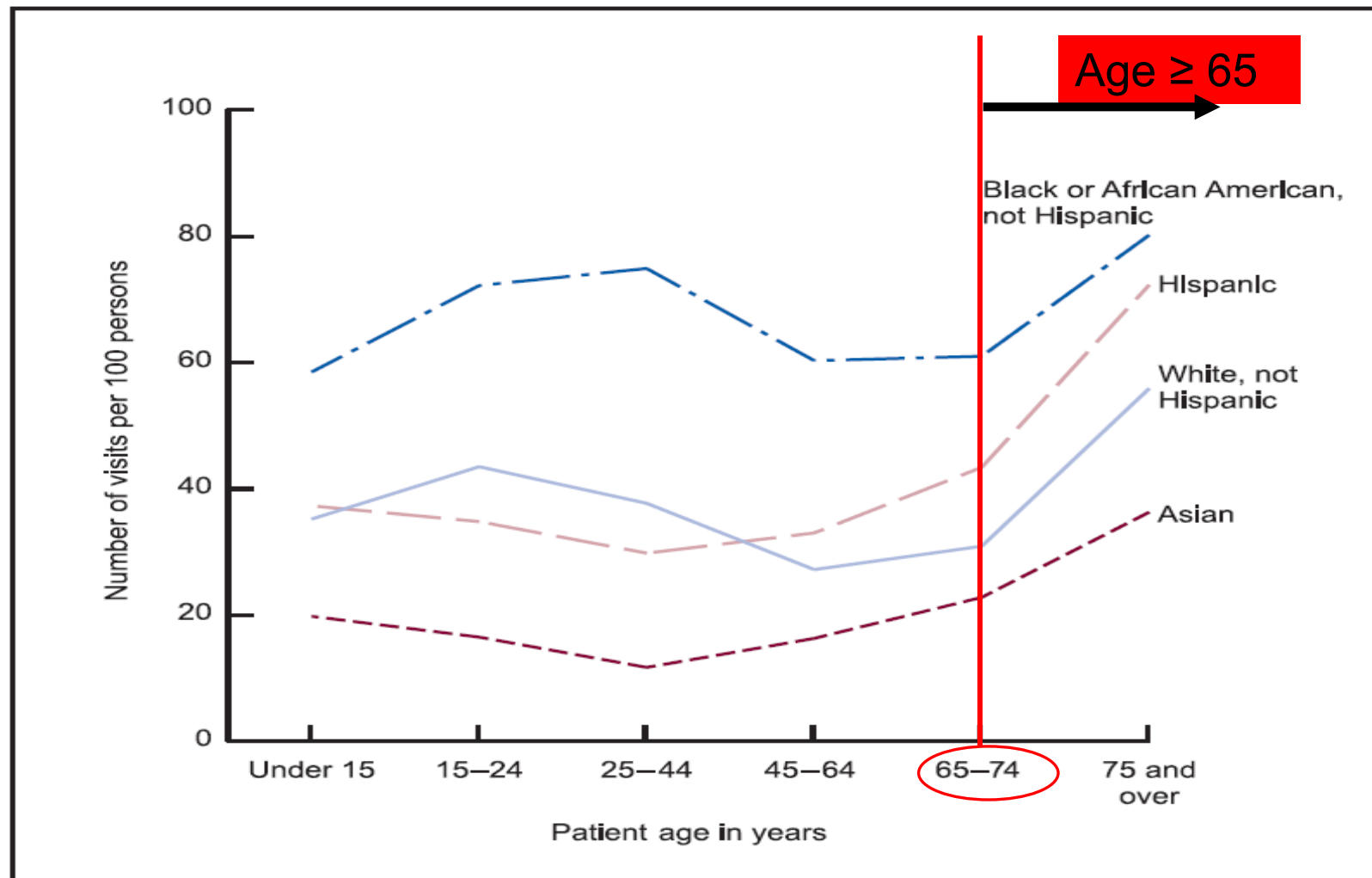
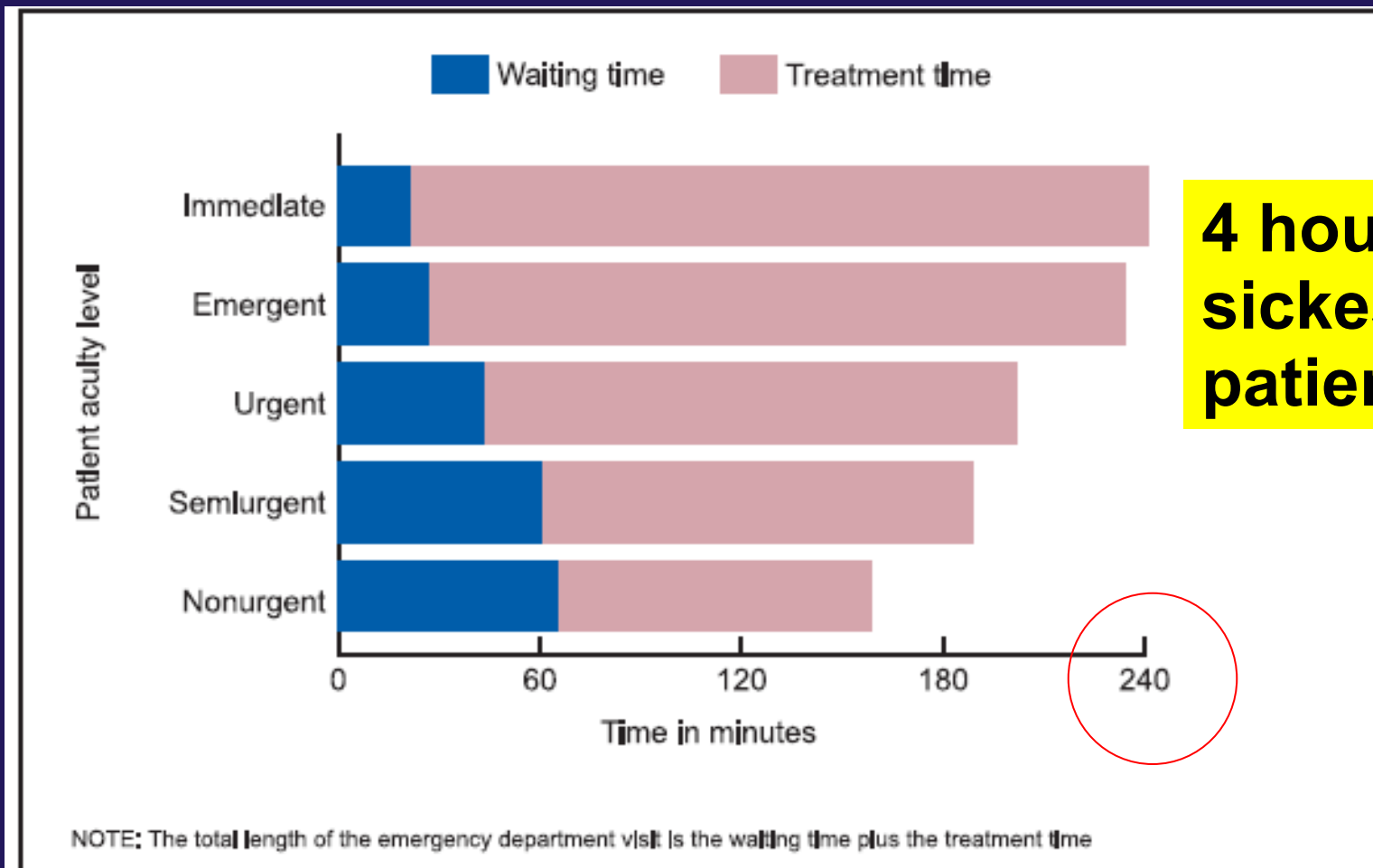


Figure 2. Annual rate of emergency department visits by patient age, race, and ethnicity: United States, 2004

McCaig 2006



# ED LOS Times (mean)



**4 hours for sickest patients**

Figure 8. Mean waiting time and treatment time in emergency departments, by patient acuity level: United States, 2004

McCaig 2006





# Levels of Acuity

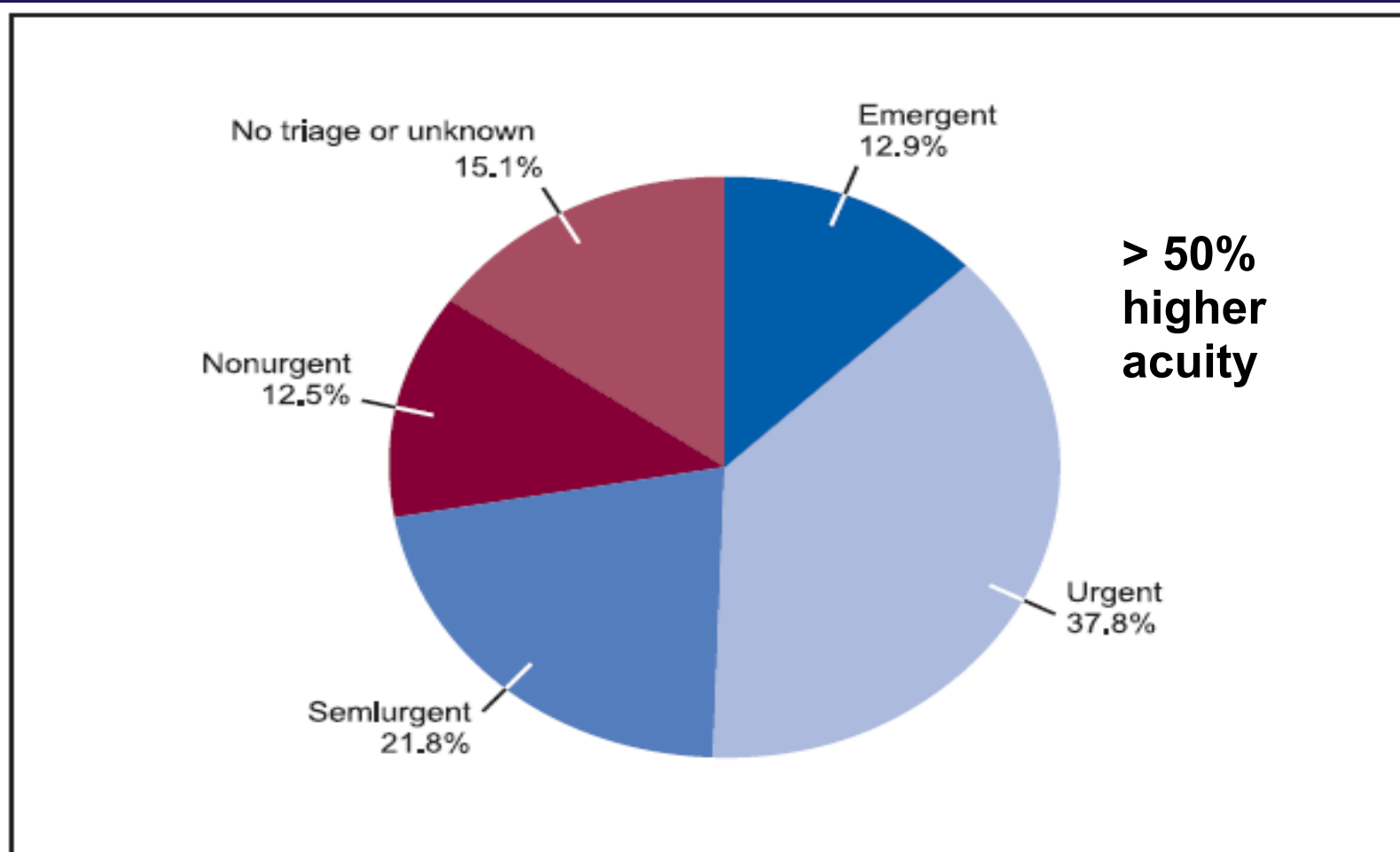


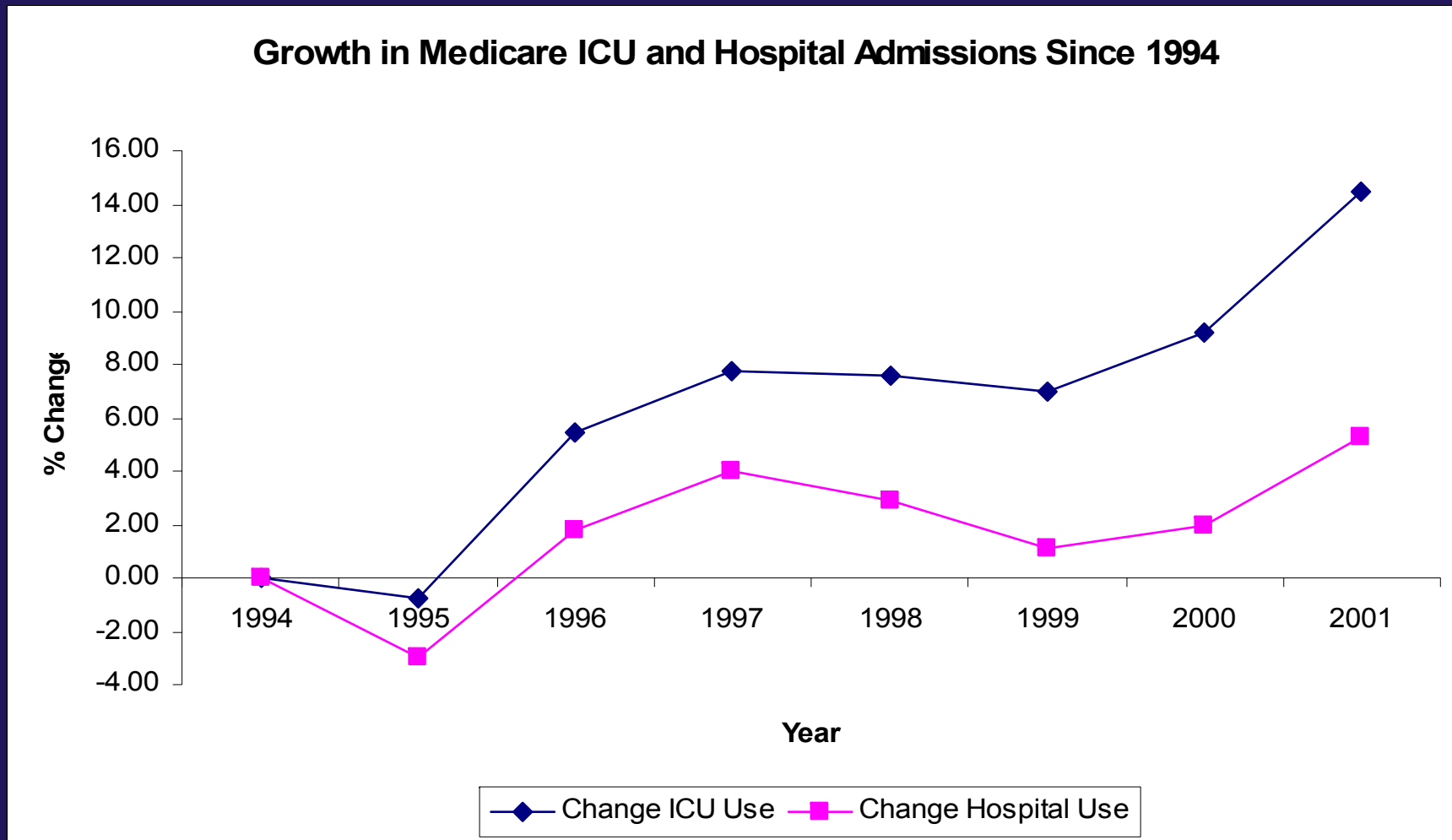
Figure 5. Percent distribution of emergency department visits, by immediacy with which the patient should be seen: United States, 2004

McCaig 2006



# Hospital and ICU Admissions

Growth in Medicare ICU and Hospital Admissions Since 1994



Milbrandt, E.B. and Angus, D.C. Unpublished data from CRISMA laboratories, Pittsburgh, PA



# EMS Data

- ☀ **Number of annual ED Visits** **114 million**
  - ☀ 26% increase since 1993
  - ☀ Avg. 2% increase/year
  - ☀ Number of ED decreased 12.3% over same time

- ☀ **Number arrived via EMS** **16 million (14%)**
  - ☀ > 1/3 are older than 65
  - ☀ This number WILL increase over the next 20 years

- ☀ **58% of EDs were urban**
  - ☀ Representing 82% of all visits



## So what are all of us faced with?

- ✱ Older population
- ✱ Increasing number of ED visits
- ✱ Decreasing number of EDs - ?increased diversion
- ✱ More EMS transports (older)
- ✱ Higher acuity
- ✱ Longer ED length of stay for the sickest
- ✱ More patients being admitted to ICU

# Can we make a difference?



## Do we already?

- ✱ STEMI – Cath lab 90 min
- ✱ Stroke – TPA within 3 hours
- ✱ Trauma system
- ✱ Sepsis?



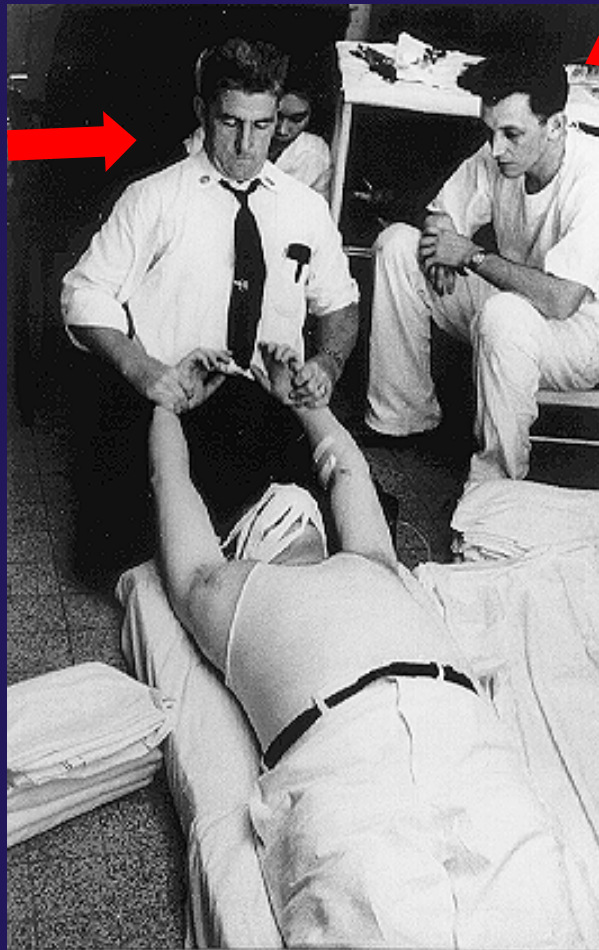
“Critical care is a continuum that begins with out-of-hospital care, continues with ED intervention, and culminates in ICU admission and management.”

- Peter Safar, MD  
1924-2003  
Father of CPR



# Peter Safar, MD 1924-2003

Capt  
McMahon,  
Chief  
Baltimore  
Fire and  
Ambulance  
Service,  
1957



BALTIMORE CITY HOSPITAL  
RESUS CITATION EXPERIMENT, JULY 13, 1957  
CHEST PRESSURE ARM-LIFT METHOD

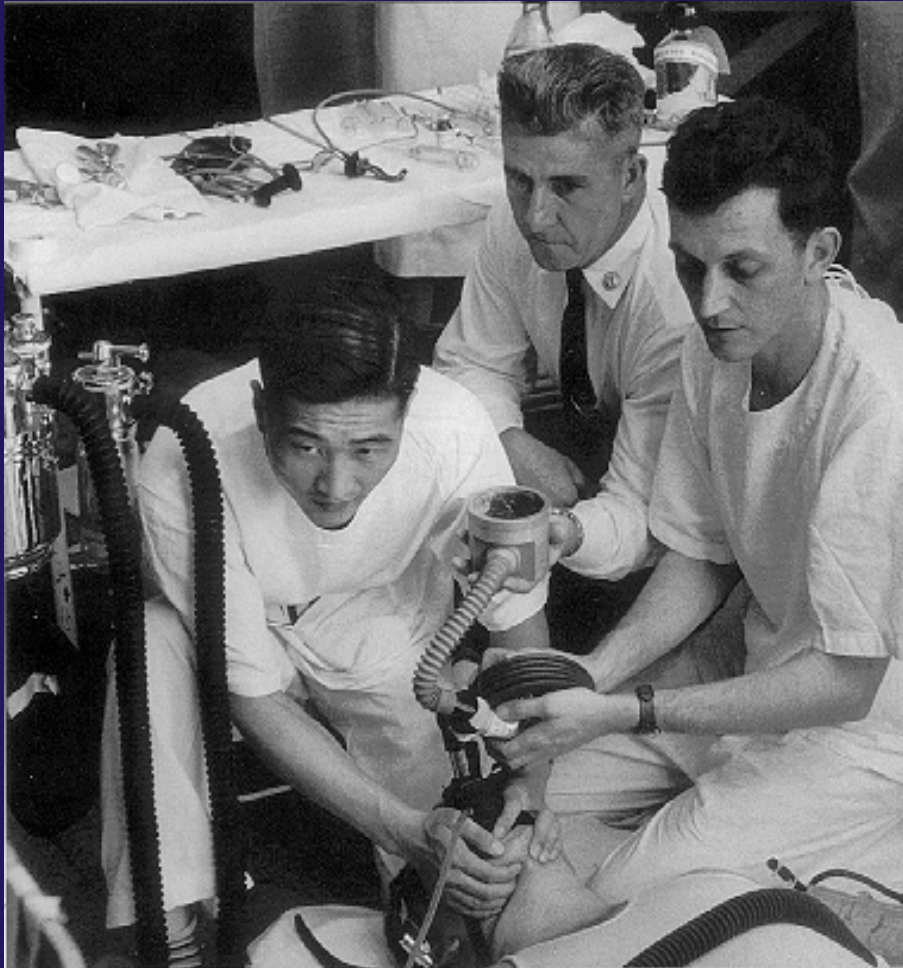


BALTIMORE CITY HOSPITAL  
RESUS CITATION EXPERIMENT, JULY 13, 1957  
CHEST PRESSURE ARM-LIFT METHOD

# Peter Safar, MD 1924-2003



“the most sophisticated intensive care often becomes unnecessarily expensive terminal care when the pre-ICU system fails.” – Peter Safar, MD



**BALTIMORE CITY HOSPITAL  
DEPARTMENT OF ANESTHESIOLOGY  
RESUSCITATION EXPERIMENT, JULY 13, 1957  
VOLUNTEER: FELIX STEICHEN, M.D.  
RESIDENT IN SURGERY**





**What do you think of  
when you hear “sepsis”?**



# *What is sepsis?*

*Greek origin = putrefaction*



***Sepsis or Septic =  
Decomposition, Decay***



# Clinically, Confusion Reigns

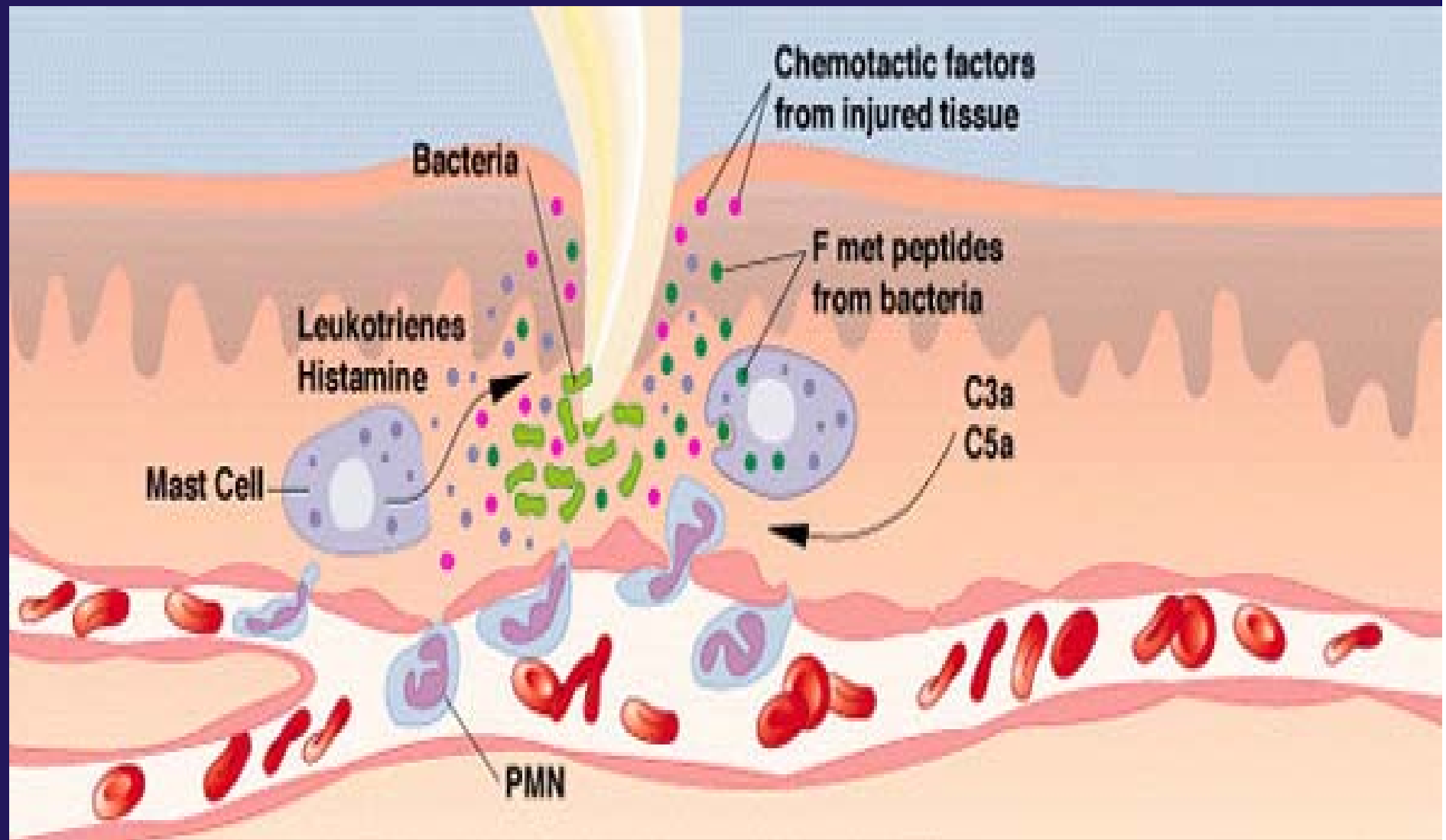
- ✱ **Wide range of mortality and morbidity**
  - ✱ 35% - 75% mortality
- ✱ **Unclear terminology commonly used**
- ✱ **No clear consensus on what “Sepsis” meant**
- ✱ **Bacteremia = septicemia = sepsis = sepsis syndrome = septic shock**



# Body's response to an “attack”

## The inflammatory response

# Inflammatory Response - Local



# The Endothelial System



**Pan-endothelial Disruption**

# SIRS



## (Systemic Inflammatory Response Syndrome)

### ☀ SIRS Definition (at least 2)

- ☀ Fever or hypothermia ( $T > 38^{\circ}\text{C}$  or  $< 36^{\circ}\text{C}$ )
- ☀ Tachypnea ( $\text{RR} > 20$  bpm or  $\text{PaCO}_2 < 32$  mmHg)
- ☀ Tachycardia ( $\text{HR} > 90$  bpm)
- ☀ Immune response ( $\text{WBC} > 12,000$ , or  $< 4,000$  or  $> 10\%$  immature (band) forms)

ACCP/SCCM Consensus Conference, Critical Care Medicine 1992; 20:864-74



# Sepsis

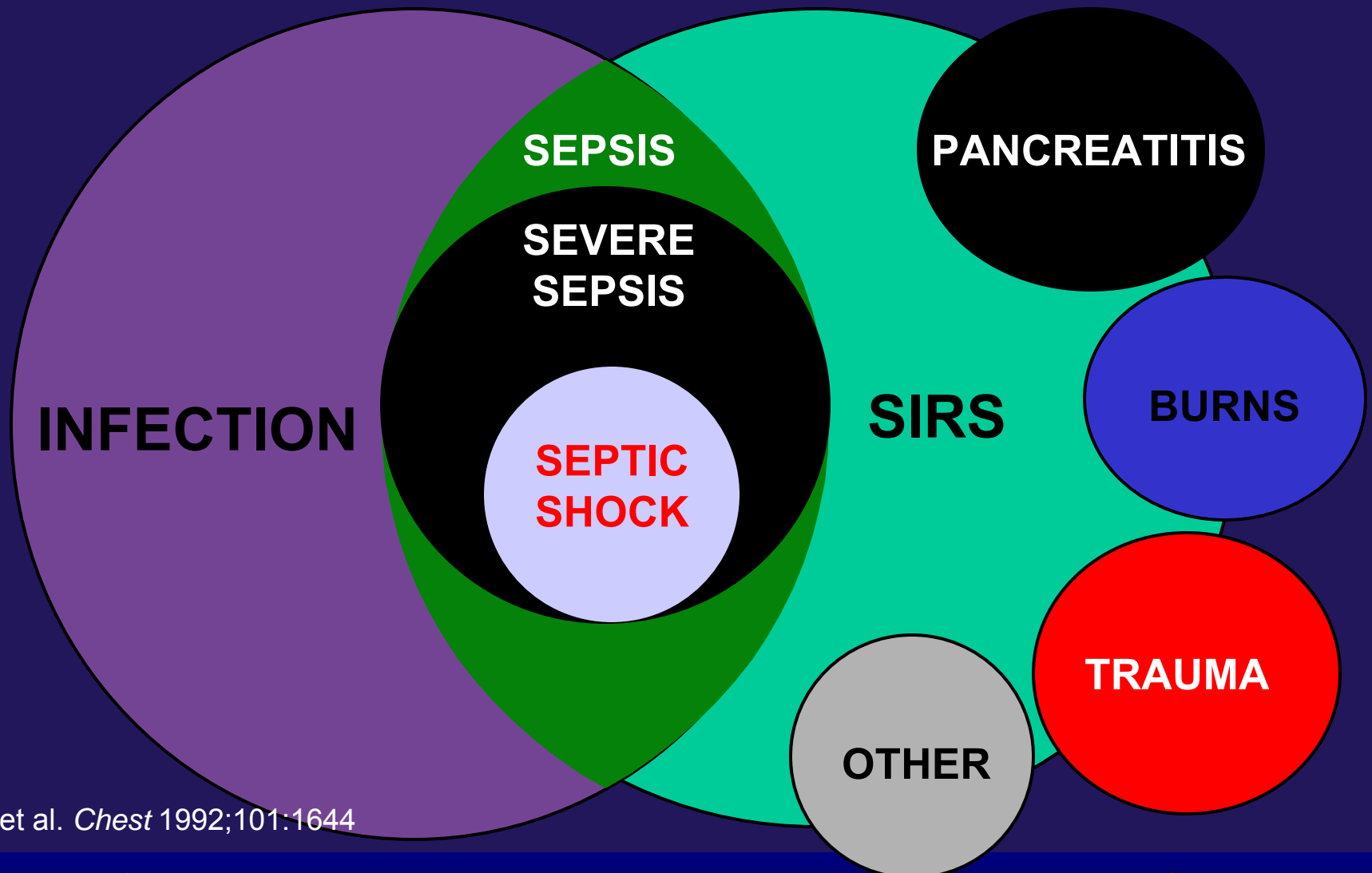
- ✱ **At least 2 SIRS criteria PLUS a suspected infection**
- ✱ **Up to 30 - 60% may be “culture negative”**
- ✱ **Culture “positive” or “negative” have similar mortalities**

ACCP/SCCM Consensus Conference, Critical Care Medicine 1992; 20:864-74





# Relationship Of Infection, SIRS, Sepsis Severe Sepsis and Septic Shock



Bone et al. *Chest* 1992;101:1644



# The continuum of sepsis

Early Goal Directed Therapy

INSULT

SIRS

Sepsis

Severe Sepsis

A clinical response arising from a nonspecific insult, including  $\geq 2$  of the following:

- Temperature  $\geq 38^{\circ}\text{C}$  or  $\leq 36^{\circ}\text{C}$
- HR  $\geq 90$  beats/min
- Respirations  $\geq 20$ /min
- WBC count  $\geq 12,000/\text{mm}^3$  or  $\leq 4,000/\text{mm}^3$  or  $> 10\%$  bands
- PaCO<sub>2</sub>  $< 32$ mmHg

SIRS with a presumed or confirmed infectious process

Sepsis with  $\geq 1$  sign of organ failure:

- Global Tissue Hypoxia ?
- Renal
- Respiratory
- Hepatic
- Hematologic
- CNS
- Unexplained metabolic acidosis

Septic Shock

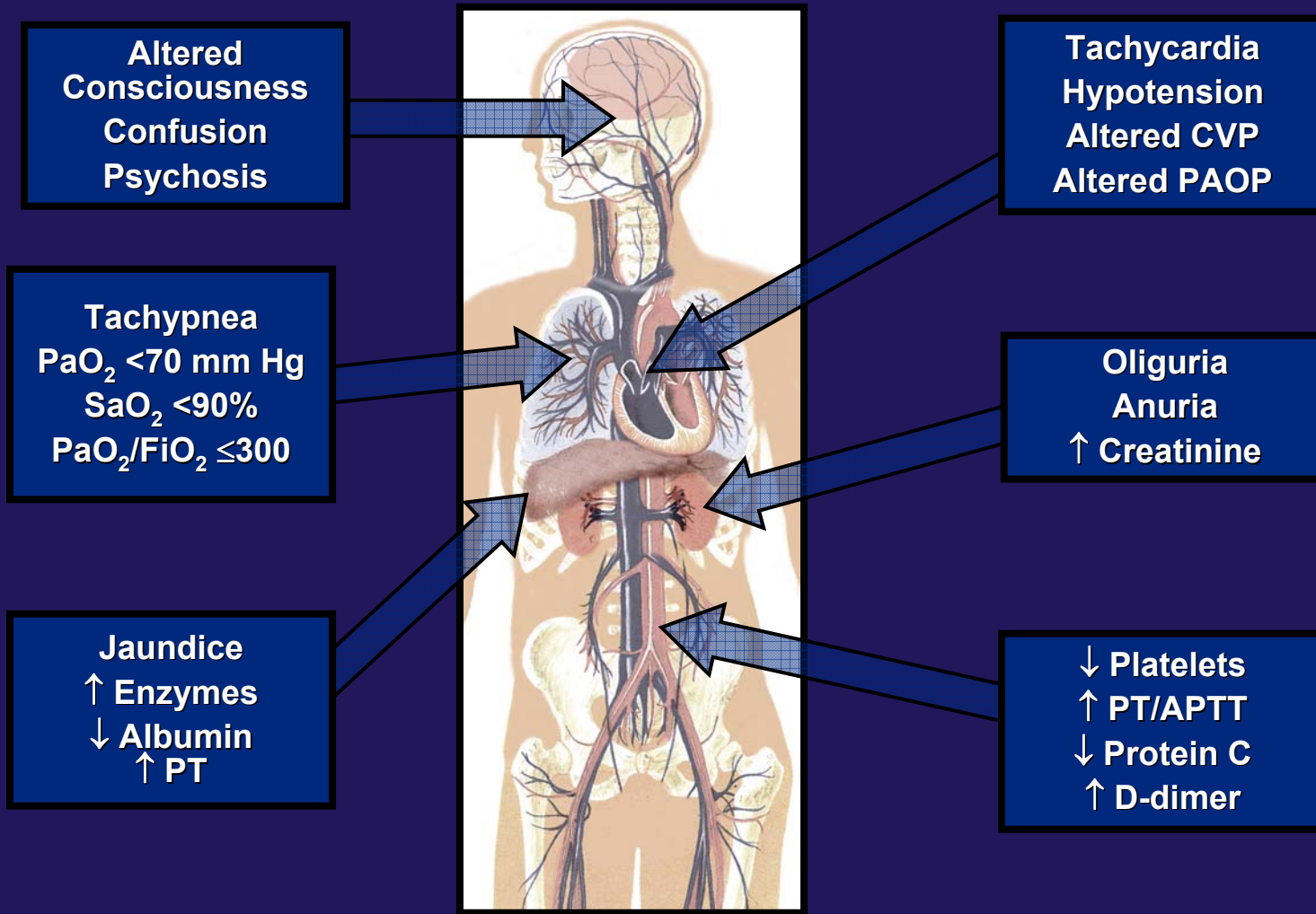
Bone et al. *Chest*. 1992;101:1644.



# Some Clinical Signs of Severe Sepsis



# Identifying Acute Organ Dysfunction as a Marker of Severe Sepsis



Balk RA. *Crit Care Clin* 2000;16:337-52.



# How big of a problem is Sepsis?



# Severe Sepsis: A Significant Healthcare Challenge

## Major cause of morbidity and mortality worldwide

- ✿ Leading cause of death in noncoronary ICU (US)\*
- ✿ 11<sup>th</sup> leading cause of death overall (US) †§

**More than 750,000 cases of severe sepsis  
in US annually with 215,000 deaths annually**

- ✿ Costs \$16.7 Billion‡

**In the US, more than 500 patients die of severe sepsis  
daily.‡**

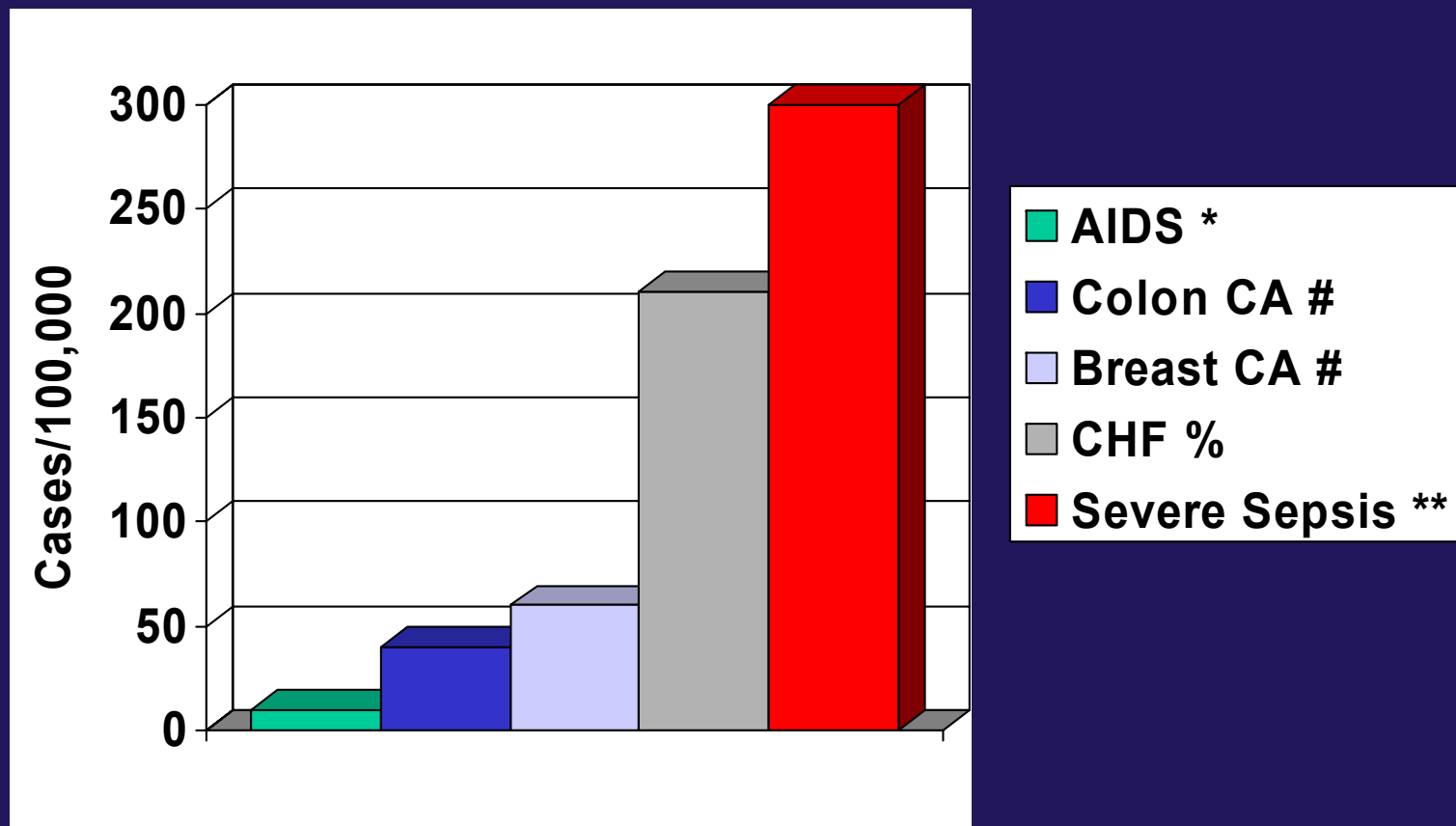
\*Sands KE et al. *JAMA*. 1997;278:234-40; †Based on data for septicemia.

§Murphy SL. National Vital Statistics Reports.

‡Angus DC et al. *Crit Care Med*. 2001;29:1303-1310; reflects hospital-wide cases of severe sepsis as defined by infection in the presence of organ failure.



# Incidence of Severe Sepsis



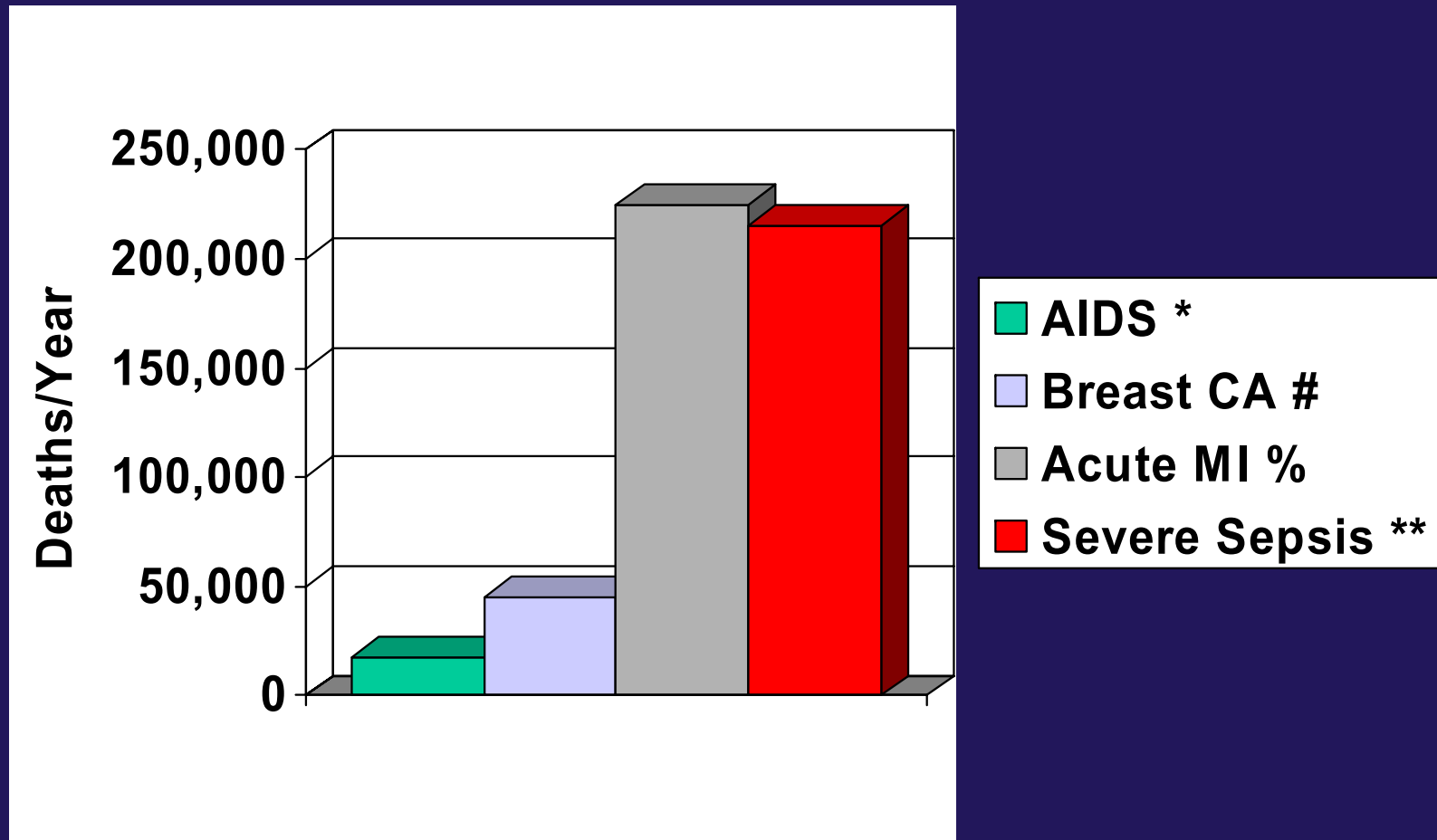
\* Karon JM et al. Am J Public Health. 2001;91:1060-8 # American Cancer Society, 2001

% American Heart Association, 2001

\*\* Angus et al. Crit Care Med. 2001;29:71303-10



# Comparative Mortality



\* Karon JM et al. Am J Public Health. 2001;91:1060-8

# American Cancer Society, 2001

% American Heart Association, 2001

\*\* Angus et al. Crit Care Med. 2001;29:71303-10



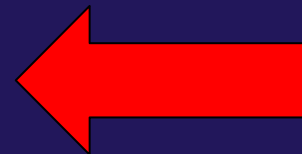


# Is there a treatment?



# New therapies for Sepsis

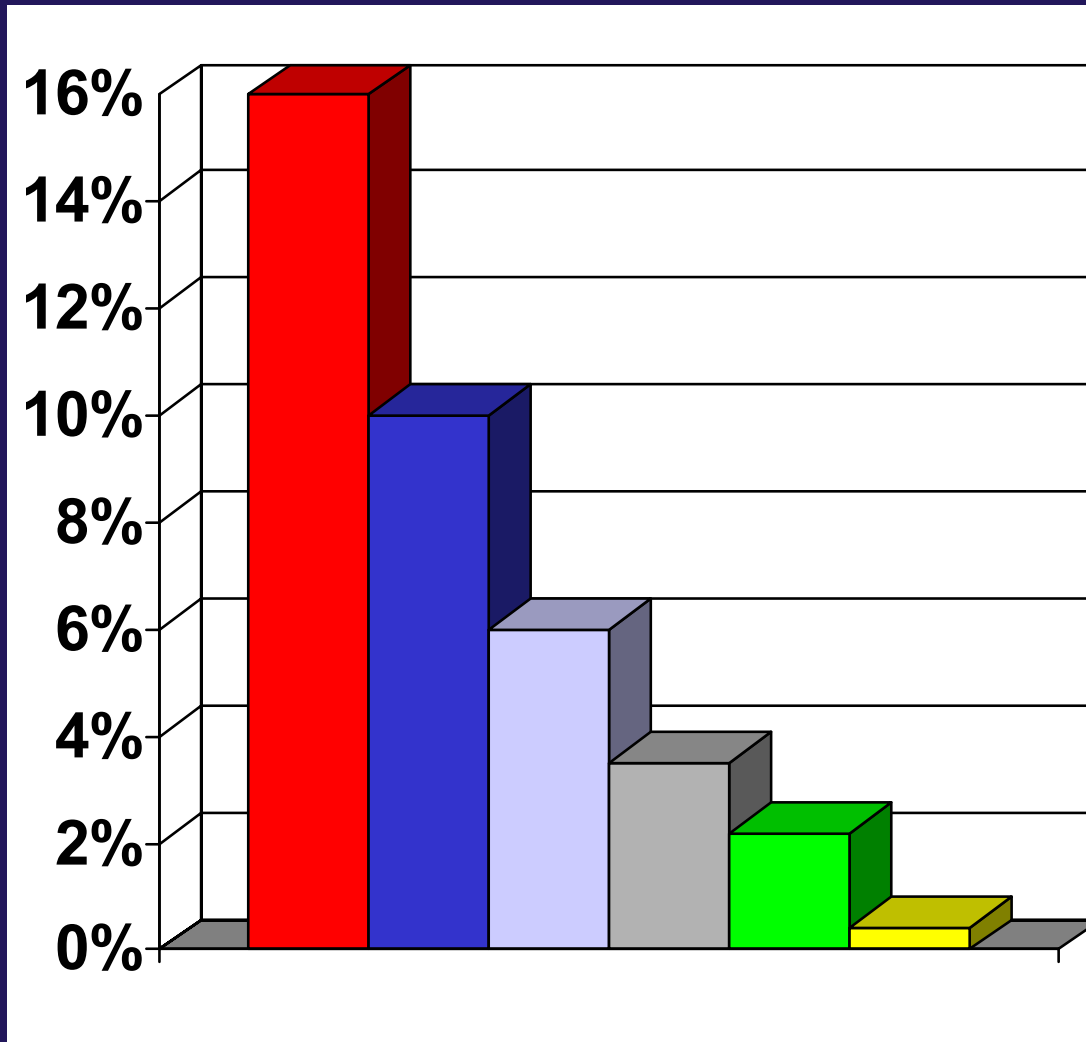
- ✱ Early antibiotic administration
- ✱ Low volume ventilation – ARDS
- ✱ Drotrecogin alpha (activated) Xigris®
- ✱ Corticosteroids
- ✱ Strict glycemetic control
- ✱ Early goal-directed therapy



# Common treatments for critically ill



Absolute Mortality Reductions



**EGDT** Sepsis

Rivers EP, NEJM 2001

**Steroids** Sepsis

Anname D, JAMA 2002

**APC** Sepsis

Bernard GR, NEJM 2001

**Intensive Insulin** ICU pts

Van den Berghe G, NEJM 2001

**Stk in STEMI**

ISIS-2, Lancet 1988 AMI

**II/b III/a inhib in NSTEMI**

Boersma E, Lancet 2002 AMI



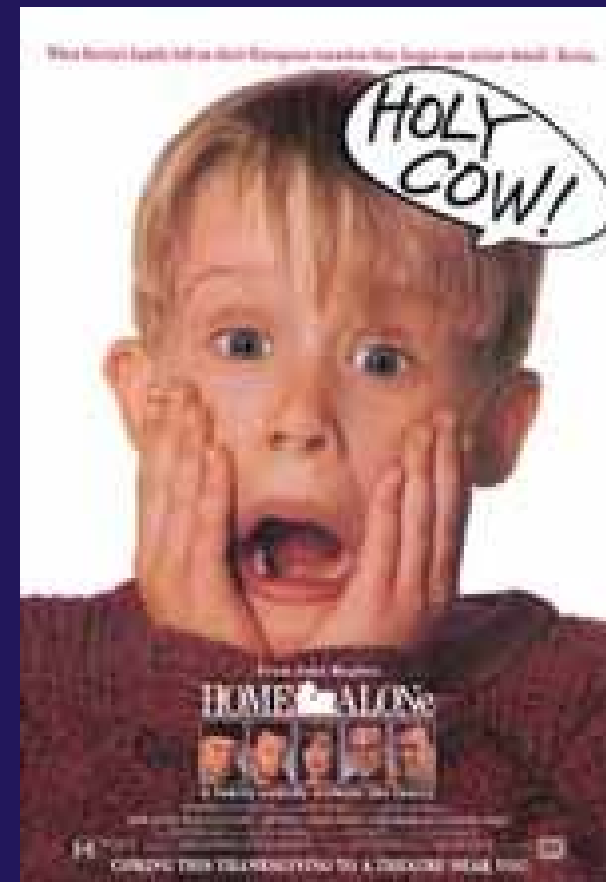
# Early Goal Directed Therapy

- ✱ Based on recognizing EARLY Shock States
- ✱ Reverses oxygen debt
- ✱ Therapy aimed at improving delivery of oxygen to the tissues
- ✱ Works along with
  - ✱ Antibiotics
  - ✱ Steroids
  - ✱ Xigris®
  - ✱ Glucose control
  - ✱ Source control (abscess drainage, etc...)



# SHOCK

# What is Shock?





# SHOCK

**Inability to supply (or utilize)  
enough oxygen to meet the  
metabolic needs of the tissue.**

**Tissue Hypoperfusion!**

# Shock: An Outdated Definition

Normal perfusion



Global Tissue  
Hypoxia and O<sub>2</sub> Debt  
**HYPOPERFUSION**



Traditional Shock

Normal Vitals



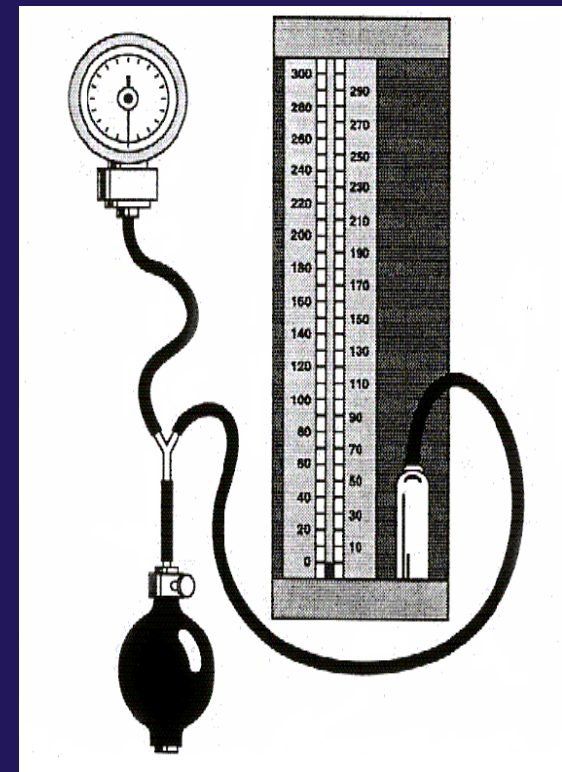
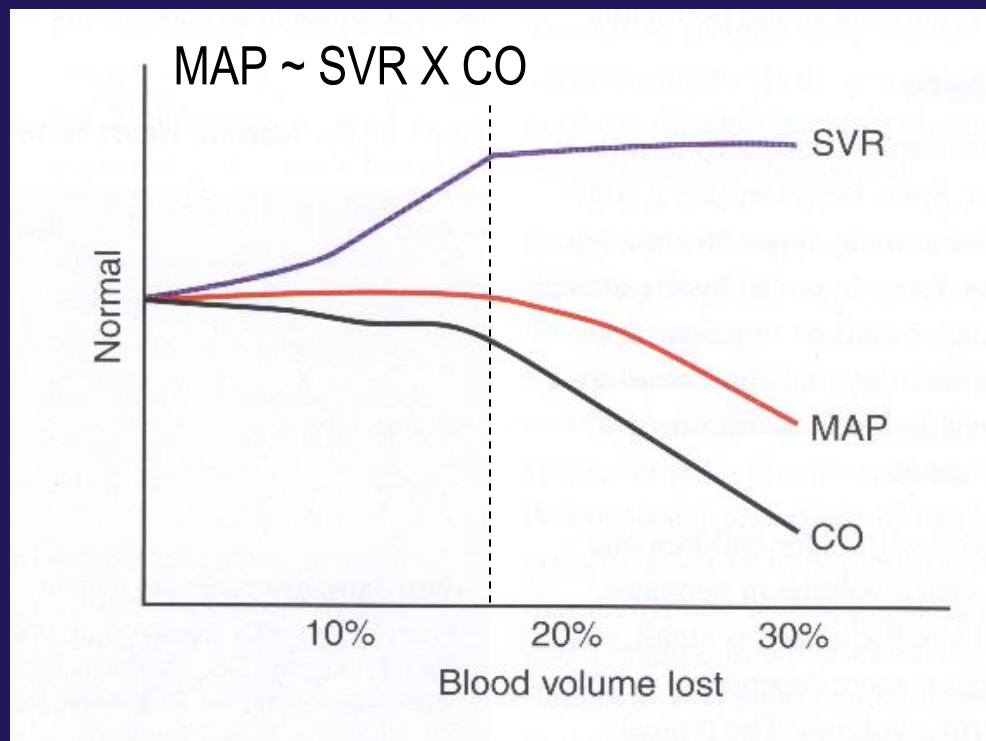
Normal Vitals →

Abnormal Vitals  
(Hypotension)



# Blood pressure fails to detect global tissue hypoxia

- ✱ Adequate pressure does not always mean adequate flow to tissues



(Schwaitzberg, J Ped Surg, 1988)



# Cryptic Shock

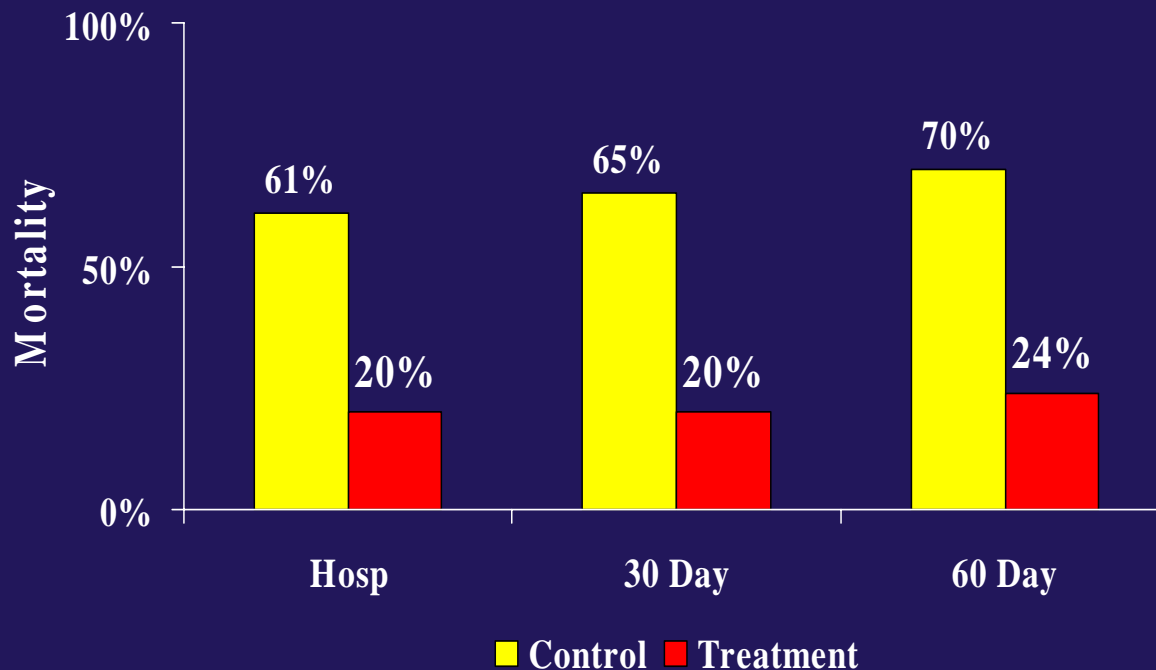
## Patients with a Baseline MAP > 100

Lactate > 4 mM/L

Control n = 25

EGDT n = 23

☀ A significant co-morbid variable:



☀ 2-fold increase in sudden cardiovascular collapse, cause of early death.

☀ 56.5% in early hospital mortality.

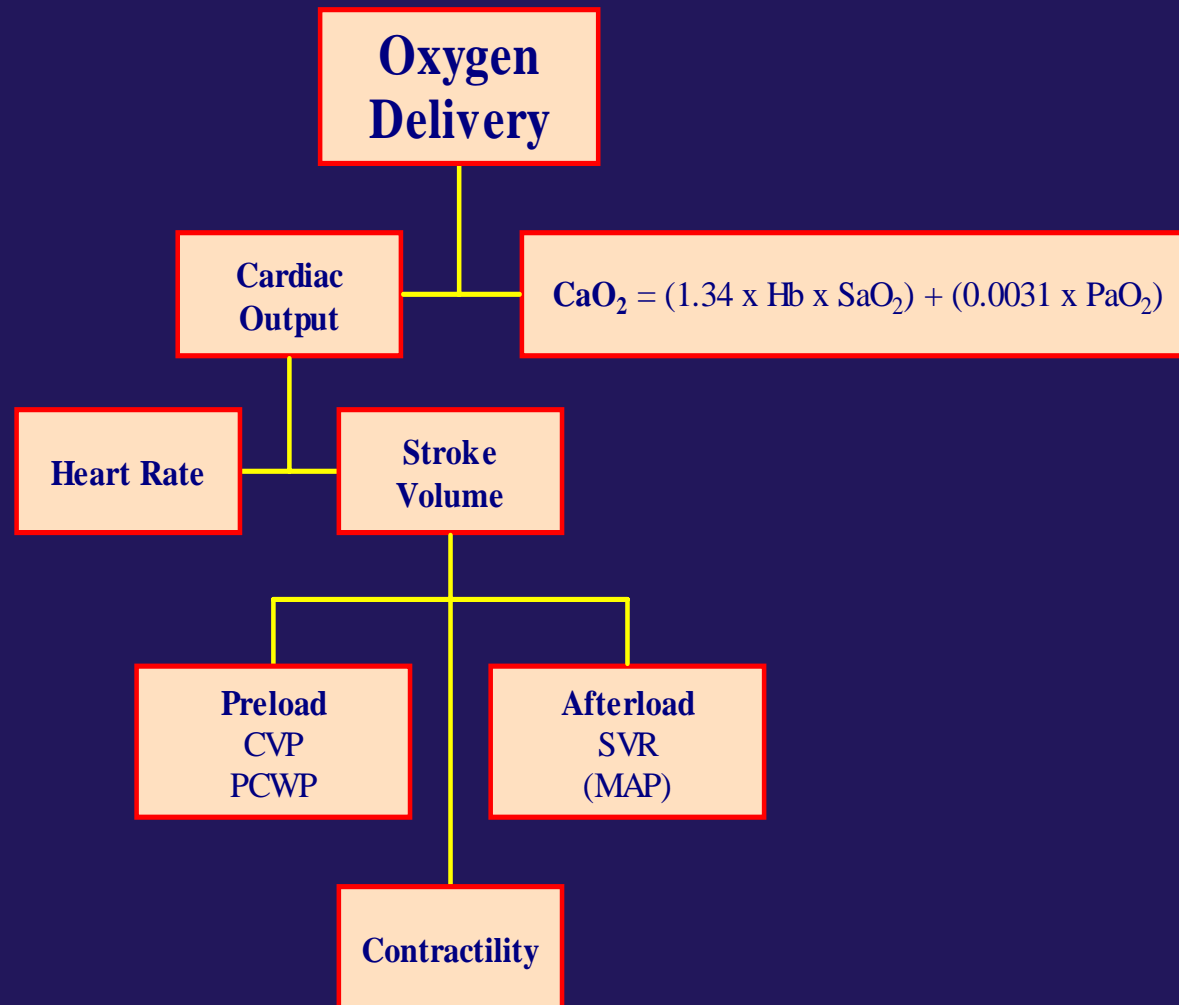
☀ Natural selection process between the onset of severe illness and ICU arrival.

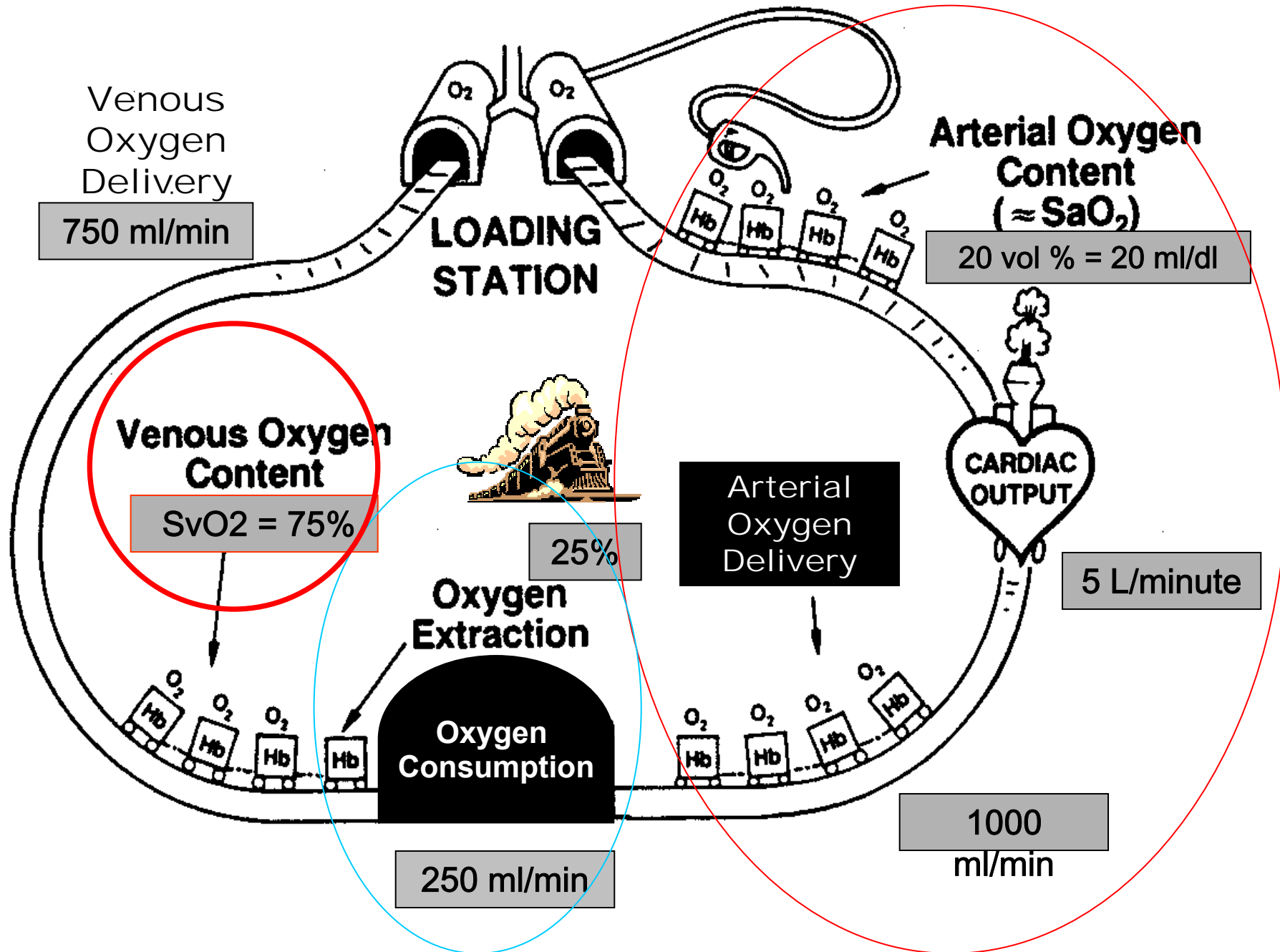


# What's really going on?



# Oxygen Delivery

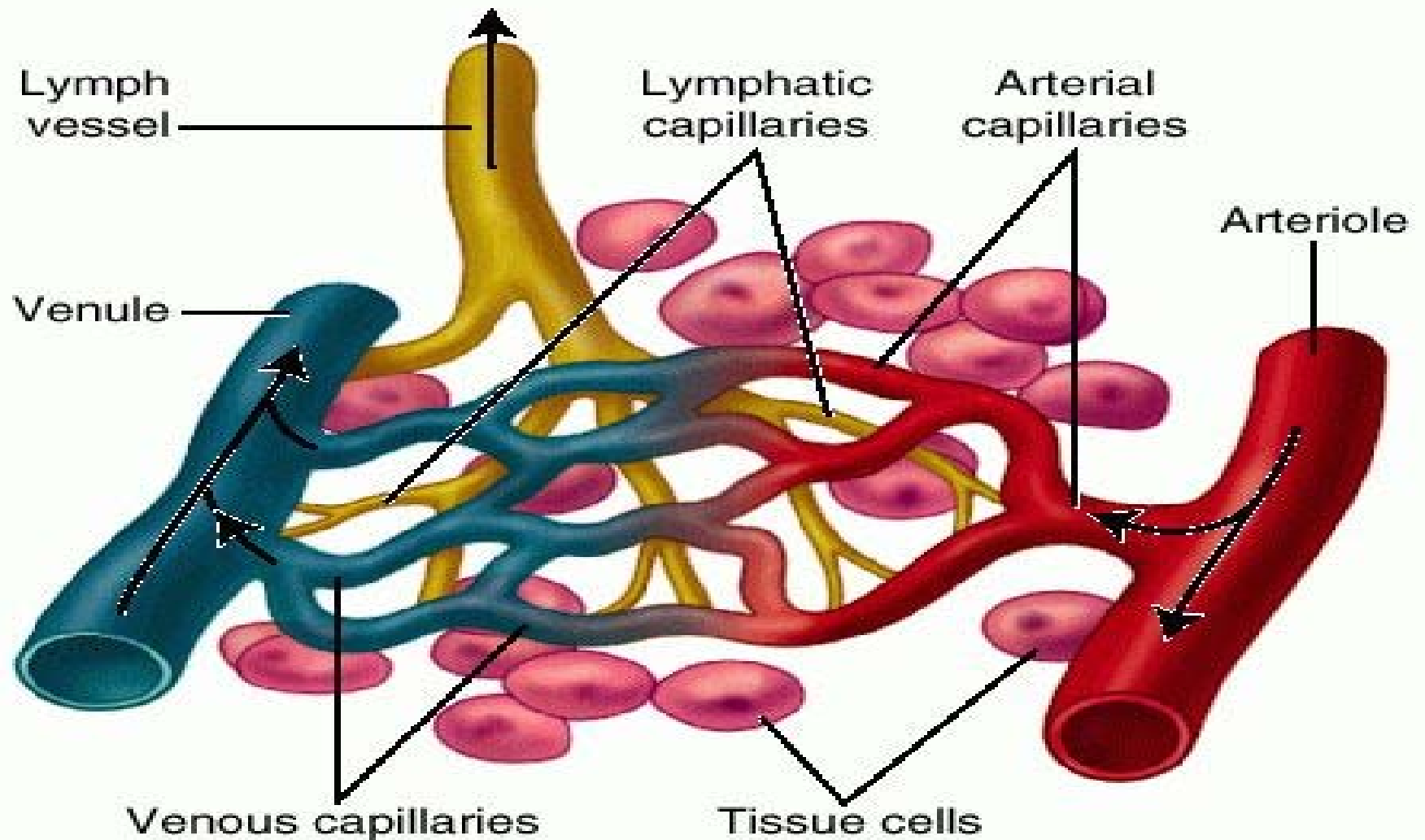






# What is going on at the tissue level?

# Capillary system



# Hypoperfusion (shock)

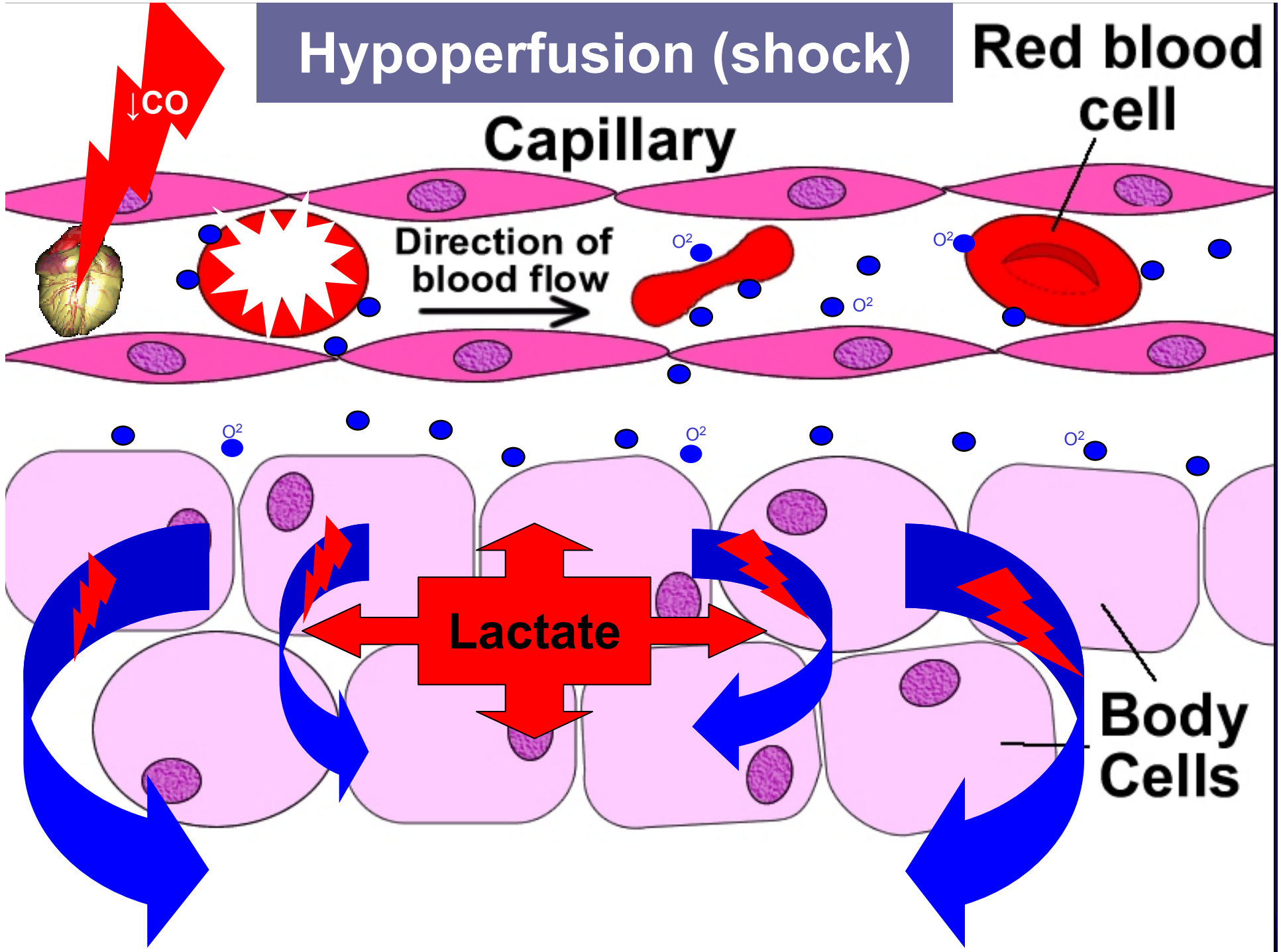
Red blood cell

Capillary

Direction of blood flow

Lactate

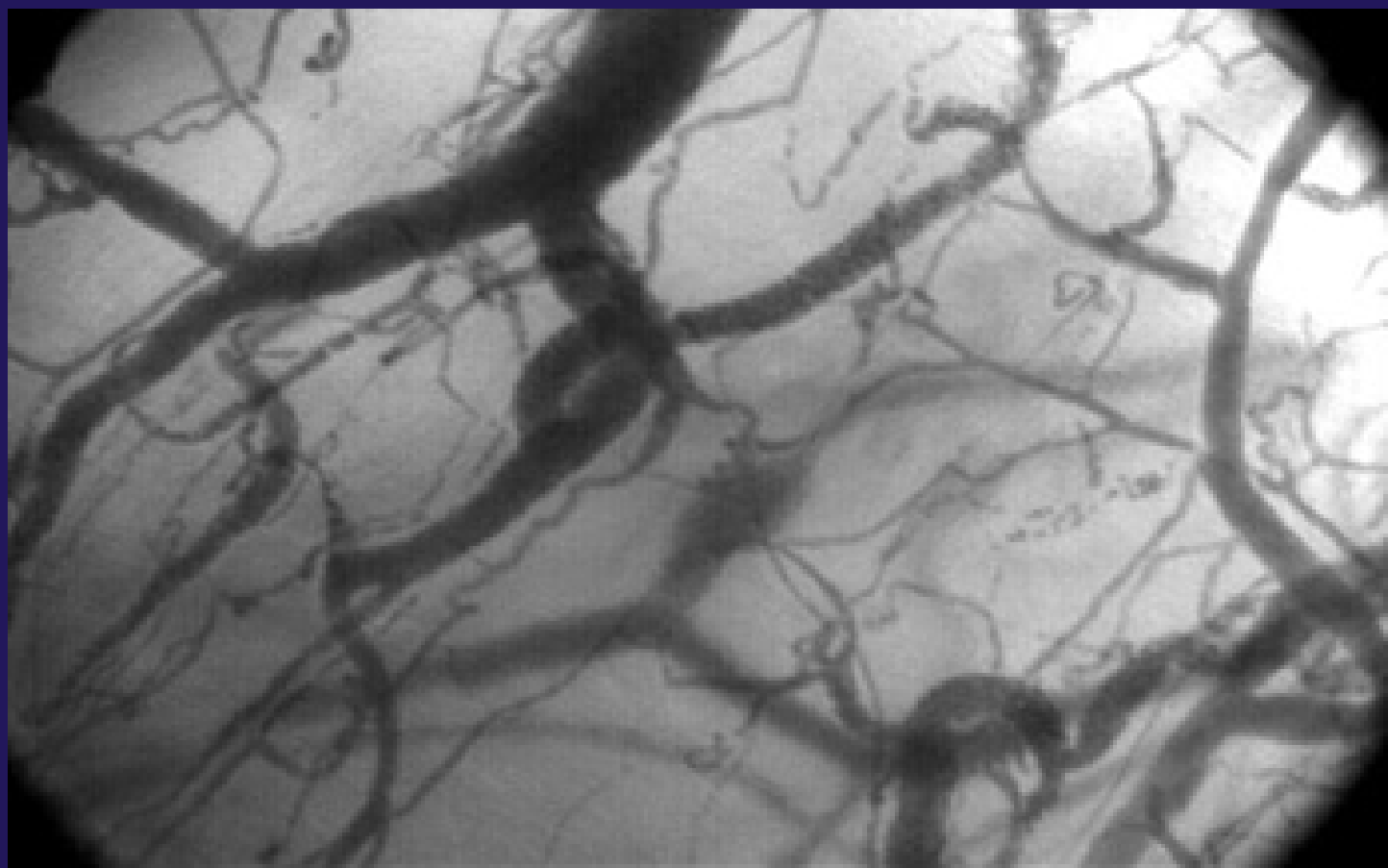
Body Cells







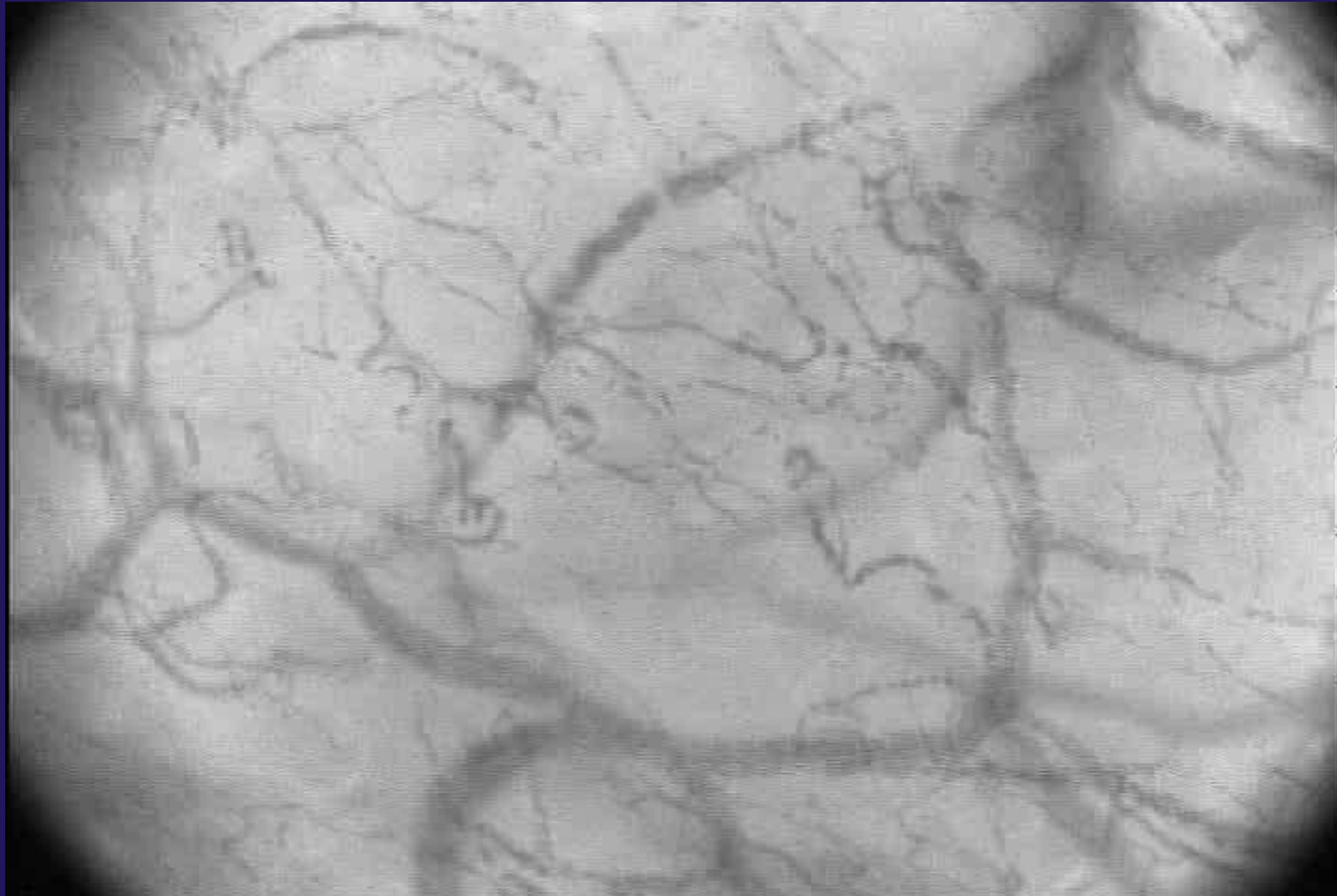
# OPS: A Picture is Worth a Thousand Words?



## Normal Sublingual Circulation



# Normal Capillary Bed



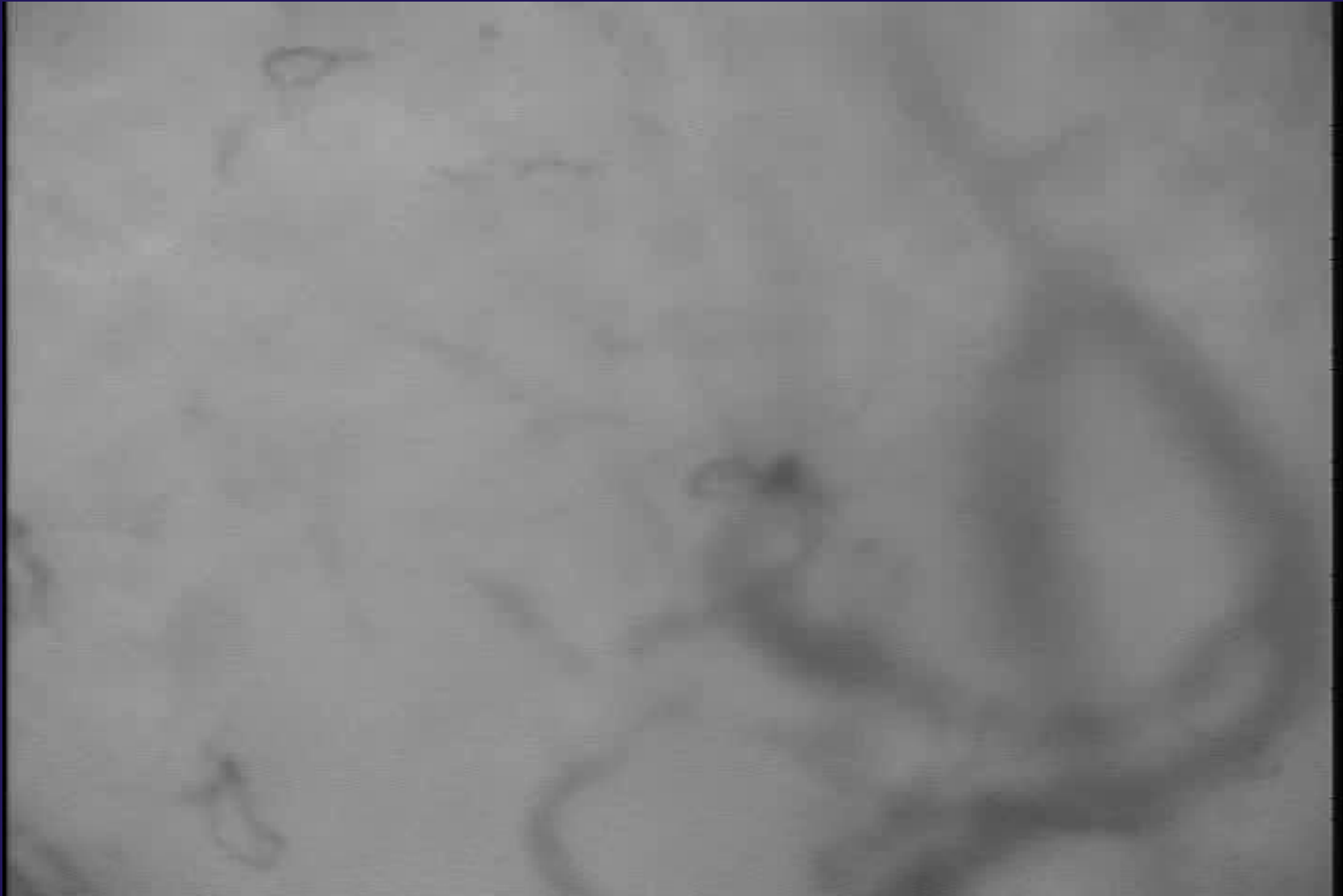


# Sublingual Circulation in Shock





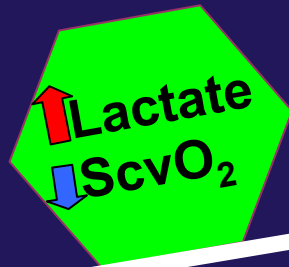
# Sublingual Circulation in Shock



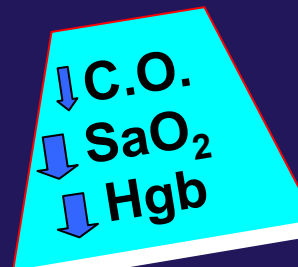


# The Balance of Life

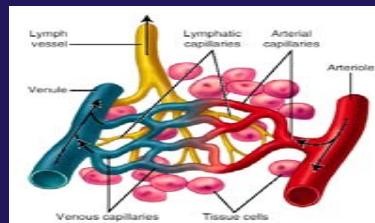
Oxygen Extraction  
(Metabolic needs  
of the tissues)



Oxygen Delivery



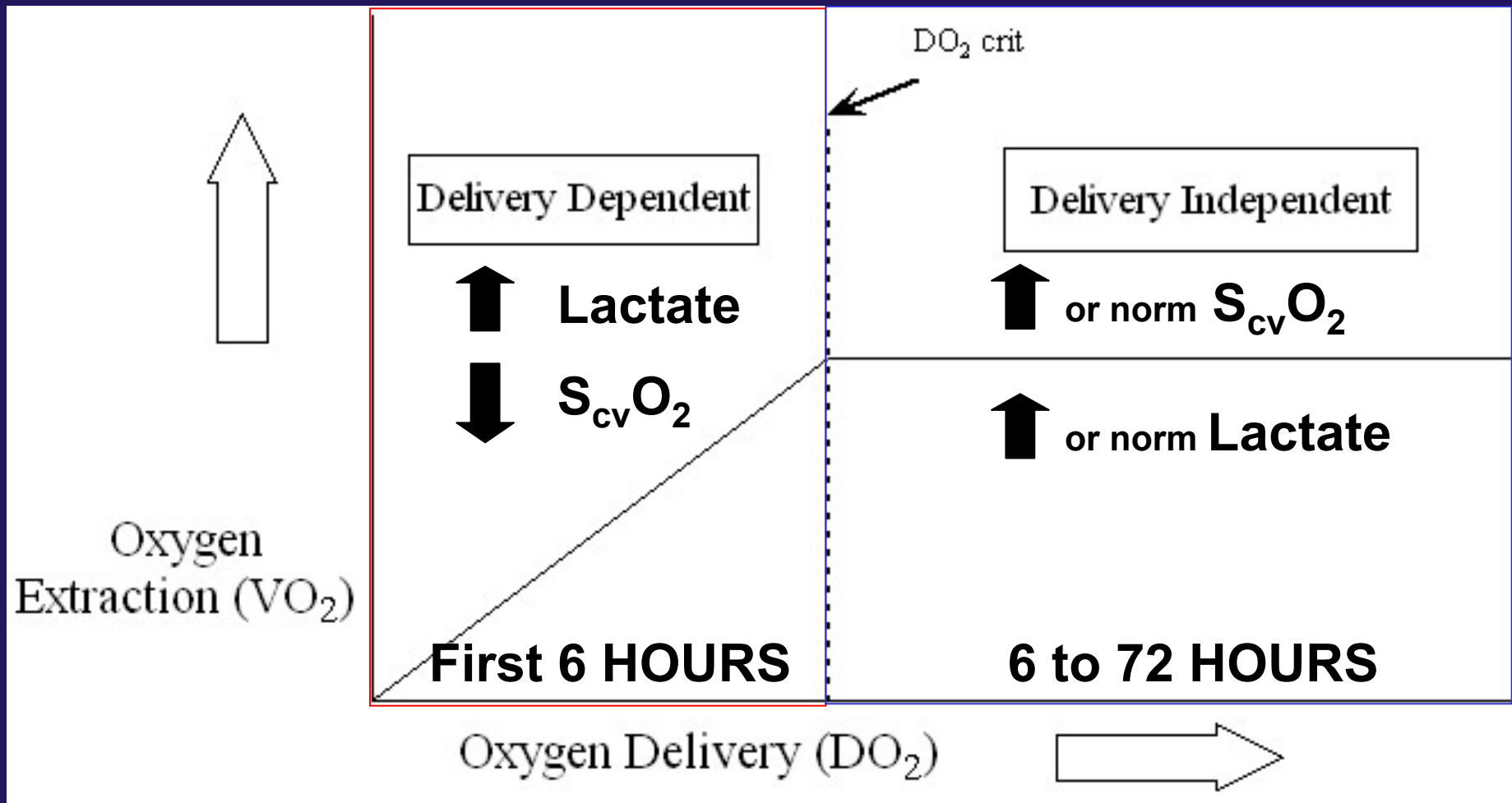
Microvascular  
Alterations



Oxygen Utilization



# Oxygen Delivery Basics



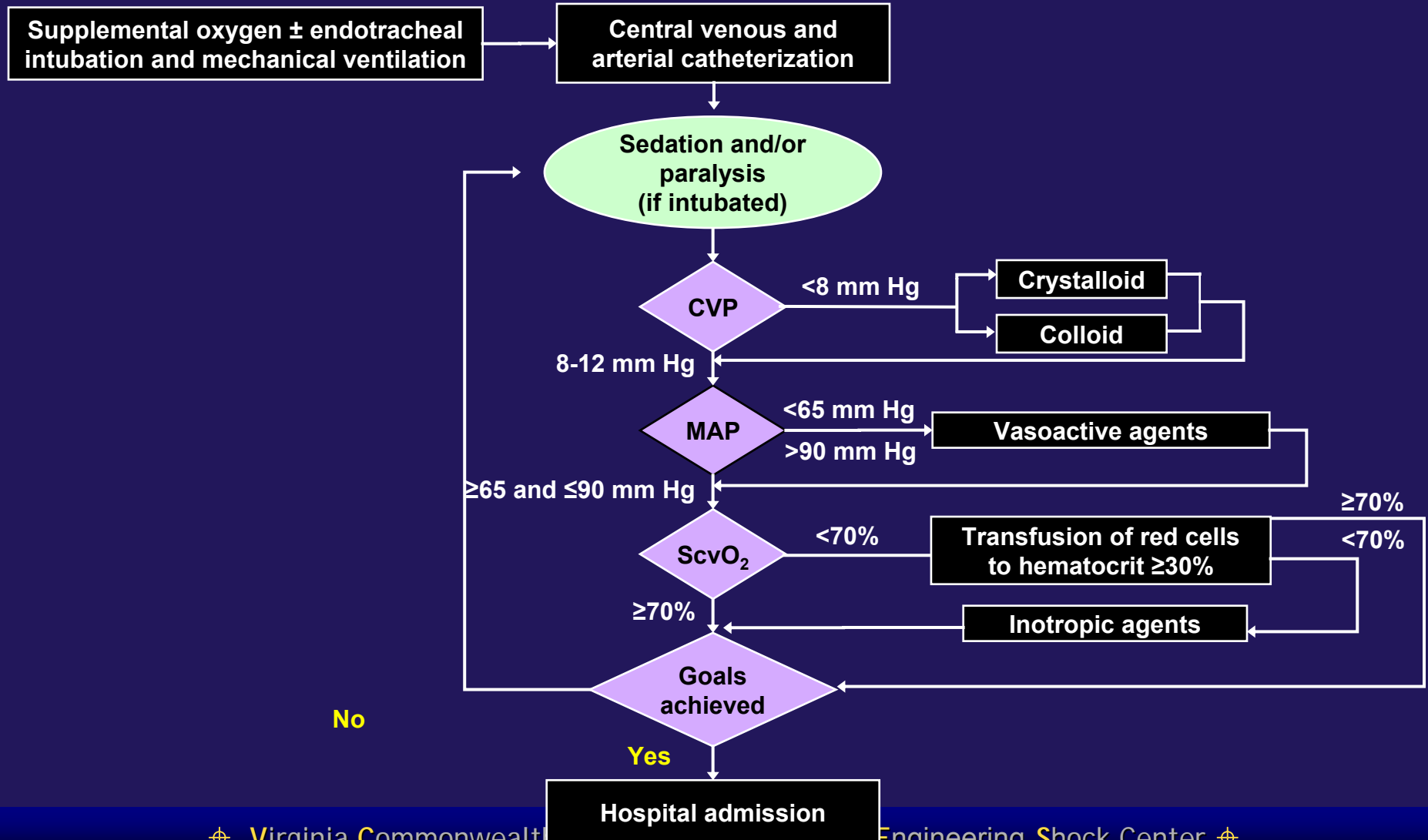


**How do we bring our septic shock patient back into “balance”?**



# Early Goal-directed Therapy

Rivers, EP et. al. Early Goal Directed Therapy In The Treatment Of Severe Sepsis And Septic Shock. 2001, Nov 8, NEJM, 345:19.







# Mortality

	Control	EGDT	RR (95% C.I.)	P-value
In-hospital	46.5	30.5	0.58 (0.38-0.87)	0.009
28-day	49.2	33.3	0.58 (0.39 – 0.87)	0.01
60-day	56.9	44.3	0.67 (0.46-0.96)	0.03

# EGDT Therapy Comparison – Timing is Everything!



	0 – 6 hr	7 – 72 hr	0 – 72 hr
<b>Total Fluid (cc)</b>			
EGDT	4,981*	8,625	13,443
Control	3,499	10,602*	13,358
<b>Transfusion</b>			
EGDT	64%*	11%	68%*
Control	19%	33%*	45%
<b>Vasopressor</b>			
EGDT	27%	29%	37%
Control	31%	43%*	51%*
<b>Inotrope use</b>			
EGDT	14%*	15%	15%
Control	1%	8%	9%
<b>Ventilator use</b>			
EGDT	53%	3%	56%
Control	54%	17%*	71%*



**Is this practical?**



# EGDT Experiences at Two Hospitals

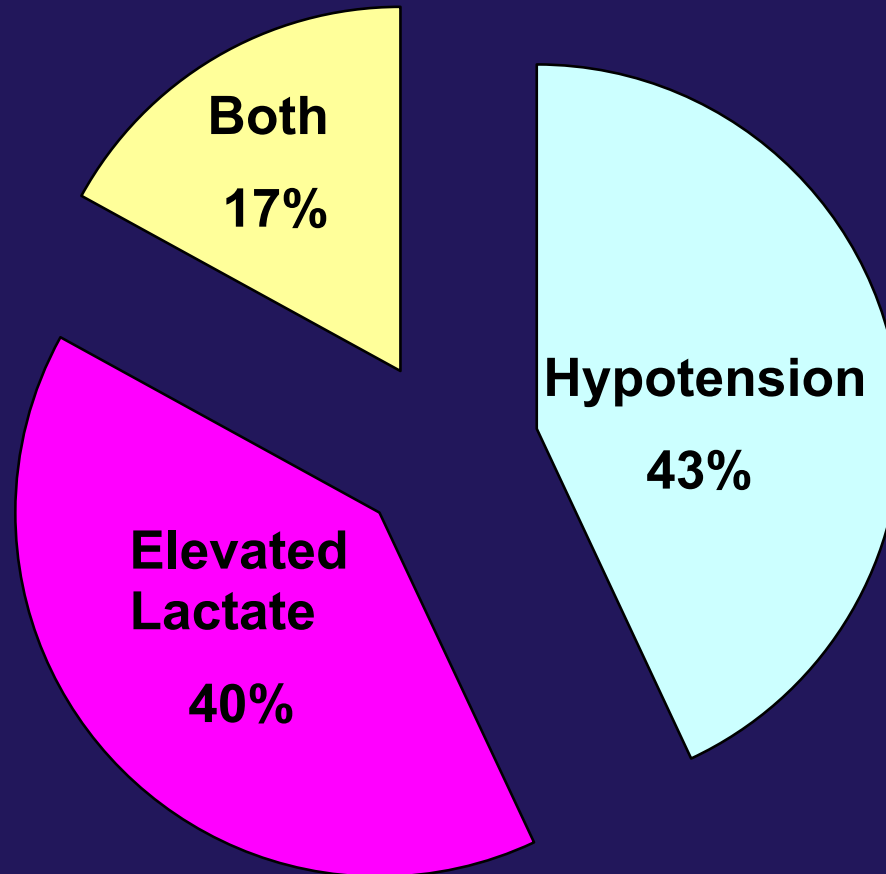
## ✱ Brown University

- ✱ Primarily ED identifies and EGDT team does the resuscitation

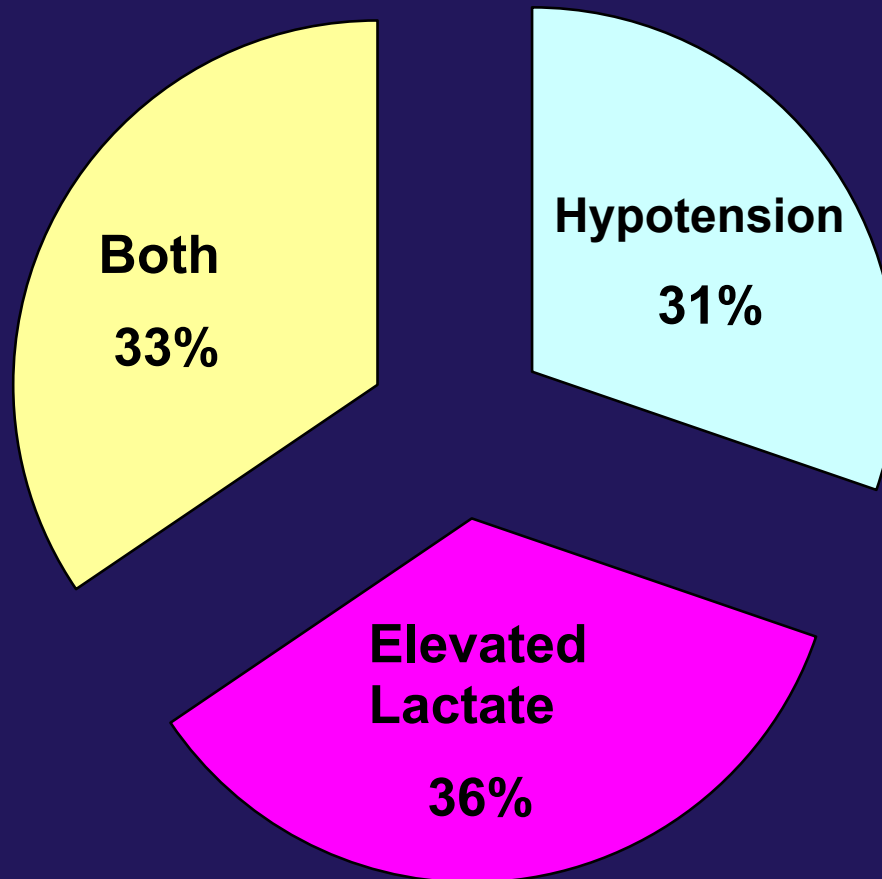
## ✱ Beth Israel Deaconess Medical Center

- ✱ ED identifies and ICU team does the resuscitation

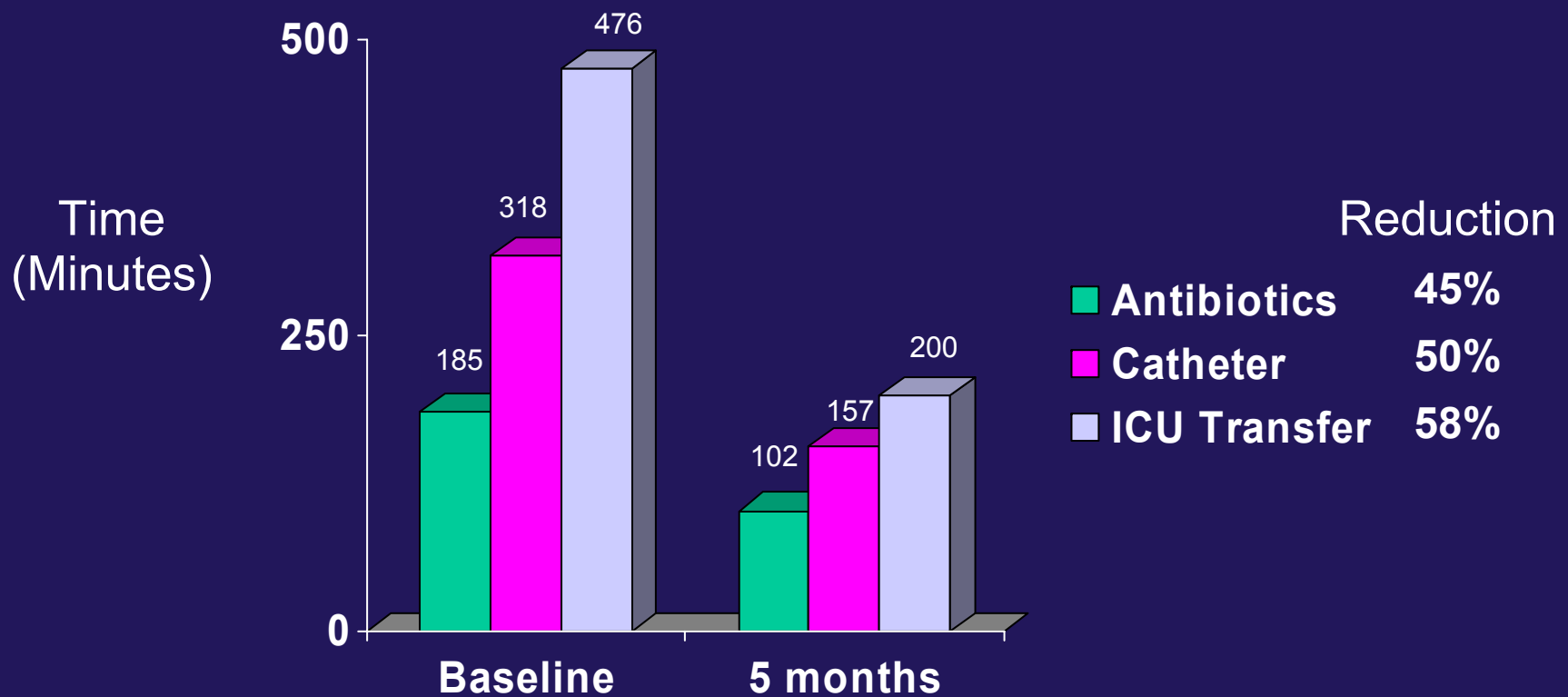
# Brown University ED Trigger to Start EGDT



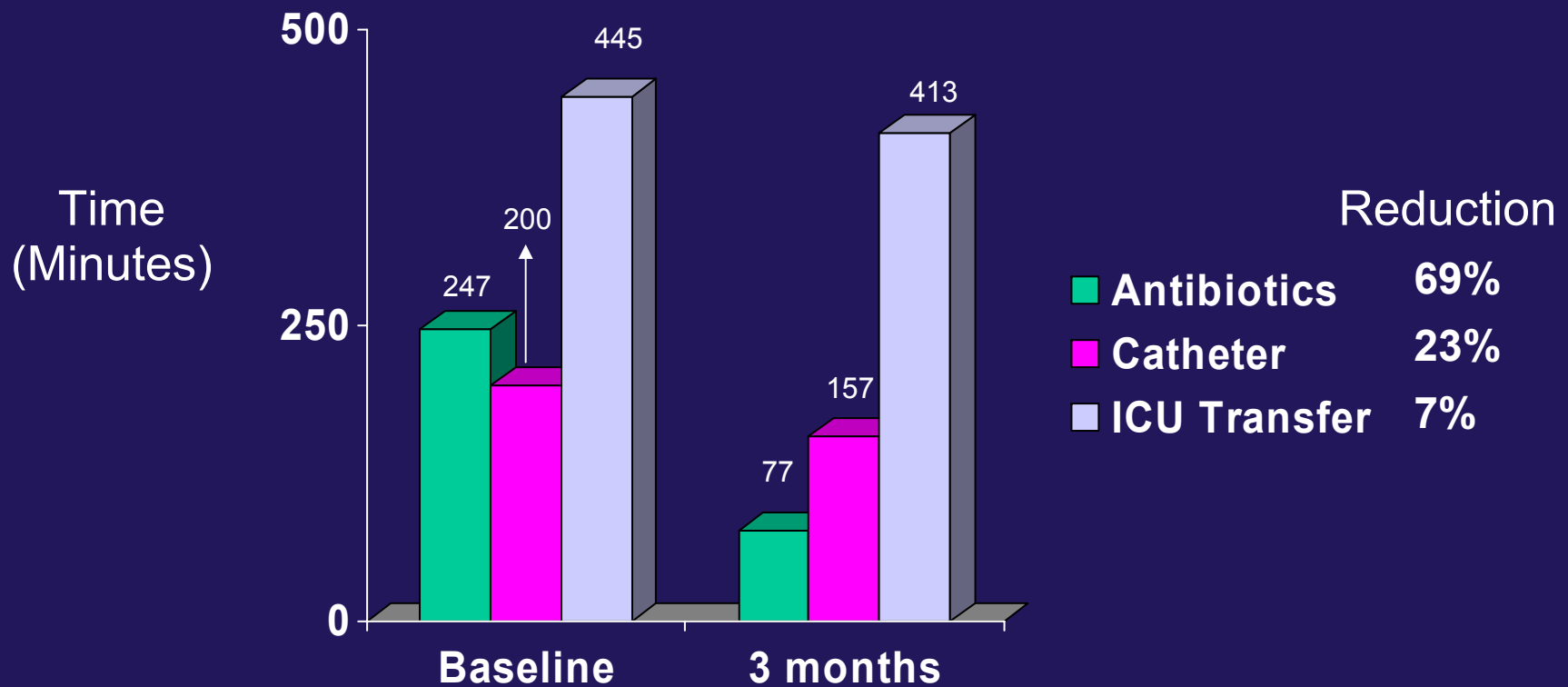
# BIDMC ED Trigger to Start EGDT



# Time for Sepsis Therapies in ED – Brown University



# Time for Sepsis Therapies in ED – BIDM







# Time to Catheter Insertion (EGDT starting)

## ✱ Both centers combined and mean times used

- ✱ Before teams formed
  - ⊗ 254 minutes (4.2 hours)
- ✱ After teams formed
  - ⊗ 157 minutes (2.6 hours)



# Common Findings

## ☀ Both institutions had difficulties –

- ☀ Most common
  - ⊕ Patient identification
  - ⊕ Line insertion

## ☀ Lactate used as a trigger = 73% of the cases!

- ☀ Lactate alone up to 40%
- ☀ Lactate with hypotension up to 33%

## ☀ TIME is TISSUE

- ☀ Early detection of tissue hypoxia is ESSENTIAL



# EGDT Pitfalls - Survey

- ✱ ED Physicians unfamiliarity with continuum of Sepsis
- ✱ Unfamiliarity with cryptic shock, only follow vital signs
- ✱ Screening in triage not sensitive enough to identify cryptic shock
- ✱ ED Physicians may have limited resources
- ✱ Many hospitals don't routinely test for Lactate or it is delayed several hours
- ✱ Possibly patients with cryptic shock are admitted to floor or even discharged home without addressing oxygen debt
- ✱ Even in prestigious medical centers with an EGDT system in place, a delay of over 2<sup>1/2</sup> hours occurs before EGDT can be started



**Can we do better?**

**Can we detect  
hypoperfusion in the  
field?**



**Lactate = the biochemical  
vital sign for hypoperfusion**

# Lactate = First biochemical vital sign!!



## ☀ Lactate is a familiar marker

- ☀ Weil shown lactate predicts mortality in 60's
- ☀ Compare to BNP or Troponin where clinicians are still getting used to interpreting the results and various assays
- ☀ Mortality outcome prediction has held the test of time
- ☀ Does not matter what causes elevated lactate (topic of debate)
- ☀ Smaller studies validate usage in several disease states
  - ☀ Cardiac
  - ☀ Infectious
  - ☀ Trauma
  - ☀ Abdominal pain



# Lactate is not a new marker

- ✱ Margaria R, Edwards R, Dill D. The possible mechanisms of contracting and paying the oxygen debt and the role of lactic acid in muscular contraction. *Am J Physiol* 1933, 106:689-715.
- ✱ Broder, G and Weil, M. H. Excess lactate: an index of reversibility of shock in human patients. *Science* 1964, 143:1457.
- ✱ Schweizer O, Howland WS. Prognostic significance of high lactate levels. *Anesth Analg* 1968, 47:383-388.
- ✱ Cowley RA, Attar S, LaBrosse E, McLaughlin J, Scanlan E, Wheeler S et al. Some significant biochemical parameters found in 300 shock patients. *J Trauma* 1969, 9:926-938.
- ✱ Weil MH, Afifi AA. Experimental and clinical studies on lactate and pyruvate as indicators of the severity of acute circulatory failure (shock). *Circulation* 1970, 41:989-1001.



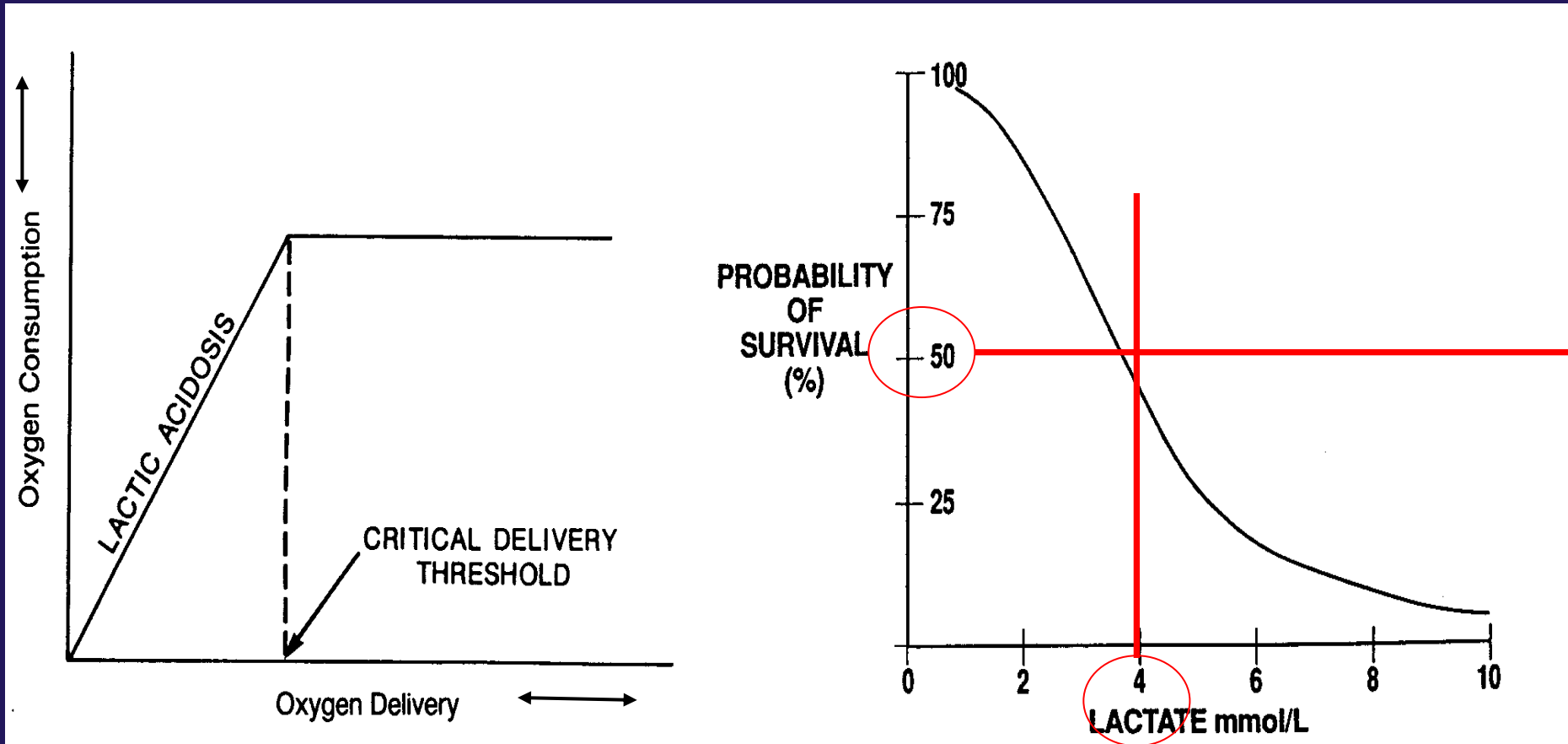
# Lactate still correlates with severity of illness

- ✱ Bakker J, Coffernils M, Leon M, Gris P, Vincent JL. Blood lactate levels are superior to oxygen-derived variables in predicting outcome in human septic shock. *Chest* 1991, 99:956-962.
- ✱ Abramson D, Scalea TM, Hitchcock R, Trooskin SZ, Henry SM, Greenspan J. Lactate clearance and survival following injury. *J Trauma* 1993, 35:584-588.
- ✱ Bakker J, Gris P, Coffernils M, Kahn RJ, Vincent JL. Serial blood lactate levels can predict the development of multiple organ failure following septic shock. *Am J Surg* 1996, 171:221-226.
- ✱ Nguyen HB, Rivers EP, Knoblich BP, Jacobsen G, Muzzin A, Ressler JA et al. Early lactate clearance is associated with improved outcome in severe sepsis and septic shock. *Crit Care Med* 2004, 32:1637-1642.





# Lactate and Outcome

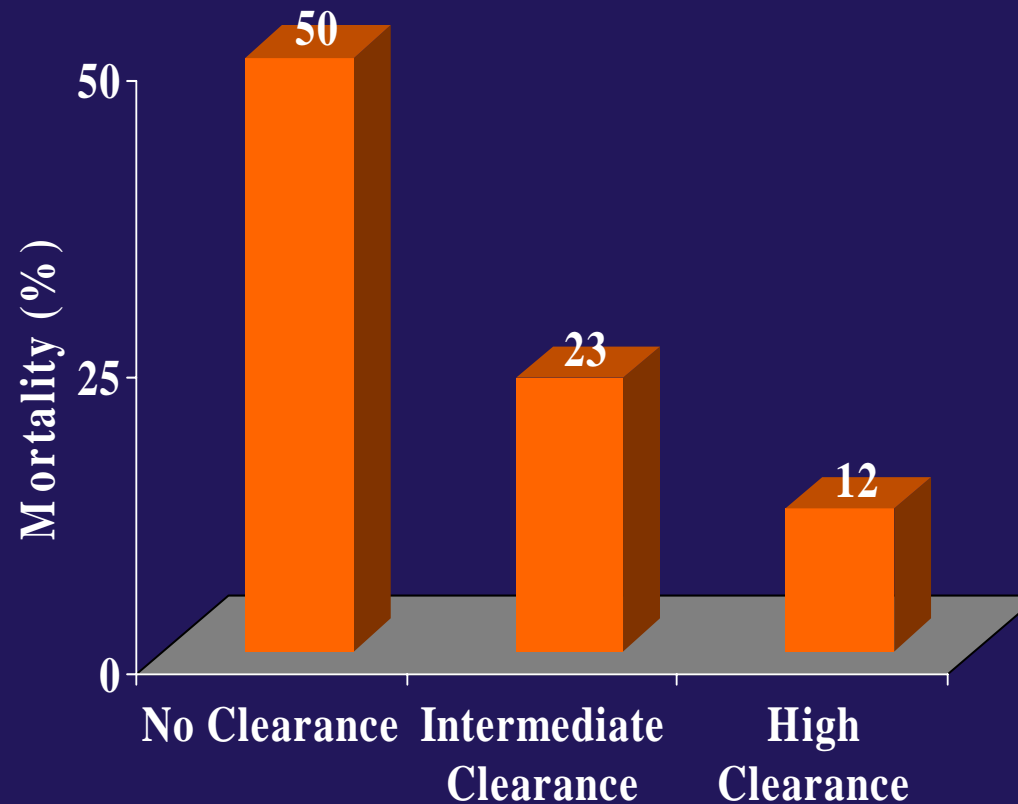


(Mizock, Dis Mon, 1989)

(Weil, Circulation, 1970)



# Lactate Clearance and Mortality

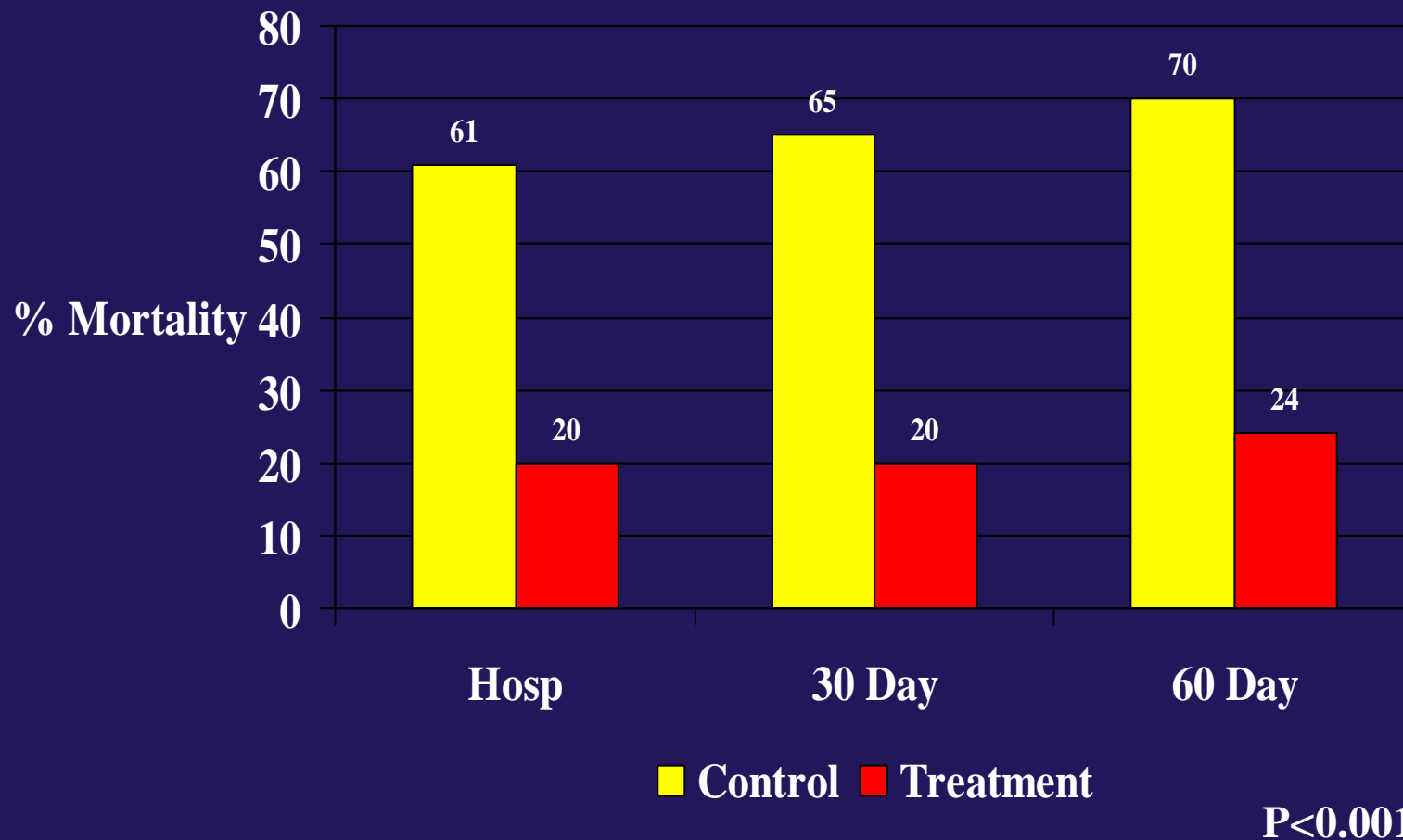


(Knoblich and Rivers, Acad Emerg Med, 1999)



# Cryptic Shock

Outcomes of Patients with a Baseline MAP > 100, Lactate > 4 mM/L  
Control n = 33 and Treatment n = 30





# Why should we detect hypoperfusion in the field

- ✱ Start therapy early (IV fluids)
- ✱ Triage to appropriate ED
- ✱ Monitor resuscitation (lactate clearance)
- ✱ Start definitive care in the ED earlier
- ✱ Improve outcome?



# How do you check lactate in the field?



Abbott i-Stat  
CLIA Mod-complex



Lactate Pro  
CLIA Waived



Roche Accutrend  
Lactate  
CLIA Mod-complex





# Why is it so hard to get adequate resources to treat sepsis?





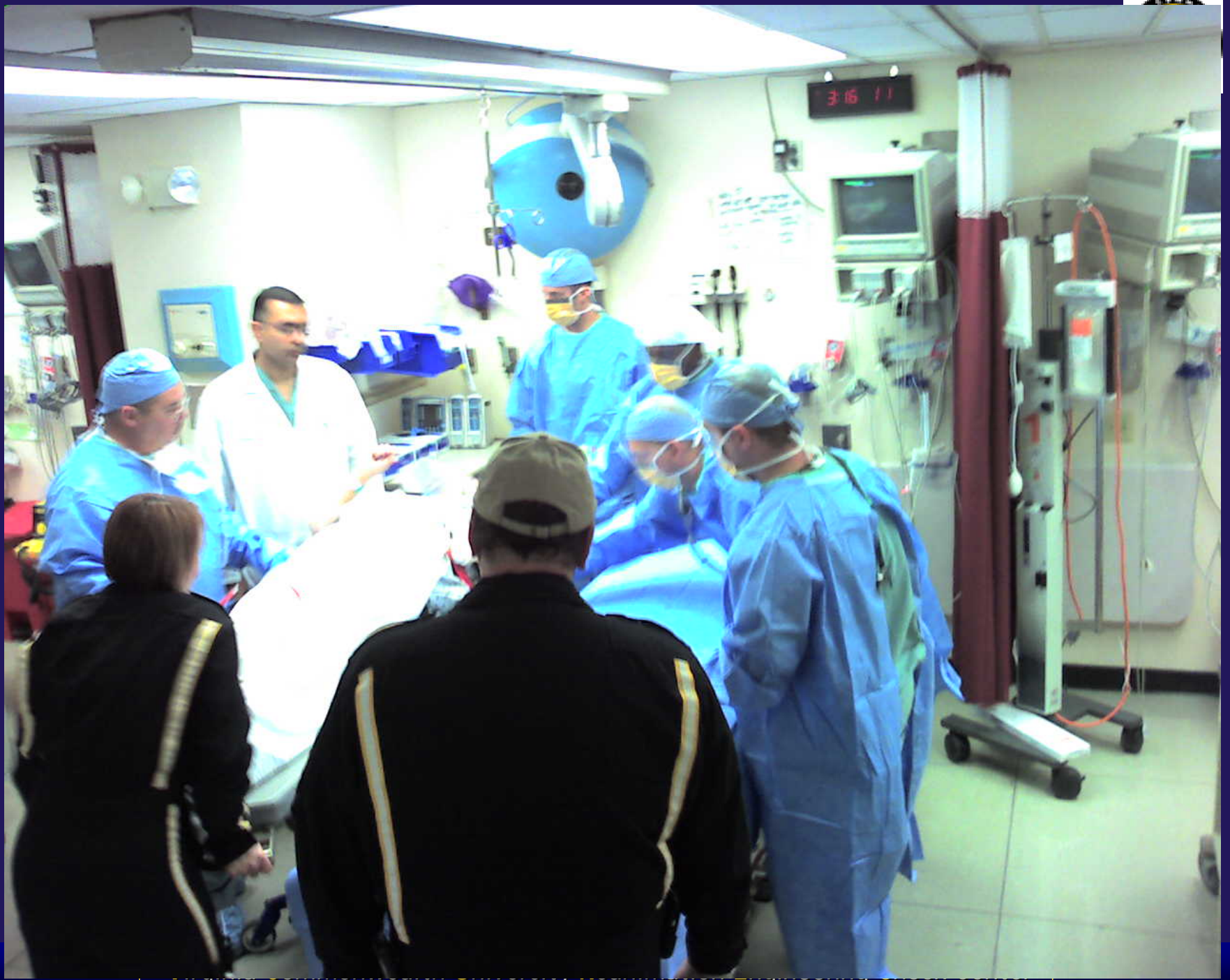
# Damn Marketing!!!

- ☀ **Heart – Thrombolytics (< 6hr onset): 1.5% ARR**
  - ☀ PTCA “Door to balloon time” < 1 hr vs up to 90 min: 4% ARR
- ☀ **Brain – rTPA : 90 min, 30% increase in functional neurologic outcome up to 90 days after.** (*Tissue plasminogen activator for acute ischemic stroke. N Engl J Med 1995*)
  - ☀ 3X the rate of ICH vs control
- ☀ **Trauma – “Golden Hour”** *R Adams Cowley, MD* coined this phrase in the 1970’s
  - ☀ Trauma centers, trauma teams
- ☀ **Severe Sepsis – Early Goal Directed Therapy: 6 hours**
  - ☀ ARR of 16% - Best results of any sepsis trial to date
  - ☀ ?????? How do you make Pus and Sepsis Sexy?!













10

11

9

8

7

6

1

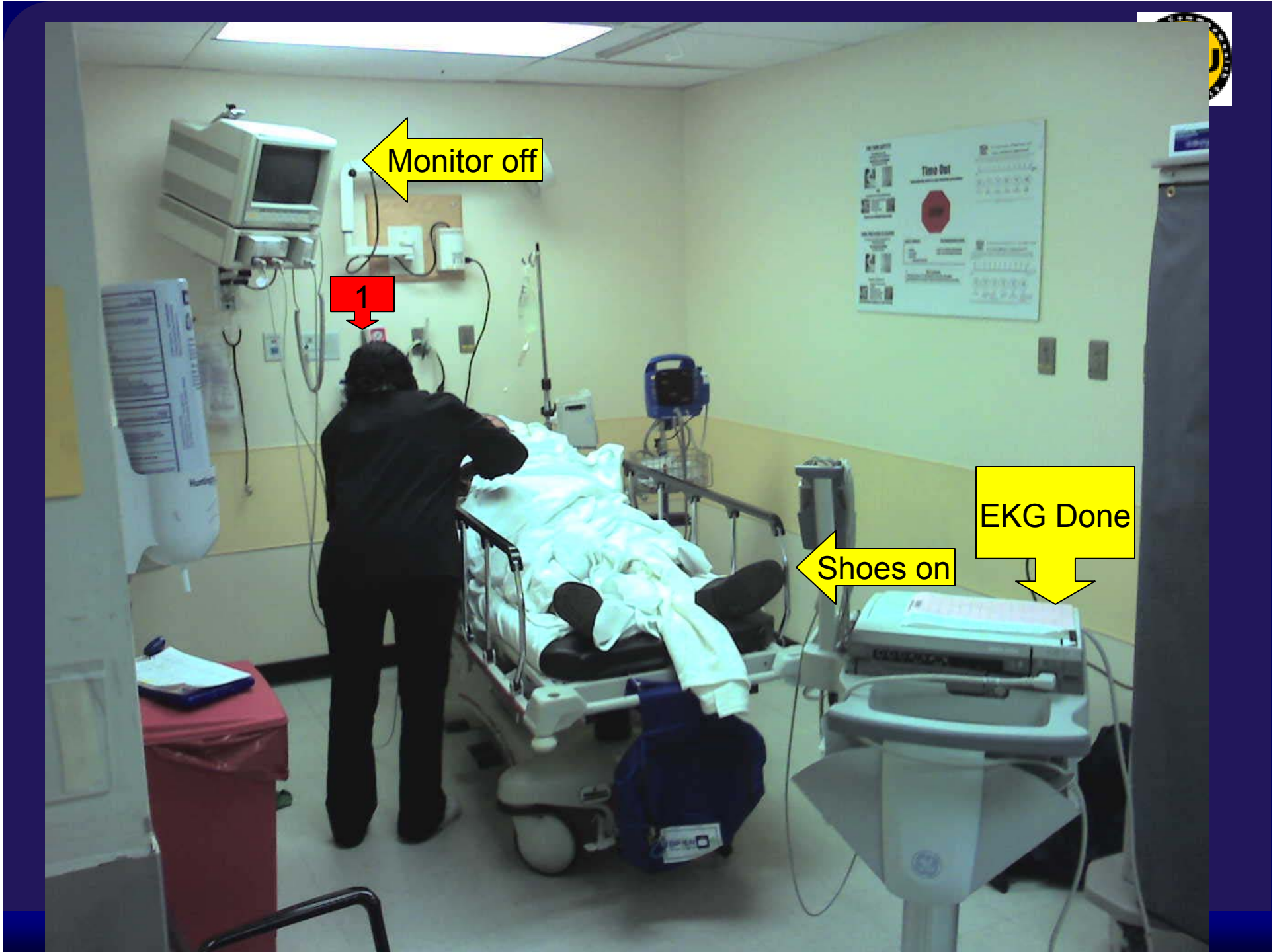
5

4

2

3

12



Monitor off

1

Shoes on

EKG Done





# Time is Tissue!

- ☀ **Need to identify hypoperfusion as early as possible**
- ☀ **Need to start treating the hypoperfusion**
- ☀ **Transfer to definitive care center**
  - ☀ Trauma Center
  - ☀ Cardiac Cath Center
  - ☀ Stroke Center
  - ☀ ?Sepsis Center?
  - ☀ ?Shock Center?



# What's New? Possible Future Direction

## EMS Lactate!



# Why should we detect hypoperfusion in the field?

- ✱ Triage to appropriate ED
- ✱ Treatment
  - ✱ Start therapy early (IV fluids)
- ✱ Monitor resuscitation (lactate clearance)
- ✱ Transport to the appropriate ED
- ✱ Start definitive care in the ED earlier
- ✱ Improve outcome?



Abbott i-Stat  
CLIA Mod-complex



Lactate Pro  
CLIA Waived



Roche Accutrend  
Lactate  
CLIA Mod-complex

# Lack of correlation between lactate and hemodynamics



## Lactate Tiers

Hemodynamic Variables	Lactate Tiers			
	Total n = 857	Normal ( $< 2.5$ ) n = 599	Intermediate ( $2.5 - 3.9$ ) n = 140	High ( $\geq 4.0$ ) n = 118
HR (BPM)	r = 0.15 (0.08 to 0.21)	r = 0.09 (0.01 to 0.17)	r = -0.15 (-0.31 to 0.01)	r = 0.13 (-0.05 to 0.30)
SBP (mmHg)	r = -0.08 (-0.14 to -0.01)	r = -0.01 (-0.09 to 0.07)	r = -0.23 (-0.07 to -0.038)	r = -0.01 (-0.19 to 0.18)
DBP (mmHg)	r = 0.14 (-0.21 to -0.07)	r = -0.04 (-0.12 to 0.05)	r = -0.26 (-0.41 to -0.09)	r = -0.08 (-0.26 to 0.11)
MAP (mmHg)	r = -0.15 (-0.21 to -0.08)	r = -0.03 (-0.10 to 0.06)	r = -0.26 (-0.41 to -0.10)	r = -0.10 (-0.28 to 0.08)
Shock Index HR/SBP	r = 0.20 (0.13 to 0.26)	r = 0.07 (-0.01 to 0.15)	r = 0.09 (-0.08 to 0.25)	r = 0.10 (-0.08 to 0.28)

Gunnerson KJ, et al. Chest, Oct 1, 2008, 134:65003S

# Cryptic Shock?



Lactate Tier (mmol / L)	Systolic Blood Pressure (mm / Hg)	
	≤ 90	> 90
< 2.5 (n = 599)	14 (2.3%)	585 (97.7%)
2.5 – 3.9 (n = 140)	11(7.9%)	129 (92.1%)
≥ 4.0 (n = 118)	12 (10.2%)	106 (89.8%)

Table 1. Number of patients in each lactate level tier and their association with hypotension (defined by a SBP ≤ 90 mm/Hg). Total n = 857

\*14% of all transports had HIGH lactate levels (≥ 4)

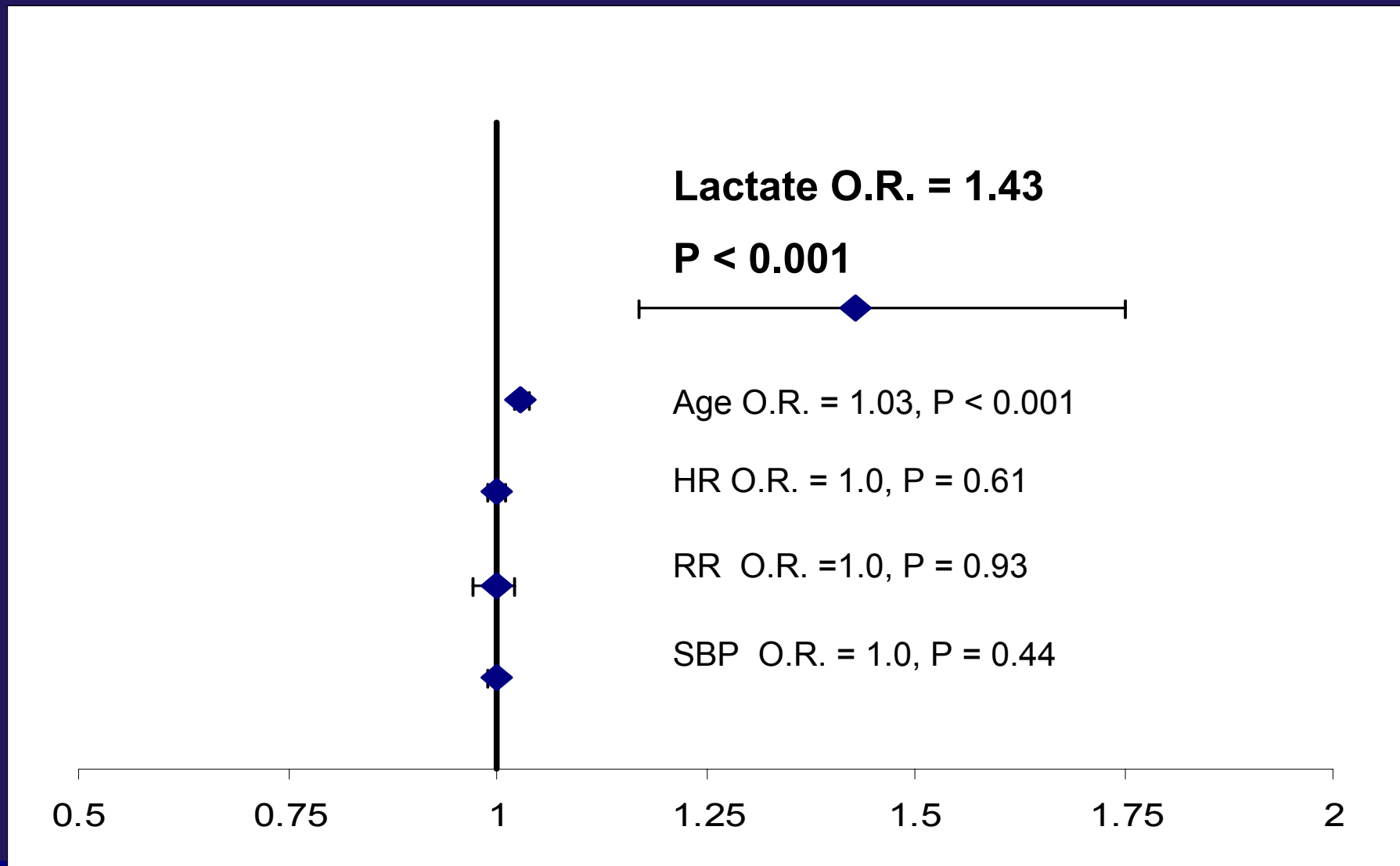
Gunnerson KJ, et al. Chest, Oct 1, 2008, 134:65003S



# Lactate as a predictor of Admission and type of admission

- ✱ 2,034 patients transported to VCU Med Center or community hospitals in Richmond area
- ✱ RAA and Chesterfield Fire and EMS
- ✱ Common EMS vital signs used (HR, BP, GCS, RR, Glucose level, Age) and LACTATE
- ✱ Logistic regression model
- ✱ Only independent predictors of admission
  - ✱ Age
  - ✱ Lactate
- ✱ Lactate was better at predicting admission by more than 40% than all other variables

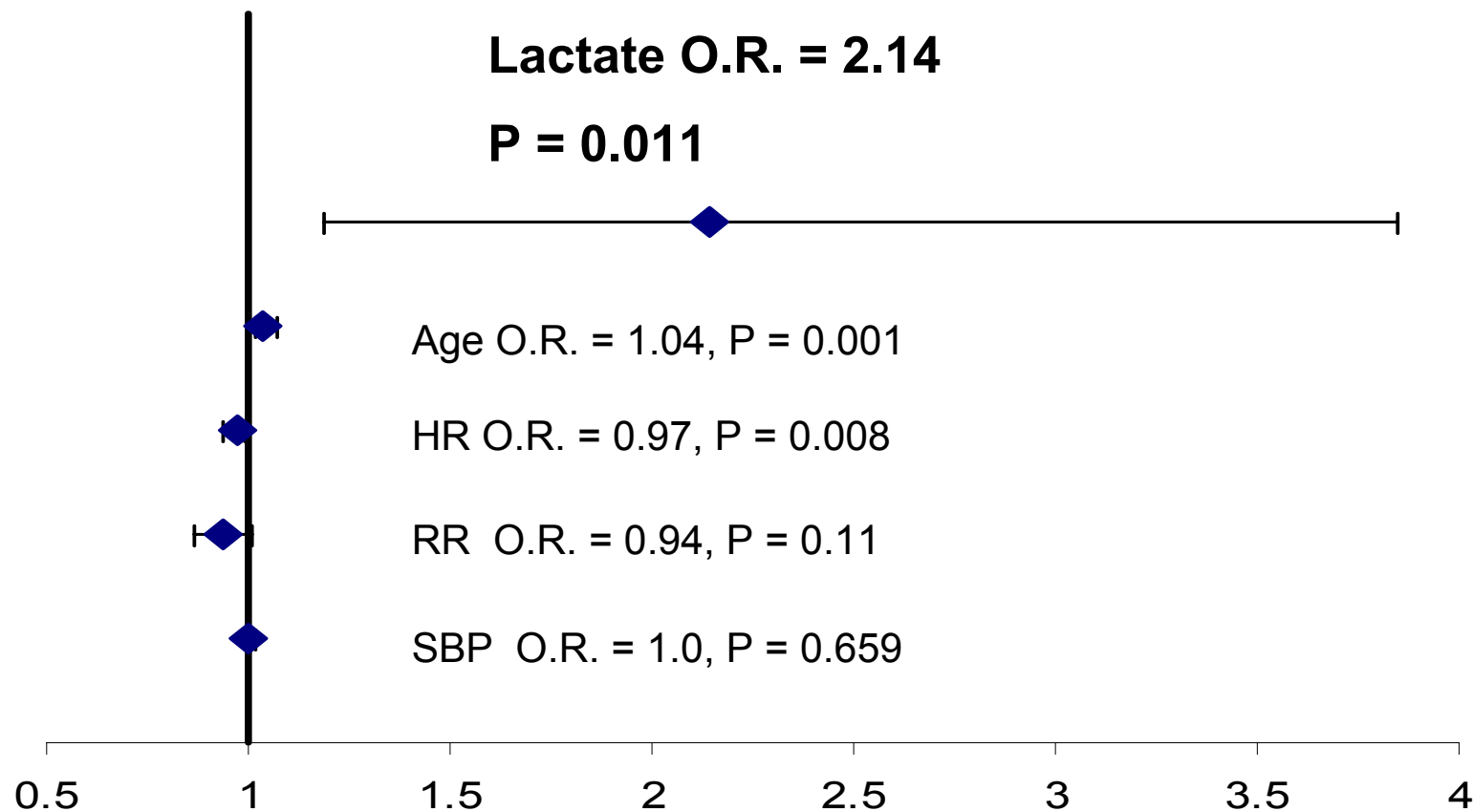
# Pre-hospital Lactate as an independent predictor of admission



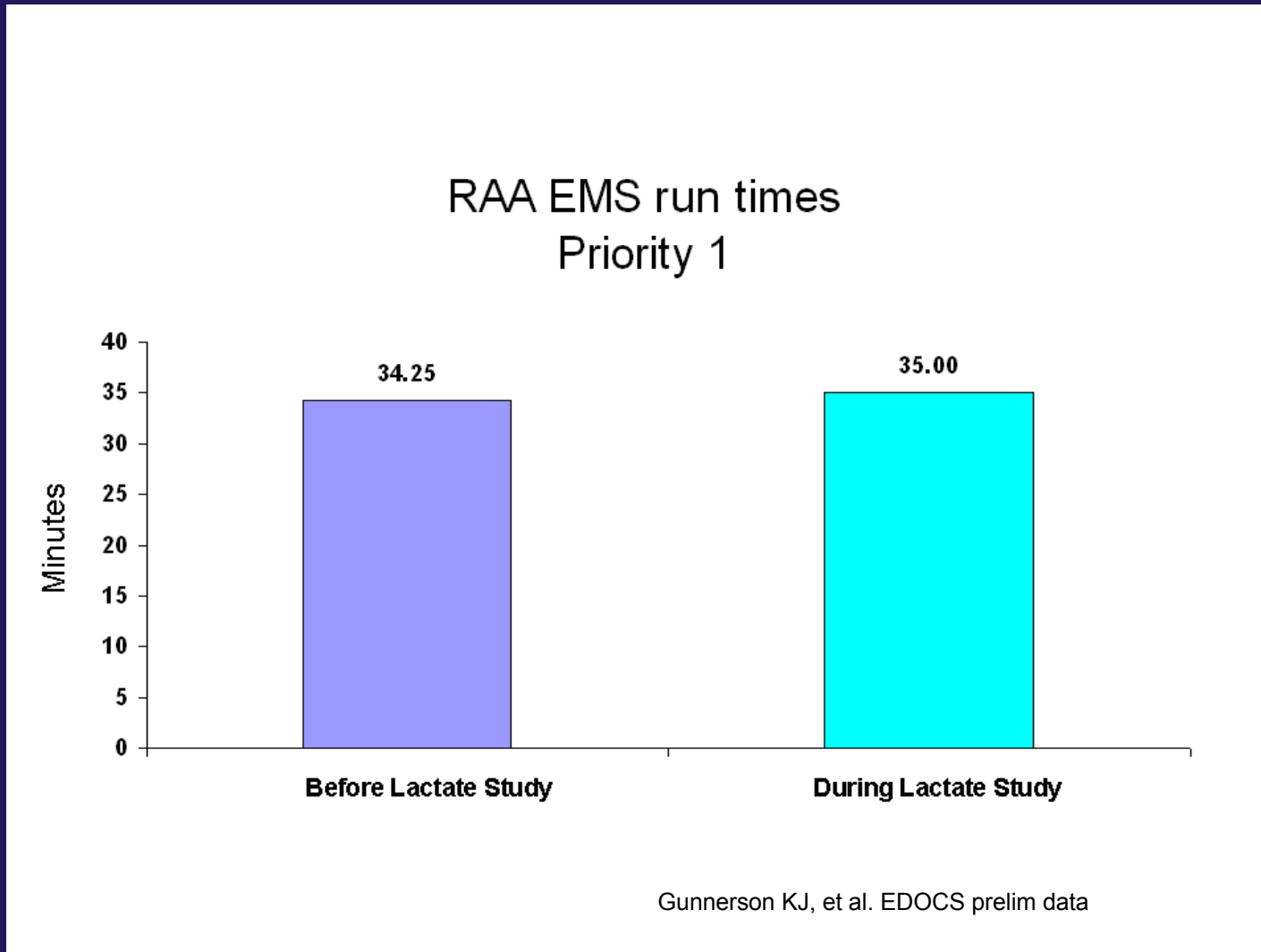




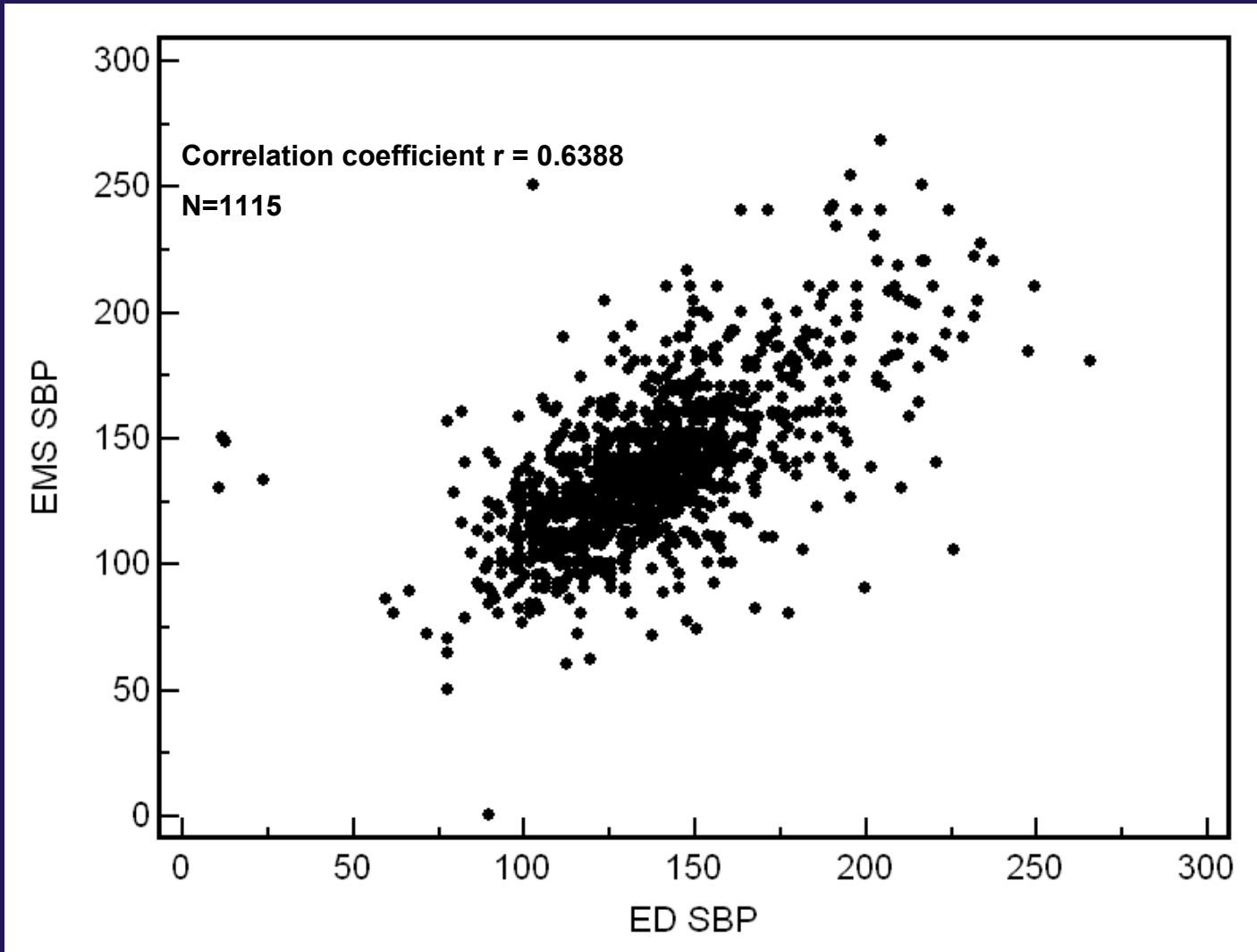
# Pre-hospital lactate as an independent predictor of death



# Does this slow down our paramedics?



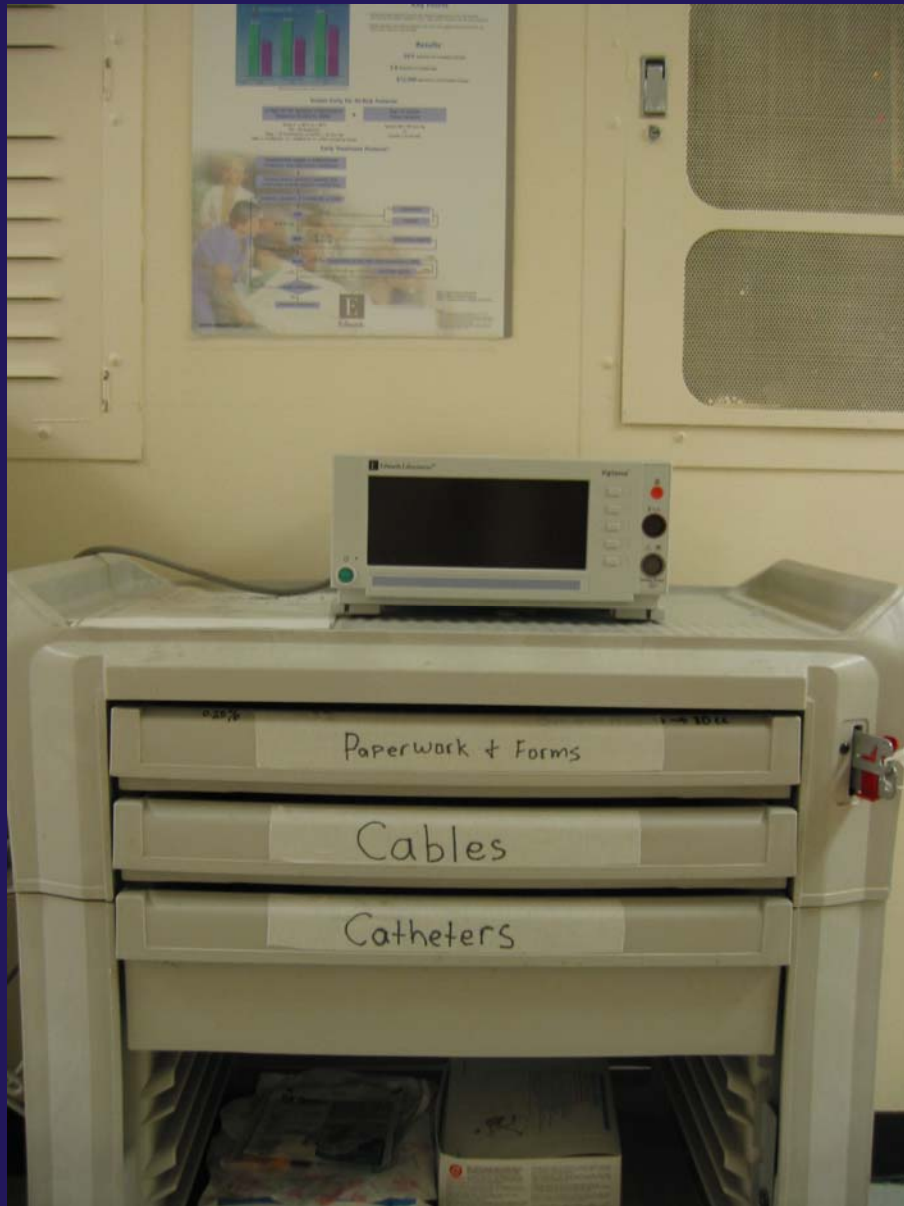
# EMS SBP overestimates ED SBP



Gunnerson KJ, et al. EDOCS prelim data



**What do we do after you drop them off?**



# Surviving Sepsis Campaign



- ✿ **Launched in Fall 2002 as a collaborative effort of European Society of Intensive Care Medicine, the International Sepsis Forum, and the Society of Critical Care Medicine**
- ✿ **Goal: reduce sepsis mortality by 25% in the next 5 years**
- ✿ **Guidelines revealed at SCCM in Feb 2004 and updated in 2008**
  - ✿ *Critical Care Medicine* March 2004 32(3):858-87.
  - ✿ Website: [survivingsepsis.org](http://survivingsepsis.org)



# Background

- ✱ **The Surviving Sepsis Campaign's mission is to increase awareness and improve outcome in severe sepsis**
- ✱ **Guidelines developed by a group of international experts representing 11 organizations**
- ✱ **Developed under unrestricted industry educational grants**
- ✱ **Published in March 3, 2004 issue of *Critical Care Medicine***

Dellinger, et. al. Crit Care Med 2004, 32: 858-873.



# Sponsoring Organizations

- ✿ American Association of Critical-Care Nurses
- ✿ American College of Chest Physicians
- ✿ American College of Emergency Physicians
- ✿ American Thoracic Society
- ✿ Australian and New Zealand Intensive Care Society
- ✿ European Society of Clinical Microbiology and Infectious Diseases
- ✿ European Society of Intensive Care Medicine
- ✿ European Respiratory Society
- ✿ International Sepsis Forum
- ✿ Society of Critical Care Medicine
- ✿ Surgical Infection Society

Dellinger, et. al. Crit Care Med 2004, 32: 858-873.





# Key Components

- ✱ **Fluid resuscitation**
- ✱ **Appropriate cultures prior to antibiotic administration**
- ✱ **Early targeted antibiotics and source control**
- ✱ **Use of vasopressors/inotropes when fluid resuscitation optimized**



# Cases



## Case 1

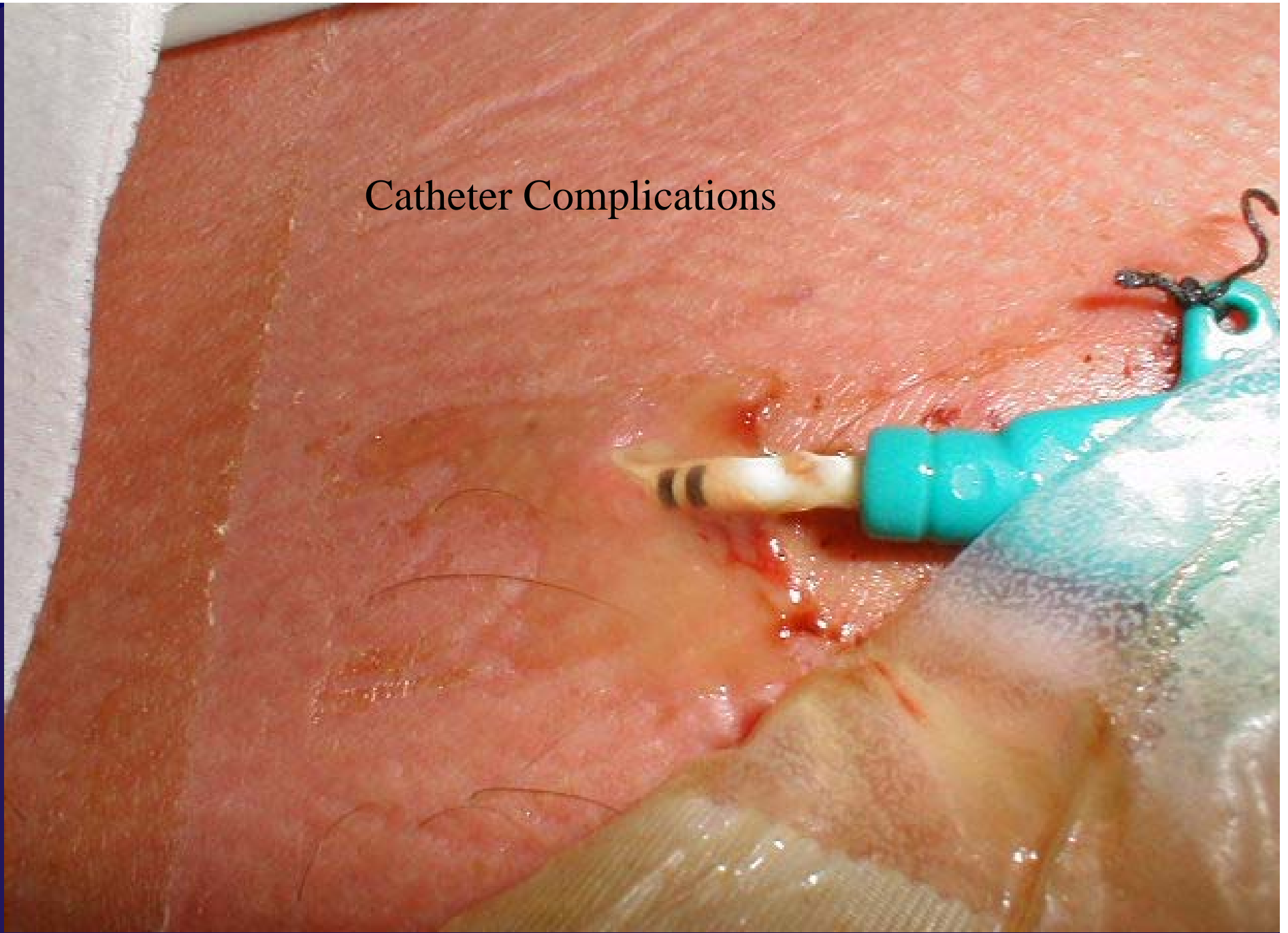
- ✱ 80 y/o Nursing home transfer with mental status changes and decreased urine output
- ✱ HR 110
- ✱ RR 28
- ✱ Temp 102
- ✱ BP 110/50
- ✱ Pulse ox 95% 2l



# Central line



## Catheter Complications





# What is the problem?

☀ Is your patient septic?

☀ Hypoperfusion? Does BP matter?

☀ Lactate in ER 9.5 mmol/L

☀ What are you going to do?



## Case 2

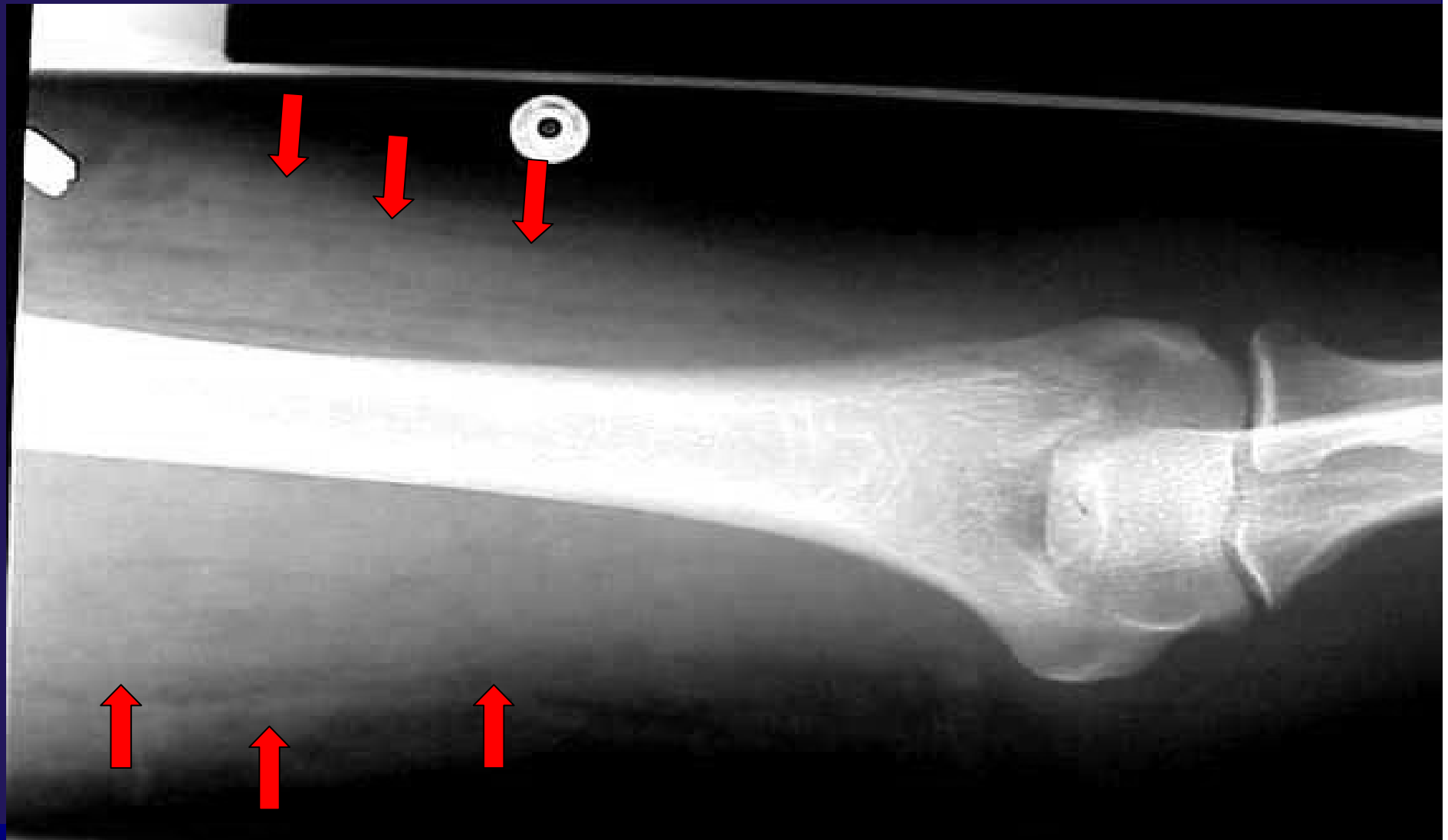
- ☀ 28 y/o male recently discharged from the hospital for an abscess in upper arm
- ☀ He is in severe pain and wants you to take him to the ER for pain meds
- ☀ HR 130
- ☀ BP 100/40
- ☀ RR 22
- ☀ Temp 96
- ☀ Pulse ox 92% on RA

# *Clostridium septicum* of upper arm after IV injection of cocaine

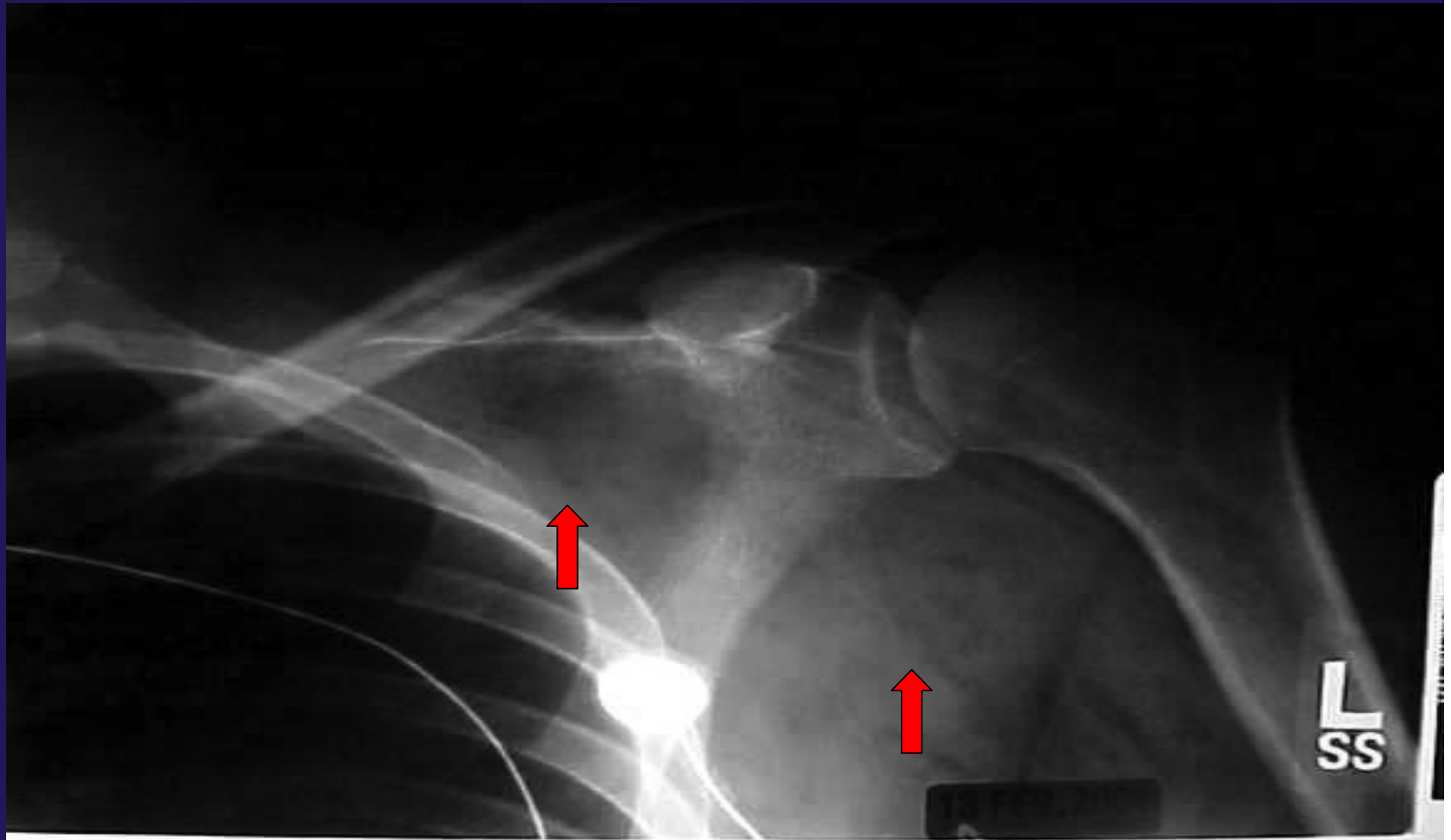




# Sub-Cutaneous emphysema of soft tissue



# Sub-Cutaneous emphysema of soft tissue in chest wall



## Case 3

- ☀ 60 yo female with family, c/o SOB, fever. Family: pt confused
- ☀ HR 130, T=39.8, RR 26, BP=80/30, MAP 55
- ☀ PE: No retractions, no ST infections, Lungs: decreased BS, ABD: s/nt/nd, Ext: no edema, Neck: no JVD





Petechiae ↑

Ecchymoses / Purpurae →

Medscape® www.medscape.com



# Typical EMS Encounter

32 F with hx of asthma  
CC: Difficulty Breathing



**RICHMOND AMBULANCE AUTHORITY** **PRE-HOSPITAL PATIENT CARE REPORT**

MILEAGE: End 102.0, Start 100.0, Total 002.8

ASSESSMENT CODES: Clear Code 13, Assessment 1 253, 2 320, 3

REFUSAL OF SERVICE -- DISCLAIMER: I hereby refuse the services, treatment, and/or transportation recommended and offered to me by personnel of Richmond Ambulance Authority... Acknowledgement: I also acknowledge that I have received a copy of the Richmond Ambulance Authority Notice of Privacy Practices.

Patient, Parent, or Guardian Signature: X Witness: X Date: X

CHIEF COMPLAINT: Diff. Breathing

ALLERGIES: Codine

PRE-EXISTING CONDITIONS: Diabetes II, Aspirin, Codeine

MECHANISM OF INJURY: None

SAFETY EQUIPMENT: None used

INITIALS: VS + BS

LOCATION TYPE: Home - Residence

INCIDENT DISPOSITION: Treated, transported by EMS

DESTINATION: Nearest Regional

RECEIVING FACILITY: Nearest Regional

Virginia Commonwealth University

RAA PPCR version placed in service September 2007

# Typical EMS Encounter

HR = 86

RR = 16

BP = 106/82

LACTATE = 9.6

**RICHMOND AMBULANCE AUTHORITY** PPCR—Page Two

HPI: Disp Pt for breathing difficulty  
AOS to front of sitting upright on edge

**PRIMARY SURVEY**

Airway:  Open  Obstructed  Required positioning with spine precautions

Breathing:  Rate normal  Depth normal  Equal chest movement

Circulation:  Central & periph. pulses present  HR normal  CR present  Skin normal

Disability:  Alert  Verbal  Painful  Unresponsive  Lactate Study **IVES**

Expose & Examine:  No major bleeding  No obvious fractures **12:24/9.6**

**SECONDARY SURVEY**

Head & Neck:  PERL  Ears & nose clear  No signs of trauma  No JVD  Trachea midline

Chest:  Thorax intact  Equal rise  Clear, equal sounds bilaterally

Abdomen:  No masses  Soft on palpation  No pain/tenderness on palpation

Pelvis:  Pelvis intact  No pain/tenderness on palpation

Extremities:  Good pulses all extremities  No signs of trauma to extremities

Skin Condition:  Warm & dry  Good color  CR <2 seconds

Neurological Status:  Good PMS all extremities  Alert & oriented x3  No loss of consciousness/less reported

**INITIAL PATIENT PRESENTATION**

TIME: **1224** ECG: **SR** SpO2: **100**

Resp Rate: **16** Pulse Rate: **86** BP: **106/82**

Eye: **4** Verbal Function: **5** Motor Function: **6** = **15**

ALS SKILLS PROCEDURES: 1 = Periph IV #1 4 = Intraosseous 7 = Oral ETT 10 = Other

2 = Periph IV #2 5 = Chest decom 8 = Nasal ETT 11 = Other

3 = Ext. jugular 6 = Cricothyroid 9 = Sternal IO 12 = Other

**ADDITIONAL NOTES**

of bed RFD on scene. Pt c/c of SOB. Pt @ distress @ visible signs of SOB. Pt hx of DMII, Asthma & Gastric Bypass sur. Pt allergies: Codeine. Pt also complaint of weakness. Pt extricated from apt via stair chair, to stretcher. Secured → ambulance. Pt SpO2 RA = 100%. Pt vitals and assessment as noted above. Pt A+O x3. Pt BS ↓ @ 46. Pt given tube of oral glucose. Pt tx to ER (short tx) 5 Δ or incident. Pt care transported @ transferred to a

**DOA / CARDIAC ARREST DATA**

**INTUBATION**

**ATACHMENTS**

**DRUG**

**CREW**

**DRUG BOX**

**PHYSICIAN (print):**

**SIGNATURE:**

**Other Glucose** 1224 1764



# Hospital Course

- ✱ Admitted for “Asthma”
- ✱ Condition worsened and moved to stepdown - severe sepsis
- ✱ E. Coli grew out in the urine
- ✱ Pseudomonas grew out of old chest tube sites
- ✱ Enterococcus grew out in blood cultures
- ✱ Hospitalized for 7 days – 3 in step-down.
- ✱ Discharged home on home IV antibiotics

32 male with hx of paraplegia, wheelchair bound,

PICC line for long term antibiotics for decubitus ulcer,

Suprapubic catheter in place.

C/O of fever and "feeling cold" to visiting nurse.

RICHMOND AMBULANCE AUTHORITY

PRE-HOSPITAL PATIENT CARE REPORT

Primary Insurance Carrier  
 Address \_\_\_\_\_  
 Group # \_\_\_\_\_ Policy # \_\_\_\_\_  
 Phone \_\_\_\_\_ Auth # \_\_\_\_\_  
 Supplemental Insurance Carrier  
 Address \_\_\_\_\_  
 Group # \_\_\_\_\_ Policy # \_\_\_\_\_  
 Phone \_\_\_\_\_ Auth # \_\_\_\_\_  
 Employer NONE Employer Phone \_\_\_\_\_

Responsible Party  
 Address Self  
 Telephone \_\_\_\_\_  
 Relationship  Patient  Spouse  Legal Guardian

BLS	End	1	02	0
2 ALS	Start	1	00	0
88 N/A	Total		2	0

AUTHORIZATION: I, the undersigned, request that payment of authorized Medicare or other health insurance benefits be made to the Centers for Medicare and Medicaid Services and its carriers and agents, as well as to RAA and its billing agents and any other payers or insurers, any information about me needed to determine these benefits or benefits payable for any services provided to me by RAA, now or in the future. I agree to immediately remit to RAA any payments that I am not entitled to receive for the services provided to me and I agree to make such payments to Richmond Ambulance Authority.

Patient, Parent, or Guardian Signature: [Signature]  
 Relationship: Patient unable to sign because

REFUSAL OF SERVICE - DISCLAIMER: I hereby refuse the services, treatment, and/or transportation recommended and offered to me by personnel of Richmond Ambulance Authority (which includes Forest View Volunteer Rescue Squad and West End Volunteer Rescue Squad), and understand and accept full responsibility for any consequences of such refusal. I further release Richmond Ambulance Authority and any and all of their personnel or contractors from any liability for any loss or damage which I suffered or may suffer, both known and unknown, as a result of my refusal of such services, treatment, and/or transportation.

Patient, Parent, or Guardian Signature: [Signature] Witness: \_\_\_\_\_ Date: \_\_\_\_\_

CHIEF COMPLAINT: Fever  
 ALLERGIES: NKDA  
 MEDICATIONS: Baclofen, Cymbalta, Docusate, Heparin, Hydrocod/APAP, meclizine, metformin, oxycodone, Robit, Tizanidine

RACE - ETHNICITY: White, non-Hispanic  
 PRE-EXISTING CONDITION (PEC): MS, Diabetes, Hypertension, Sych problems, Seizure disorder, Emphysema, Chronic resp failure, Heart Disease, Chronic renal failure, Cancer  
 MECHANISM OF INJURY (MOI): \_\_\_\_\_  
 MVA IMPACT: \_\_\_\_\_  
 SAFETY EQUIPMENT: \_\_\_\_\_

PHYSICAL ASSESSMENT: 100  
 SIGNS AND SYMPTOMS: 14 Hypertension, 15 Hypothermia, 16 Paralysis, 18 Palpitations, 19 Preg-Birth Miscar, 20 Seizures convulsions, 21 Syncope, 22 Unresp. Unconscious, 23 Vaginal bleeding, 24 Vomiting, 25 Weakness (malaise)  
 VITALS: BP 100/60, HR 72, RR 18, SpO2 98%  
 PHYSICIAN: John Smith  
 TYPE OF CALL: Medical Emergency  
 SAFETY EQUIPMENT: None used

TYPE OF SERVICE: 1 Unscheduled  
 CITY: Richmond COUNTY: Henrico ZIP: 23226  
 LOCATION, TYPE: Home - Residence  
 INCIDENT DISPOSITION: 1 Treated, transported by EMS  
 DESTINATION (IF APPLICABLE): 2 Closest Facility  
 DESTIN. TRANSFERRED: 1 Home  
 RECEIVING FACILITY: Chippendale



HR 120,  
RR 22,  
BP 134/68,  
Temp 100.8 (ER)  
WBC 12.2

Lactate 6.9

SIRS Criteria?

Potential  
infectious source

PICC Line

Decubitus ulcer

Suprapubic Catheter

- Only on vancomycin

**RICHMOND AMBULANCE AUTHORITY**      **PPCR—Page Two**

**HPI:** pt was found to have a fever during routine vital check per NS/home

**PRIMARY SURVEY**

- Airway:  Open    Obstructed    Required positioning with spine precautions
- Breathing:  Rate normal    Depth normal    Equal chest movement
- Circulation:  Central & periph. pulses present    HR normal    CR present    CR Skin normal
- Disability:  Alert    Verbal    Painful    Unresponsive    Lactate Study    IVES
- Expose & Examine:  No major bleeding    No obvious fractures

**SECONDARY SURVEY**

- Head & Neck:  PERL    Ears & nose clear    No signs of trauma    No cervical pain, tenderness, or deformity on palpation
- Chest:  Thorax intact    Equal rise    Clear, equal sounds bilaterally    Not obtained
- Abdomen:  No masses    Soft on palpation    No pain/tenderness on palpation    Not obtained
- Pelvis:  Pelvis intact    No pain/tenderness on palpation    Not obtained
- Extremities:  Good pulses all extremities    No signs of trauma to extremities    Not obtained
- Skin Condition:  Warm & dry    Good color    CR <2 seconds    Temp 104.4
- Neurological Status:  Good PMS all extremities    Alert & oriented x3    No loss of consciousness reported

**VITAL PATIENT PRESENTATION**

TIME	2010	ECG	164	SpO <sub>2</sub>							
Resp Rate	22	<input type="checkbox"/> Not obtained	<input type="checkbox"/> Unable to obtain	<input type="checkbox"/> Not obtained							
Pulse Rate	120	<input type="checkbox"/> Not obtained	<input type="checkbox"/> Increased not abated	<input type="checkbox"/> Increased not abated OR decreased/failed							
BP	134/68	<input type="checkbox"/> Not obtained	<input type="checkbox"/> Unable to obtain	<input type="checkbox"/> Normal <input type="checkbox"/> Decreased							
Eye	4	Verbal Function	5	Motor Function							
set		Time	AVPU	Resp	Pulse	BP	Gluc	SpO <sub>2</sub>	ETCO <sub>2</sub>	ECG	GCS
2	2054	A	22	116	120	134/68					15

**ADDITIONAL NOTES:** meds contd: vancomycin, Tylenol  
Diazepam, morph, Insulin, Z gantab  
Arginaseid, Boost  
upon EMS arrival pt found seated on edge of Bed ATD x3 NAD 1/2 fever and feeling cold IZ xposed sitting up POC pt has pre established PICC Line @ Arm  
contacted vic cell phone re orders no changes or problems

**ALS SKILLS**

1 = Periph IV #1	4 = Intraosseous	7 = Oral ETT	10 = Other
2 = Periph IV #2	5 = Chest decom	8 = Nasal ETT	11 = Other
3 = Ext jugular	6 = Cricothyroid	9 = Sternal Q	12 = Other

**PROCEDURES**

CODE	LOC	SIZE	TIME	EMP #	ATT	MISS
10	PFC	Line	Not staff			

**DRUG**

DRUG	ROUTE	TIME	EMP #	ROUTE	TIME	EMP #
Adenosine						
Albuterol						
Amodarone						
Aspirin						
Atropine						
Atrovent						
D50W						
Epi 1:1,000 (vial)						
Epi 1:10,000						
Epi 1:10,000						
Lasix						
Morphine						
Narcan						
Nitro						
Vasopressin						
Vasopressin						

**DOA - CARDIAC ARREST DATA**

**INTUBATION**

**PRESENTING RHYTHM**

**ATTACHMENTS**

**HOSPITAL CONTACT**

**DRUG**

**DOA - CARDIAC ARREST DATA**

**INTUBATION**

**PRESENTING RHYTHM**

**ATTACHMENTS**

**HOSPITAL CONTACT**

**DRUG**

Not witnessed      ATT 2      FR ST RN OTH NA

Narcotics accounted for:      PHYSICIAN (print):      DEA#:      SIGNATURE:

RAA PPCR version placed in service September 2007



# Hospital Course

- ✱ Taken to community hospital
- ✱ “Vital signs” not much different than EMS
- ✱ Rapid Urine Screen (+) for UTI
- ✱ Final culture *Candida albicans*
- ✱ Discharged back home
- ✱ No lactate available for follow-up



# Sepsis conclusions

## ☀ Does my patient have sepsis?

- ☀ 2 of 4 SIRS Criteria (HR, Temp, WBC, Resp Rate)
- ☀ Infection causing this?

## ☀ Is there hypoperfusion (organ dysfunction)

- ☀ Altered mental status
- ☀ Jaundice
- ☀ Petechiae
- ☀ Elevated Lactate,  $> 4$  mmol/l?

## ☀ Start treating the hypoperfused state

- ☀ IVF
- ☀ Tell the ED doc

## ☀ Definitive care

- ☀ Sepsis Teams
- ☀ Shock Centers



**Thank you for your  
attention**

**Questions?**

**Email:  
kgunnerson@vcu.edu**