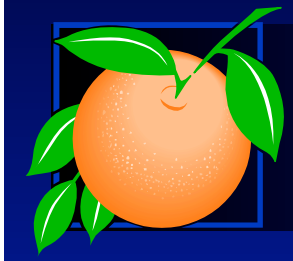

# "Inflammatory Statements"

## Using $ETCO_2$ Analysis in Sepsis Syndromes

**George A. Ralls M.D.**
**Orange County EMS System**

# Sepsis


- **Over 750,000 cases annually**
  - **Expected growth of 1.5% per year**
- **Over 215,000 deaths**
- **10th leading cause of death in US**
  - **Equals deaths from AMI**

# Sepsis

- Infection that triggers a systemic inflammatory response

- Systemic Inflammatory Response Syndrome (SIRS)
  - 36-38°C
  - Heart rate >90 beats/min
  - Respiratory rate of >20 or a $PCO_2$<32 mm Hg
  - White blood cell count <4000 or >12000

**SIRS**
**36-38°C**
**HR >90**
**RR >20**
**WBC**

**Known or Suspected Infection**

Sepsis

Organ Dysfunction

**Severe Sepsis**

- **Mortality rate of 30-40%**
  - **Up to 60 % if hypotensive**
  - **Once activated, acute organ dysfunction may occur even if infection controlled**

# Sepsis

- **Tissue hypoxia begins early in the sepsis continuum**
  - **May be "occult"**
  - **May precede any significant changes in vital signs**
- **Tissue hypoxia results in elevated serum lactate levels**
  - **Oxygen demand exceeds supply**
  - **Eventually lactic acidosis ensues**

**Elevated lactate levels signify a "High Risk" patient**

# Early Goal Directed Therapy

Protocolized management that starts in the ED reduces mortality from sepsis:

- Early recognition and treatment of sepsis
- Reversal of global tissue hypoxia in the first few hours of treatment

- Presence of SIRS criteria in addition to elevated lactate levels or hypotension


## 2 SIRS Criteria

- 36-38°C
- HR >90
- RR >20 or PCO2<32 mm Hg
- WBC count <4000 or >12000

+

## Global Tissue Hypoxia

- Hypotension (SBP < 90)
- Lactate level > 4 mmol/L

↓

**EGDT**

**34% reduction in in-hospital mortality**
**32% reduction in mortality at 28 days**

## 2 SIRS Criteria

- 36-38°C
- HR >90
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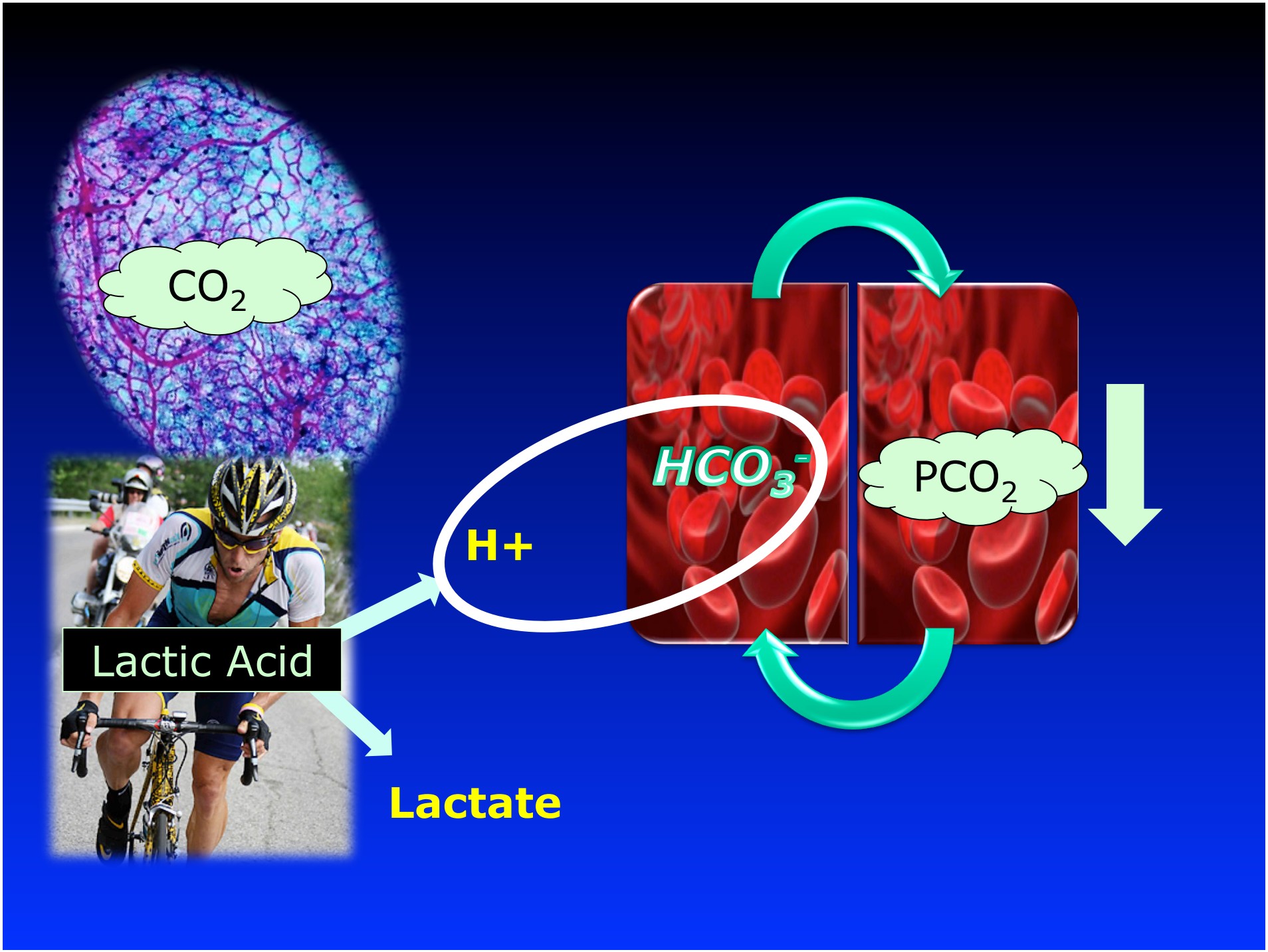
+

## Global Tissue Hypoxia

- Hypotension (SBP < 90)
- Lactate level > 4 mmol/L

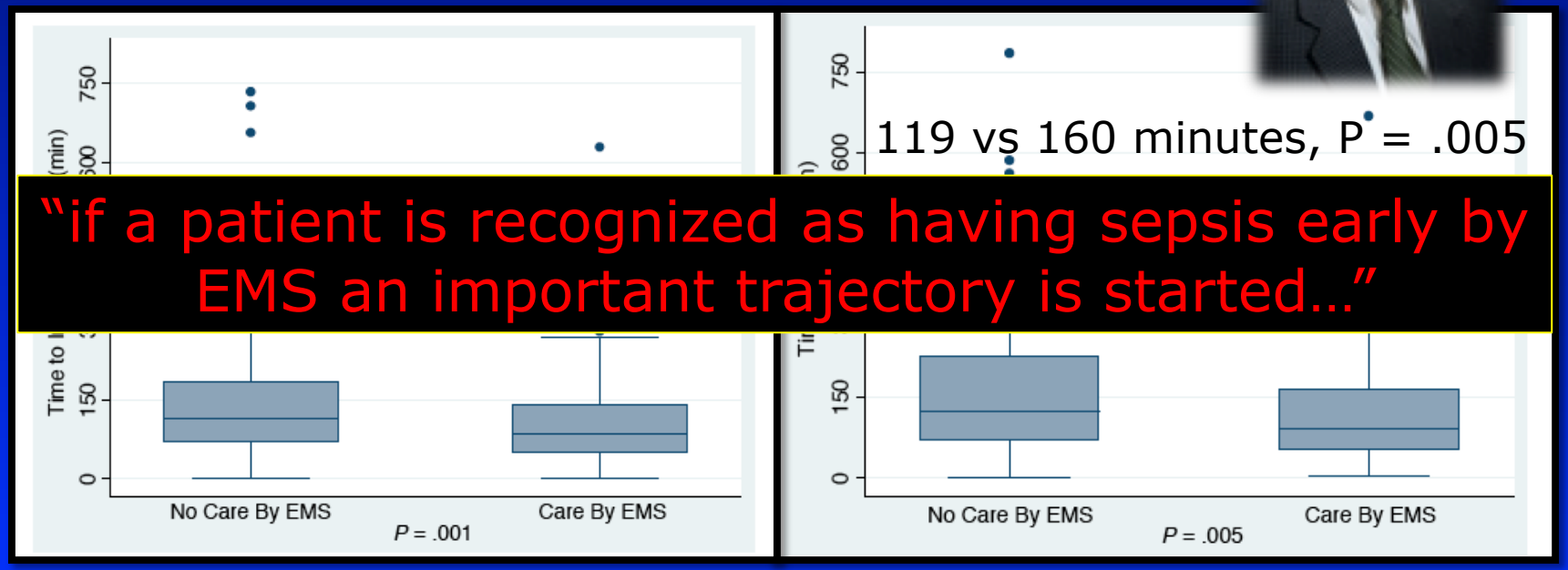
- **Early Goal Directed Therapy**
- **Resuscitation Centers**


$CO_2$
Lactic Acid
H+
$HCO_3^-$
$PCO_2$
Lactate

# Impact of EMS on ED Care on Severe Sepsis

Jonathan Studnek, et al.

- **EMS provided care for half of patients with severe sepsis requiring EGDT**
- **EMS patients had shorter time to antibiotics and shorter time to initiation of EGDT**




119 vs 160 minutes, P = .005

"if a patient is recognized as having sepsis early by EMS an important trajectory is started…"

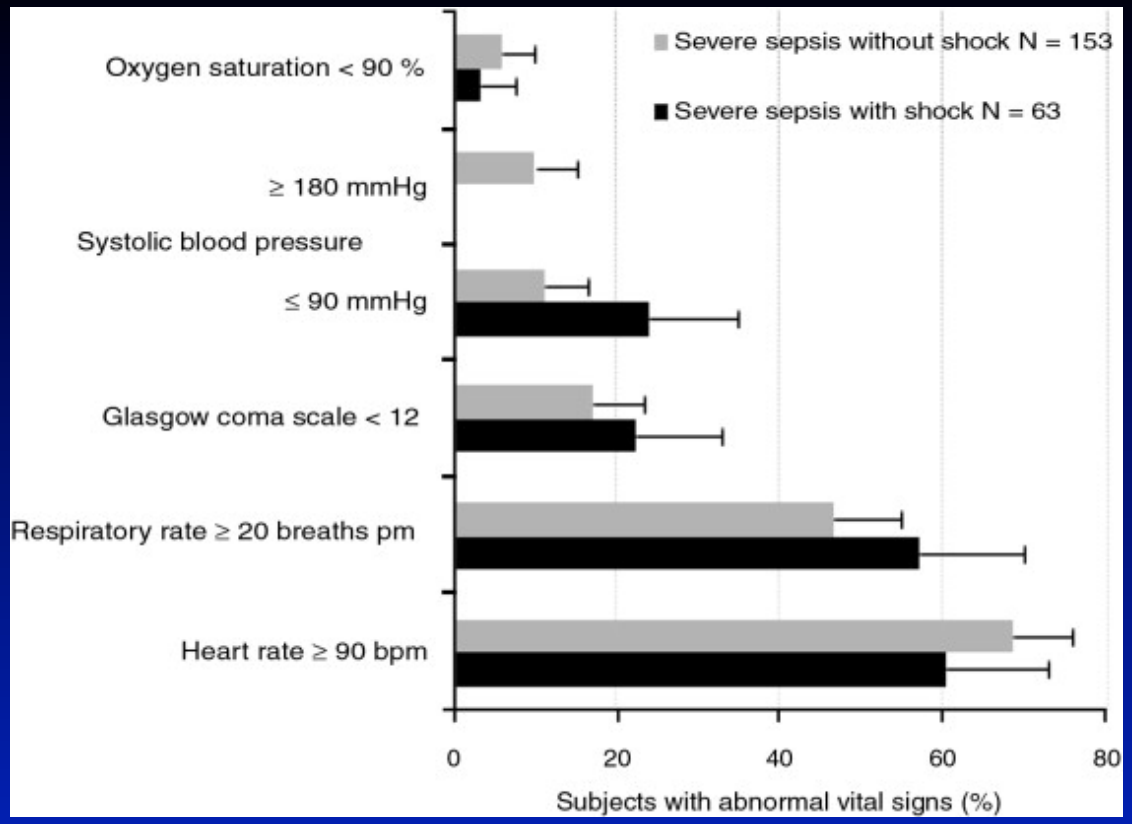
The impact of emergency medical services on the ED care of severe sepsis. Studnek JR, Artho MR, Garner CL Jr, Jones AE. Am J Emerg Med. 2010 Oct 2

# Opportunities for EMS Care of Sepsis
## Henry E. Wang, et al.

- 4613 ED patients presenting with serious infections
  - 34% received initial EMS care
- Mortality rate:
  - 8.0% for EMS transported patients
  - 2.2% for those who were not
- EMS transported 61% of patients who qualified for protocolized sepsis care in the ED
- EMS patients more likely to present with severe sepsis (OR 3.9) or septic shock (OR 3.6)
- EMS patients had higher sepsis acuity (mortality in ED sepsis score 6 vs. 3, $p < 0.001$)

- *EMS provides care for the majority of patients with severe sepsis*
- *May offer important opportunities for advancing sepsis diagnosis…*

H.E. Wang et al. / Resuscitation *81 (2010) 193–197*




- **Less than half of patients with severe sepsis transported by ALS received out-of-hospital fluid**

Prediction of critical illness during out-of-hospital emergency care. Seymour CW, et al. JAMA. 2010 Aug 18;304(7):747-54
Out-of-hospital characteristics and care of patients with severe sepsis: a cohort study, Seymour CW, et al. J Crit Care. 2010 Dec;25(4):553-6
Out-of-hospital fluid in severe sepsis: effect on early resuscitation in the emergency department, Seymour CW, et al. Prehosp Emerg Care. 2010 Apr 6;14(2):145-52

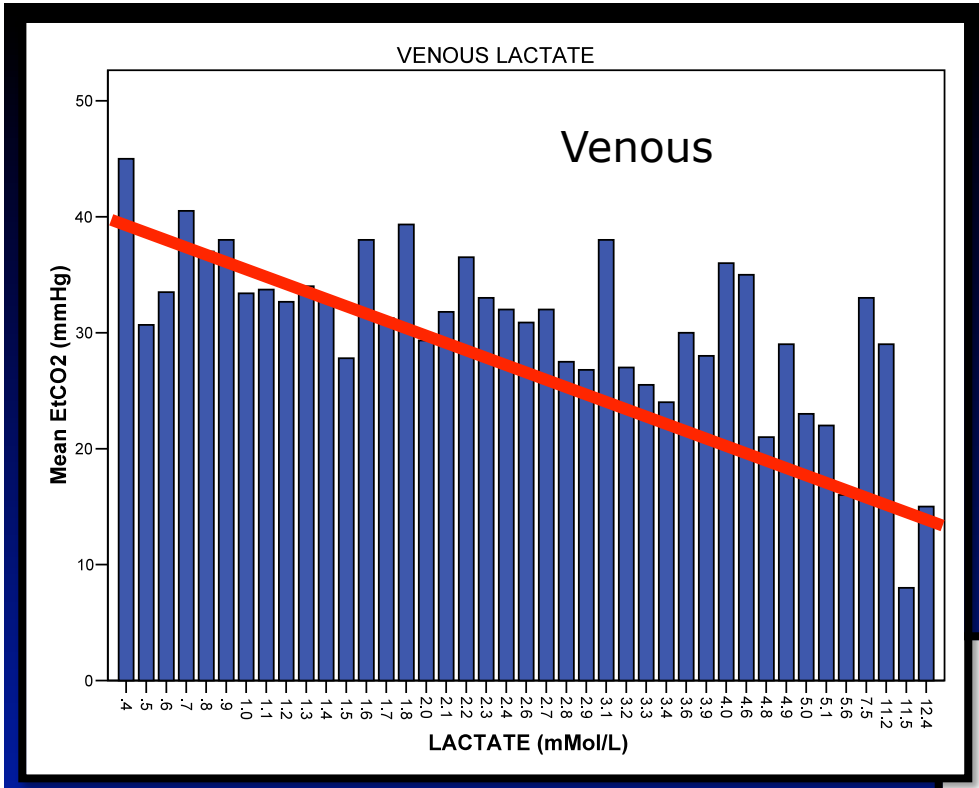
# End-Tidal Carbon Dioxide Levels Are Associated with Mortality In Emergency Department Patients with Suspected Sepsis

*Hunter CL,* et al. Orlando Regional Medical Center, Orlando, FL

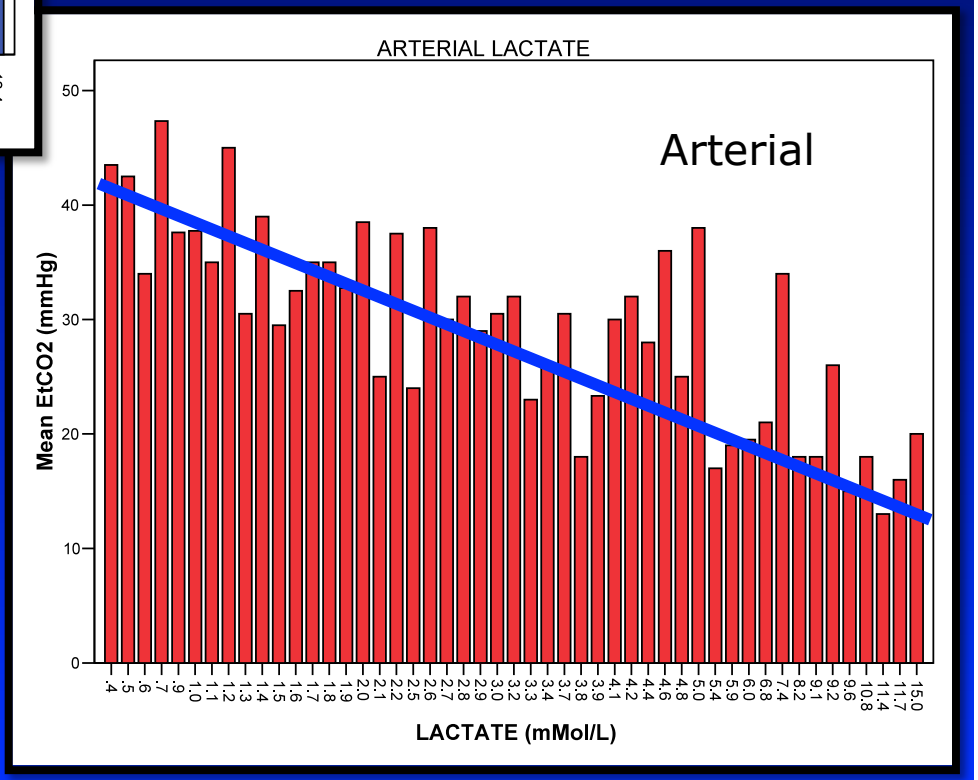
- **There was a significant association between levels of ETO2 and in-hospital mortality in emergency department patients with suspected sepsis**

- **ETCO2 levels were significantly and inversely correlated with lactate levels in these patients**

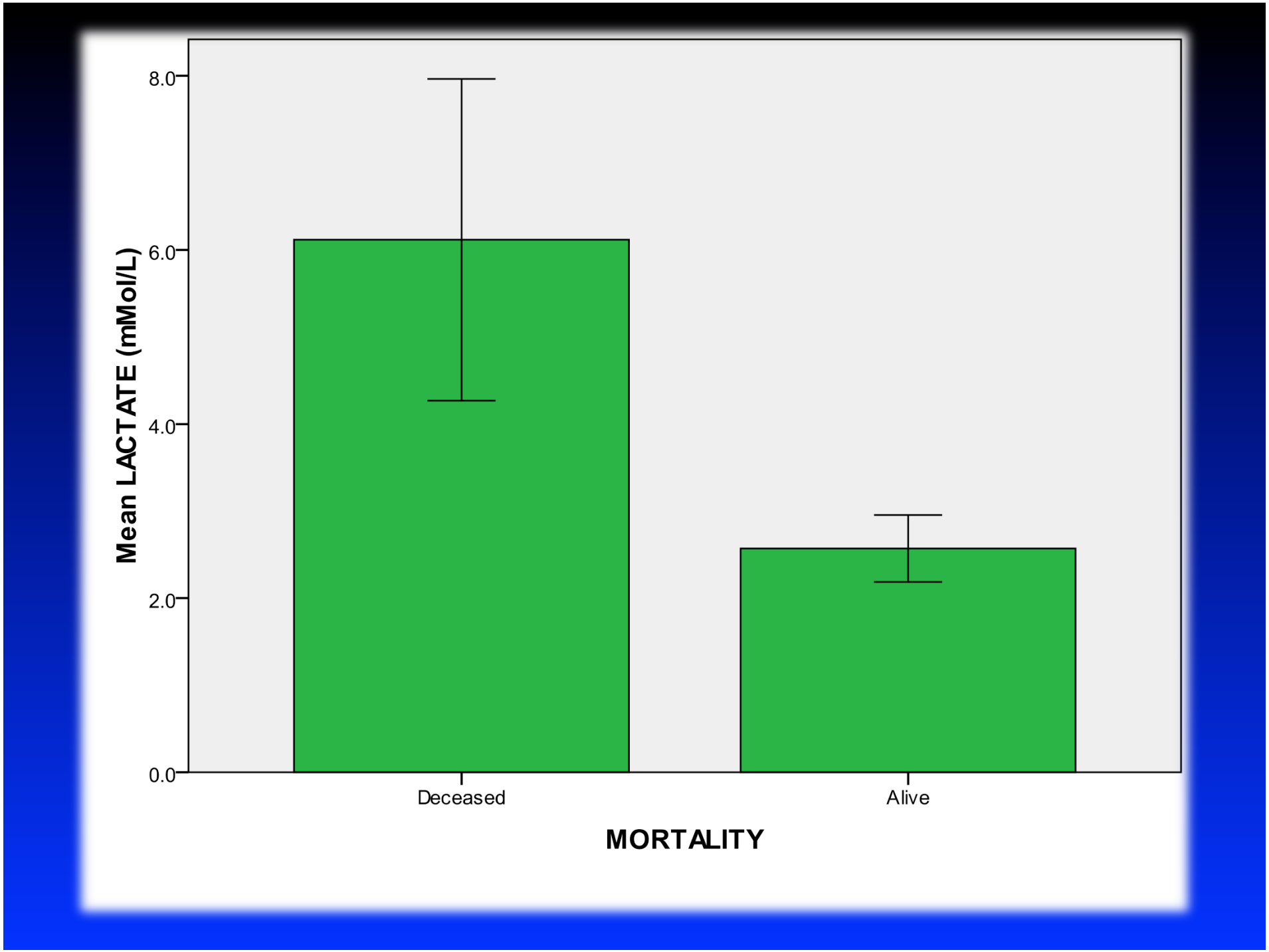
| | Total Patients N=201 | Survivors N=172 | Non-Survivors N=29 |
|---|---|---|---|
| Age | 65 (18-99) | 65 [62-68] | 63 [55-71] |
| Gender (%female) | 47 [40-54] | 49 [42-57] | 34 [16-53] |
| LOS | 8.6 [7.4-9.8] | 9.2 [7.9-10.5] | 5.0 [2.1-7.9] |
| Intubated (%) | 18 [13-23] | 13 [8-18] | 48 [29-68] |
| ICU Admit (%) | 36 [29-42] | 27 [20-34] | 86 [73-100] |
| + Blood Cultures | 31 [24-37] | 29 [22-36] | 41 [21-60] |
| Required Vasopressors (%) | 24 [18-30] | 14 [8-19] | 83 [68-97] |
| Lactate (mMol/L) | 3.1 [2.6-3.5] | 2.6 [2.2-3.0] | 6.1 [4.3-8] |
| ETCO2 (mmHg) | 32 [30-33] | 33 [31-34] | 26 [21-30] |

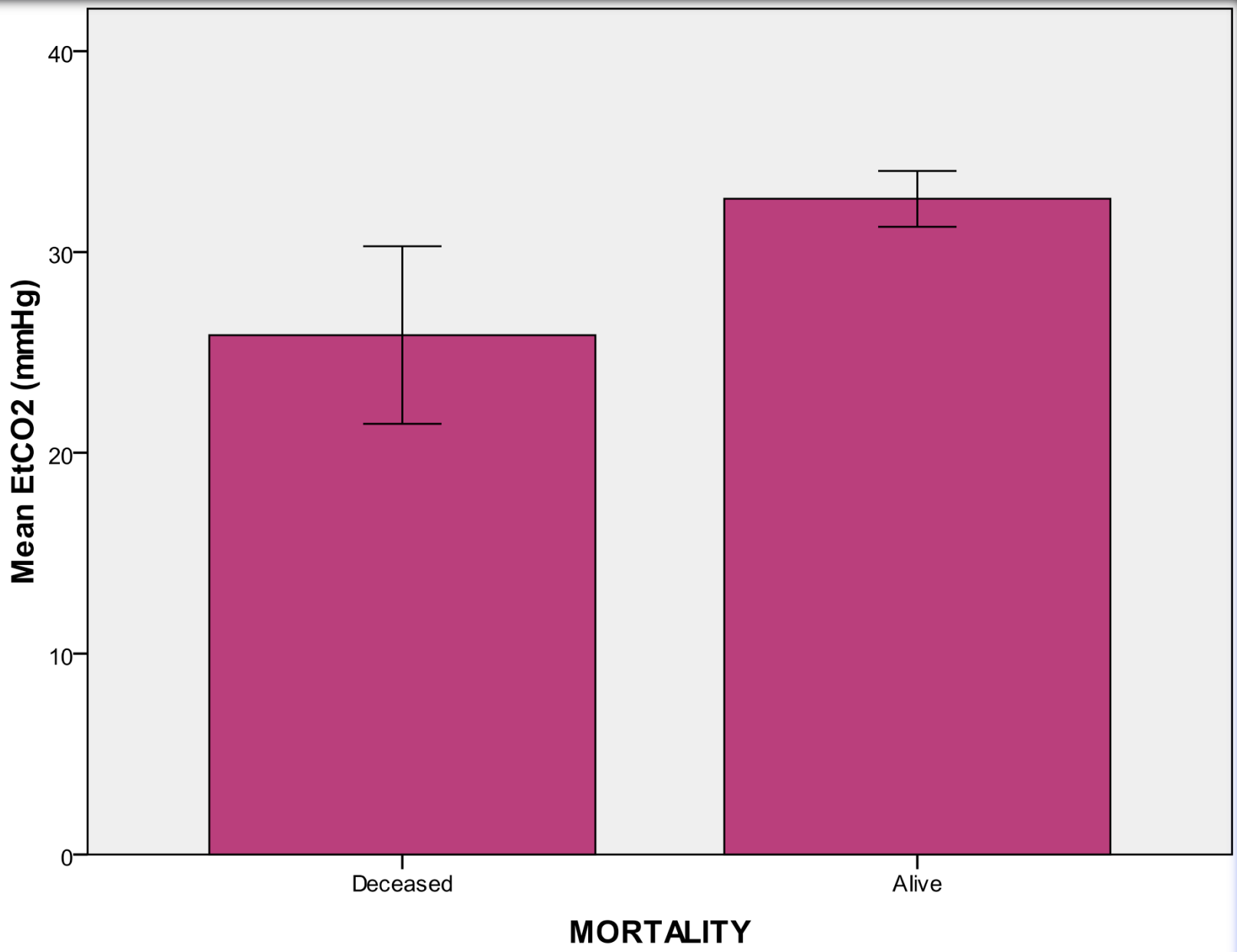


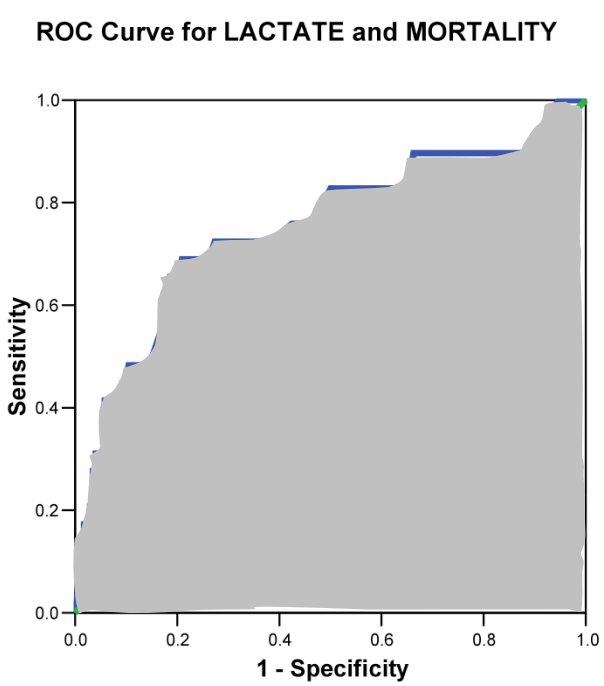

Correlation coefficient= -0.526
P<0.001

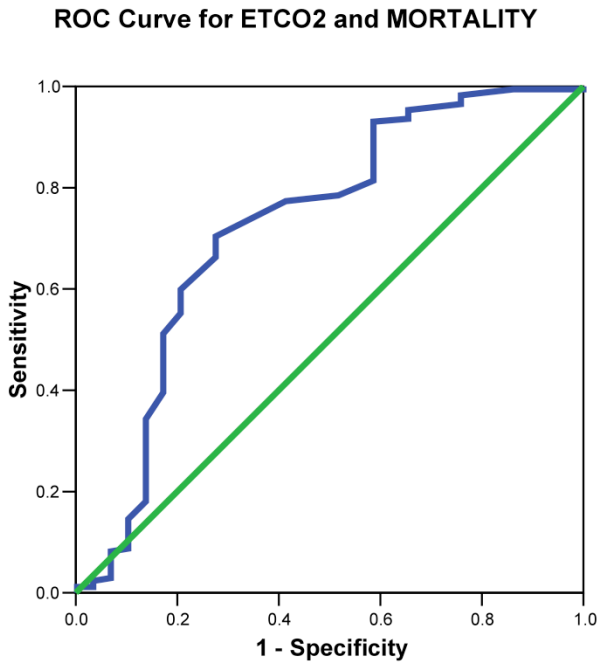



Correlation coefficient= -0.493
P<0.001


8.0
6.0
4.0
2.0
0.0
Mean LACTATE (mMol/L)
Deceased
Alive
MORTALITY


40
30
20
10
0
Mean EtCO2 (mmHg)
Deceased
Alive
MORTALITY


ROC Curve for LACTATE and MORTALITY
Sensitivity
1 - Specificity
0.0
0.2
0.4
0.6
0.8
1.0


ROC Curve for ETCO2 and MORTALITY
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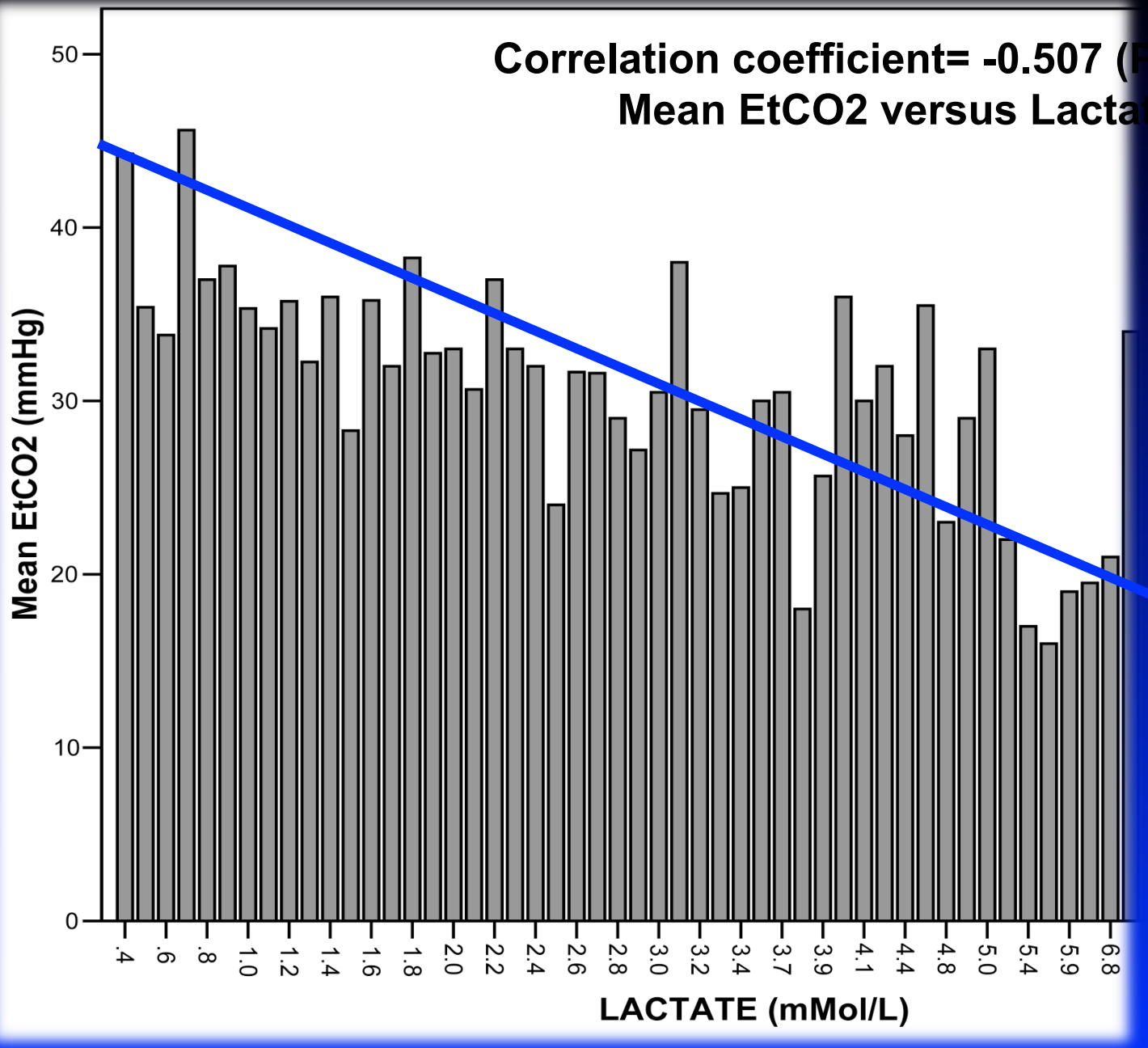
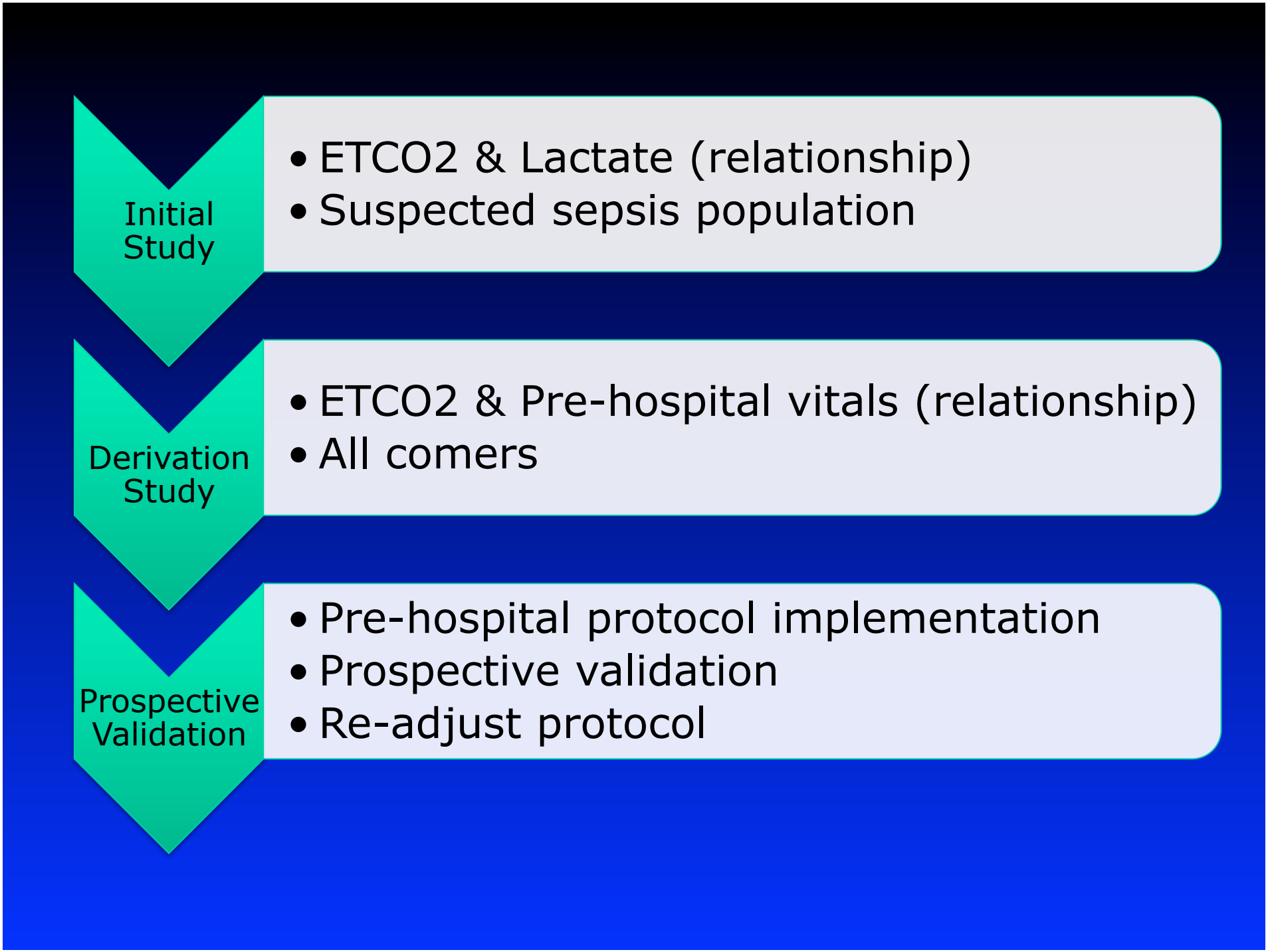
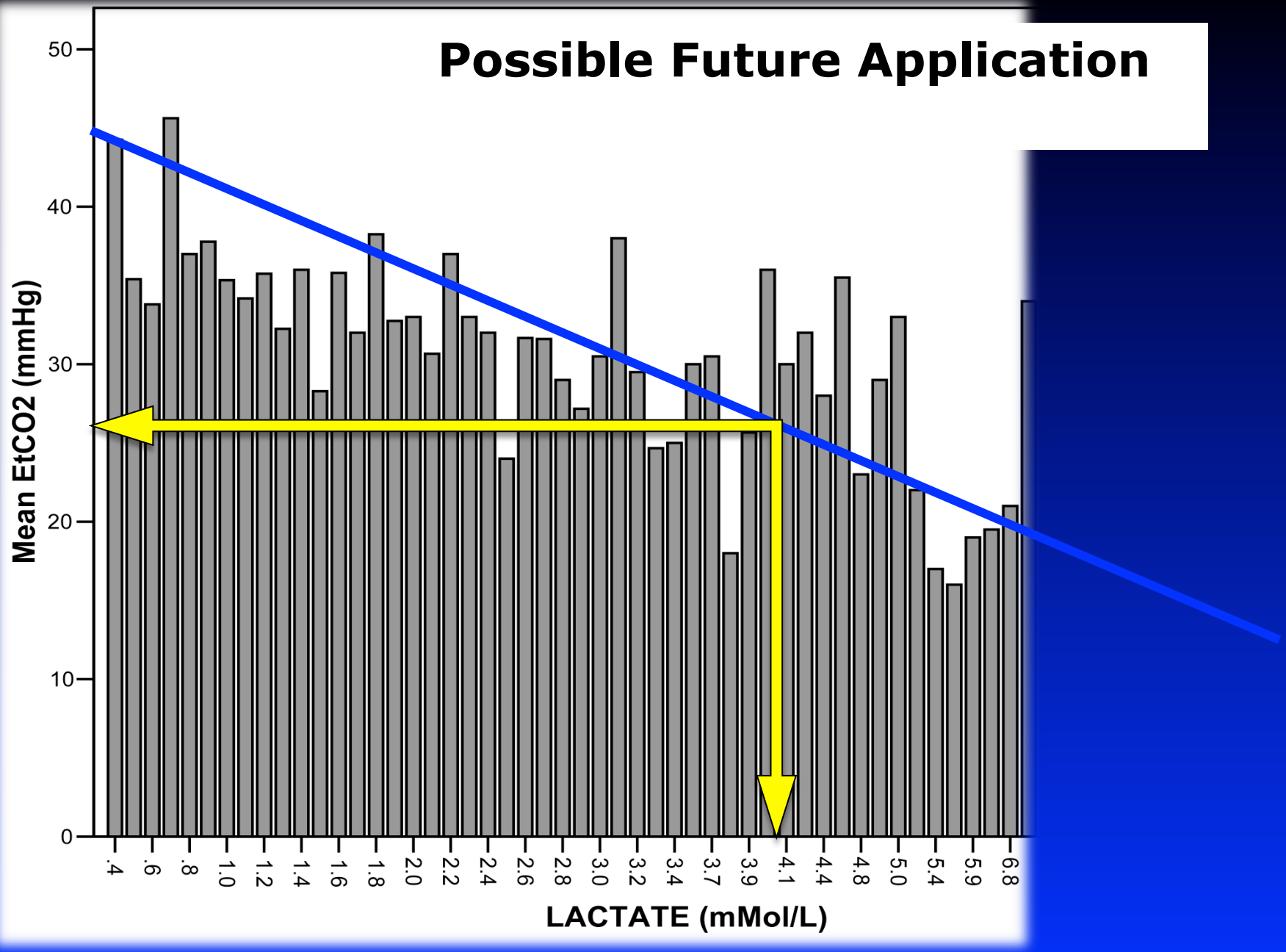
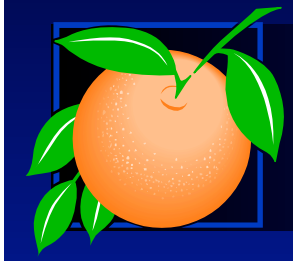

Correlation coefficient= -0.507 (P<0.001)
Mean EtCO2 versus Lactate
Mean EtCO2 (mmHg)
50
40
30
20
10
0
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.7
3.9
4.1
4.4
4.8
5.0
5.4
5.9
6.8
LACTATE (mMol/L)


Initial Study
• ETCO2 & Lactate (relationship)
• Suspected sepsis population
Derivation Study
• ETCO2 & Pre-hospital vitals (relationship)
• All comers
Prospective Validation
• Pre-hospital protocol implementation
• Prospective validation
• Re-adjust protocol

# Possible Future Application





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