SIMEU PUGLIA 2013

L'Emogasanalisi in Medicina d'Urgenza & Pronto Soccorso

Fernando Schiraldi

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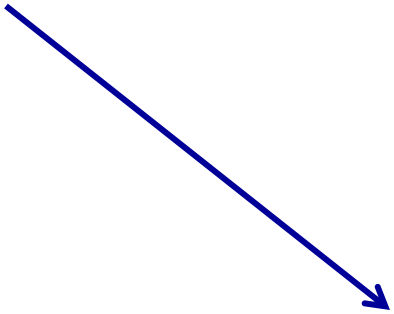
OUTLINE

- *The Basics*
- *Hypoxia puzzle*
- *Monitoring tools*
- *Therapeutic options*

ABG ESSENTIALS

PRIMARY DISORDER



"EXPECTED" COMPENSATION

….PLUS ELECTROLYTES

"a too good pH"

6.1 6.1

pH = 6.1 + log 20 = 6.1 + 1.3 = 7.4

"a too good pH"

$$pH = 6.1 + \log \frac{12}{19 \times 0.03} = 7.42$$

Diagnostic Strategies

RESP ALKALOSIS
- PO_2
- CNS
- mediators

RESP ACIDOSIS
- acute
- "mixed"
- chronic

pH vs PCO_2

	acute	"mixed"	chronic
pH	7.22	7.25	7.32
PCO_2	70	70	70
HCO_3	28	30	35

pH vs PCO_2

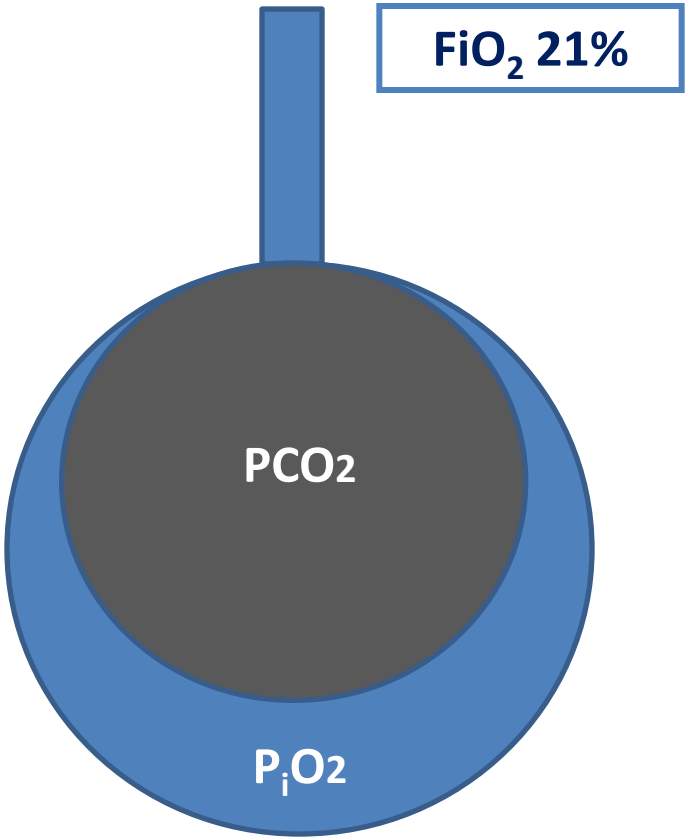
	"mixed"	"mixed"
pH	7.08	7.38
PCO_2	70	70
HCO_3	20	40

PO_2 vs FiO_2

	1	2	3
PaO_2	63	72	80
FiO_2	21%	24%	40%
P/F	300	300	200

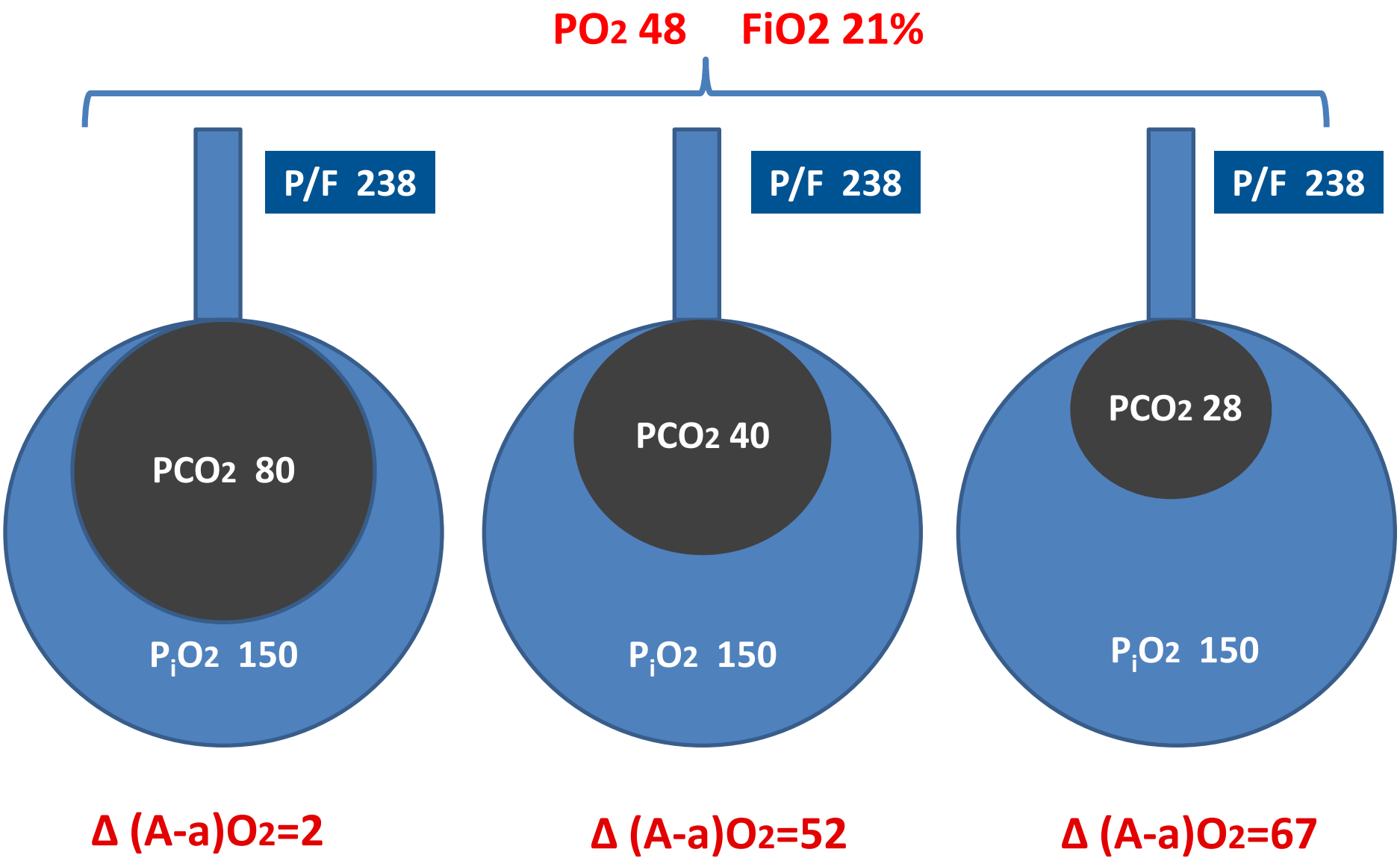
PO_2 vs PCO_2

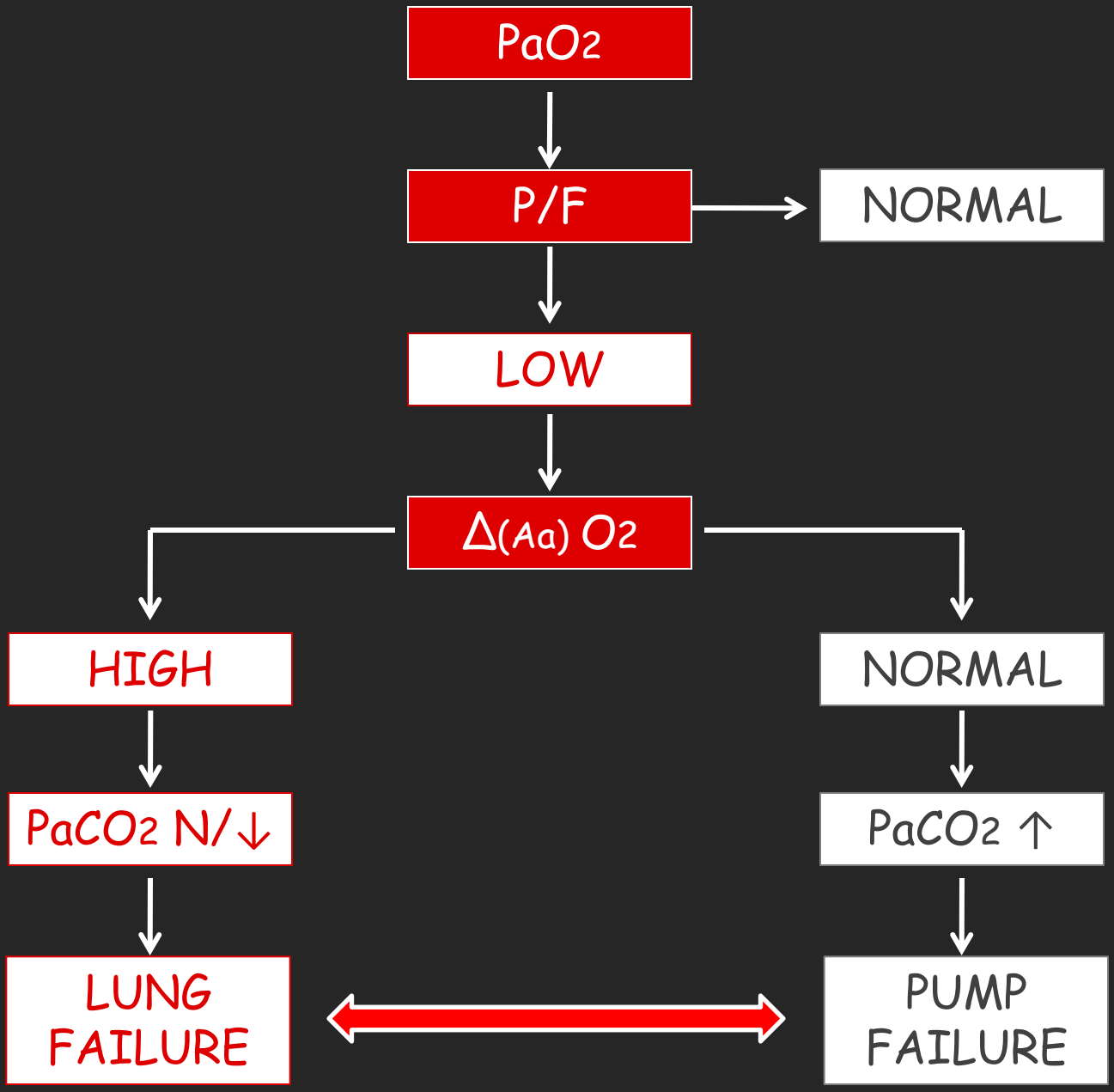
pCO_2	100
PO_2	23
P/F	109
P_AO_2	25



$$P_AO_2 = 150 - (PCO_2/0.8)\ ,\ \text{DA-aO2=2}$$

P/F vs Δ (A-a)O_2


PO2 48 FiO2 21%
P/F 238
P/F 238
P/F 238
PCO2 80
PCO2 40
PCO2 28
PiO2 150
PiO2 150
PiO2 150
Δ (A-a)O2=2
Δ (A-a)O2=52
Δ (A-a)O2=67


PaO2
P/F
NORMAL
LOW
Δ(Aa) O2
HIGH
NORMAL
PaCO2 N/↓
PaCO2 ↑
LUNG FAILURE
PUMP FAILURE

Diagnostic Strategies

RESP ALKALOSIS
- PO_2
- CNS
- mediators

RESP ACIDOSIS
- acute
- "mixed"
- chronic

MET ALKALOSIS
- ↑ IVF
- ↓ IVF (Cl_u)

MET ACIDOSIS
- AG ↑
- NAG → UAG
- SID ?

BGA AND FLUIDS

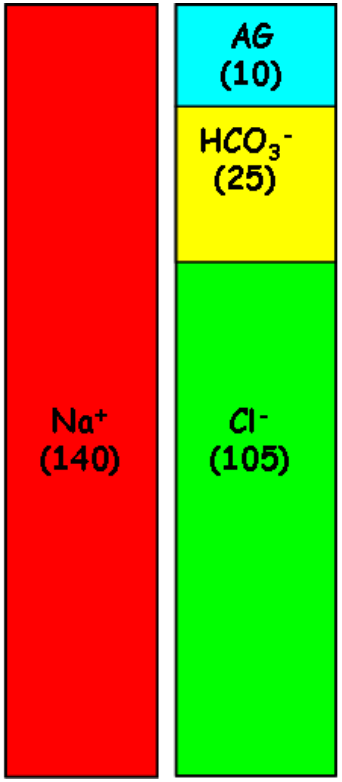
↓ IVF

↑ BLOOD pH
↓↓ URINE pH
↓↓ URINE Na, Cl

↓ ↓ ↓ IVF

DEHYDRATION
+ ↓ BLOOD pH

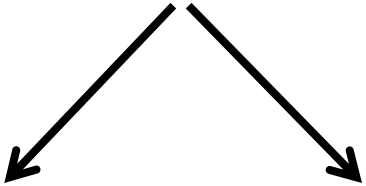
$Na - (Cl + HCO_3) = 10 \pm 2 = AG$



METABOLIC ACIDOSIS
(according to AG)

NORMAL AG

HCO_3 LOSSES



Renal

low UAG

GI

norm. UAG

HIGH AG

CONSUMPTION

- DKA
- Uremia
- Shock
- Toxics

The Difference Between Critical Care Initiation Anion Gap and Prehospital Admission Anion Gap is Predictive of Mortality in Critical Illness*

Michael S. Lipnick, MD[1]; Andrea B. Braun, MD[2]; Joyce Ting-Wai Cheung, BSc[3]; Fiona K. Gibbons, MD[4]; Kenneth B. Christopher, MD[5]

18.985 ICU pts (1997-2007)

delta AG	*<0*	OR 0.75
	5–10	*OR 1.56*
	>10	*OR 2.18*

Conclusion: An increase in standard anion gap at critical care initiation relative to prehospital admission standard anion gap is a predictor of the risk of all cause patient mortality in the critically ill.

Crit Care Med 2013; 41:49–59

Scand J Clin Lab Invest 1993; 53, Suppl 214: 99-104

Siggaard-Andersen and the "Great Trans-Atlantic Acid-Base Debate"

JOHN W. SEVERINGHAUS

THE "MAKE-UP" EFFECT OF METABOLIC ALKALOSIS ON METABOLIC ACIDOSIS

- pH 7.21
- PCO_2 25
- HCO_3 14
- BE -11

- Na 136
- Cl 100

- AG 22

- pH 7.38
- PCO_2 38
- HCO_3 24
- BE 0

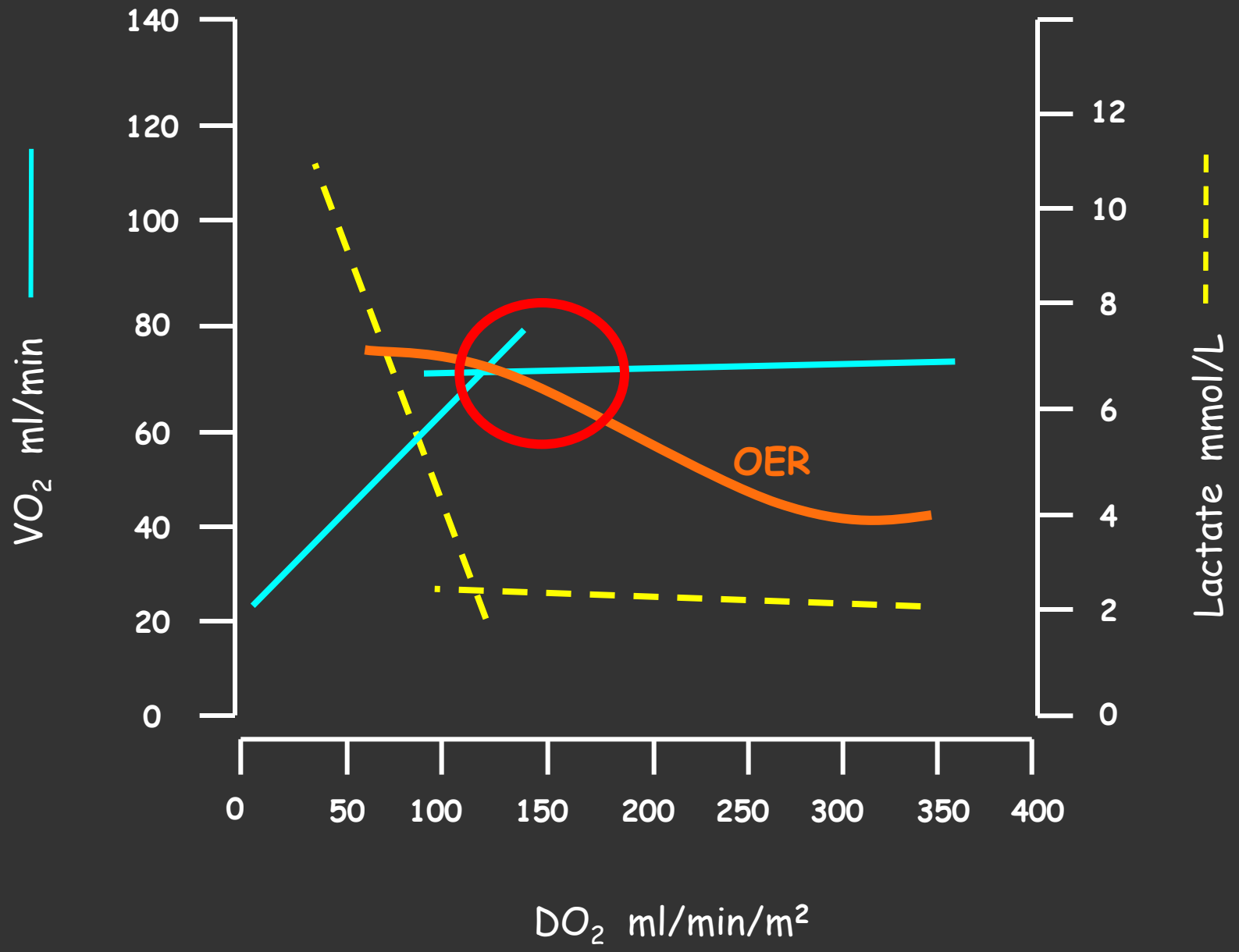
- Na 134
- Cl 88

- AG 22

BGA = a quick look at the

"OCCULT HYPOPERFUSION"

The Supply-Dependency

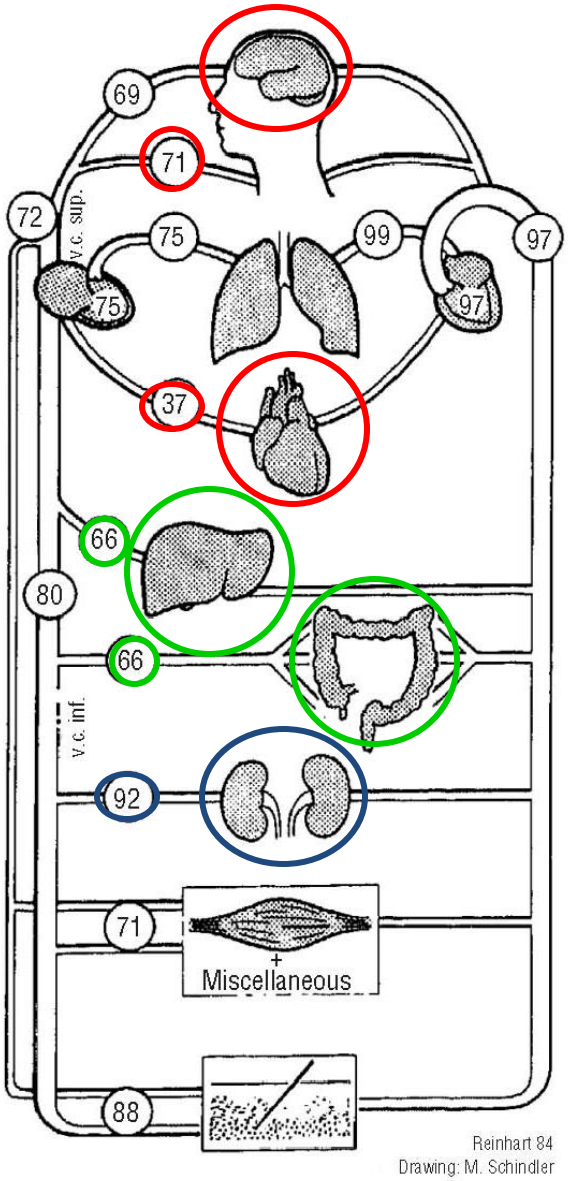


Oxygen extraction in various organs

FAST

??

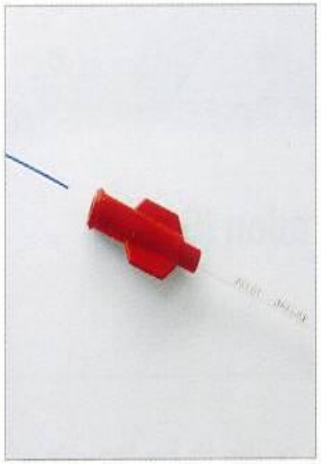
SLOW



$ScvO_2$ monitoring

Startup procedure:

Probe connected to the optical module of the CeVOX – in vitro calibration

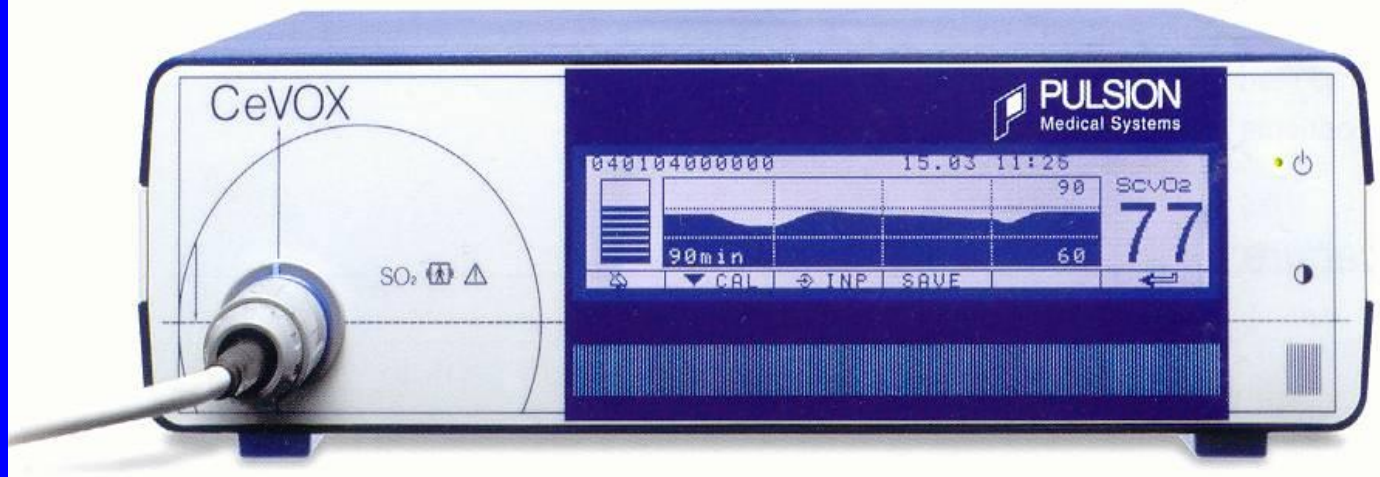


Insertion of the probe into the distal lumen of the central venous catheter

Tip of the probe exceeds the catheter tip by 2.0–3.0 cm. Make sure that tip is not located in right atrium

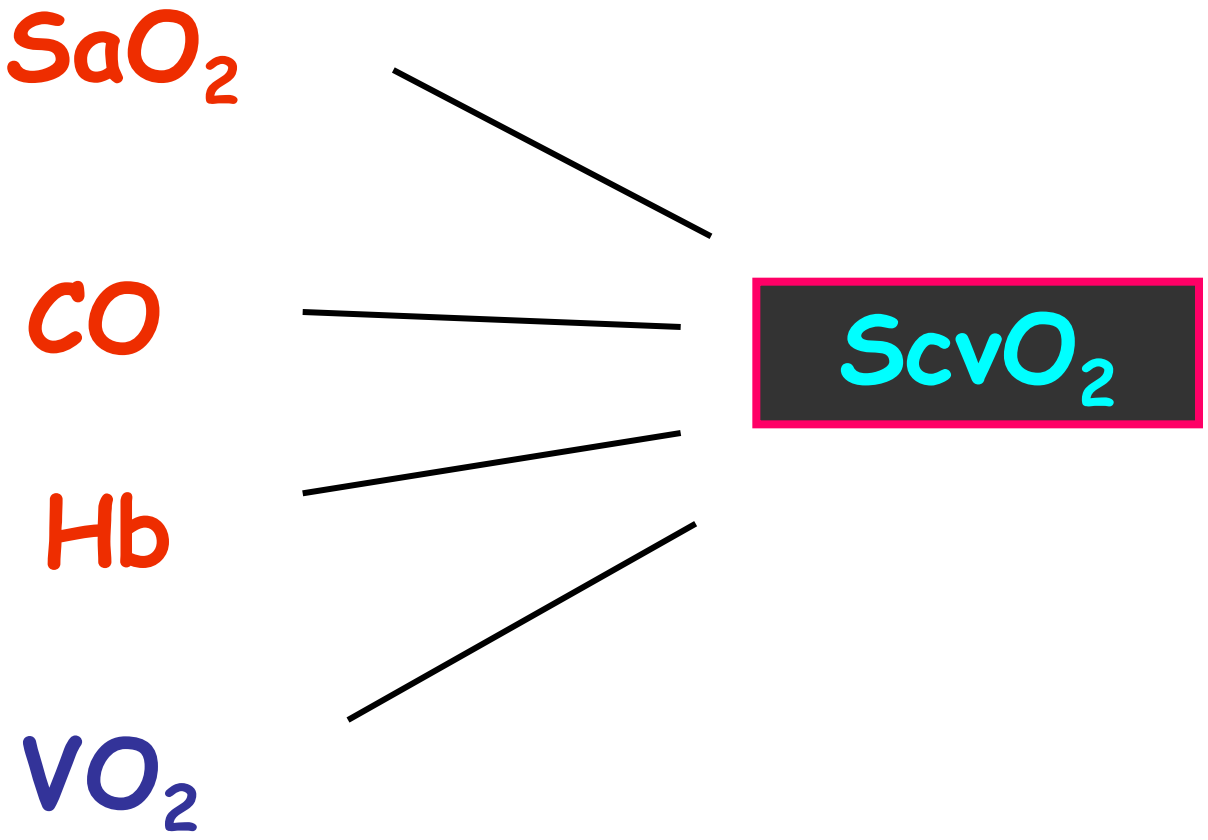
Probe is securely locked to the distal hub

Central venous oxygen saturation monitor



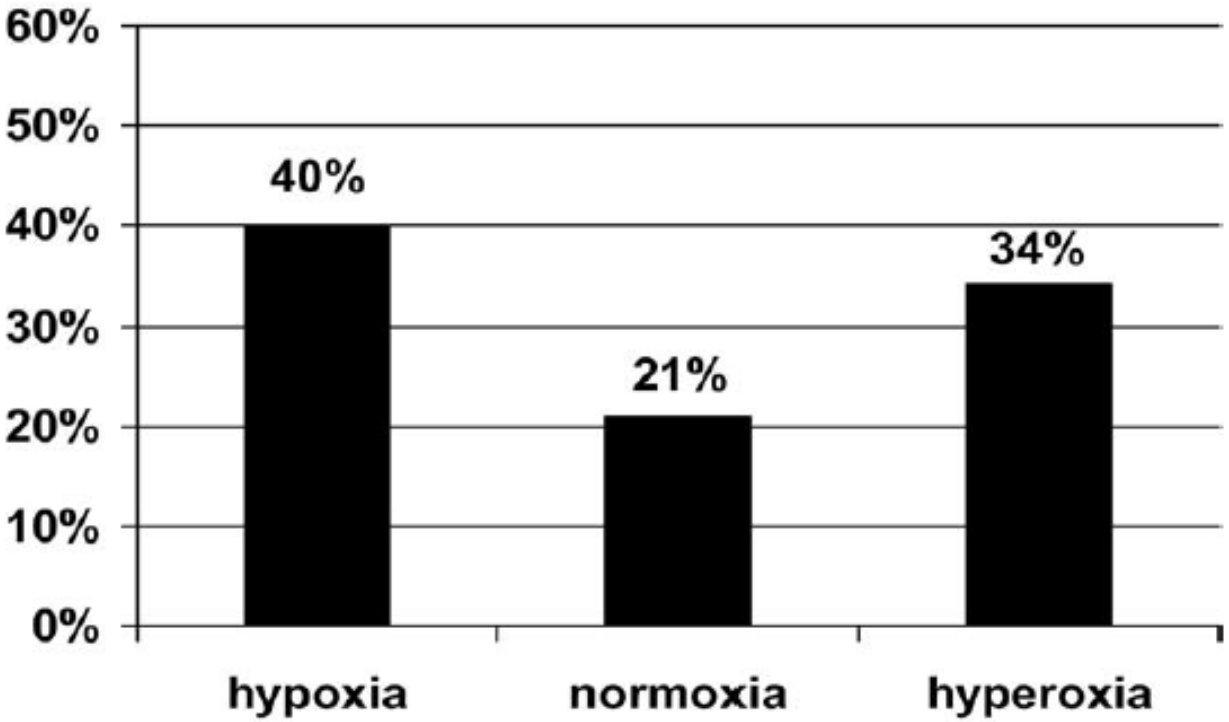
- Continuous central venous oxygen saturation ($ScvO_2$)

RIVERS EP, et al (2001) Curr Opin Crit Care 7: 204-211


SaO_2
CO
Hb
VO_2
$ScvO_2$

Multicenter Study of Central Venous Oxygen Saturation ($ScvO_2$) as a Predictor of Mortality in Patients With Sepsis

Jennifer V. Pope, MD
Alan E. Jones, MD
David F. Gaieski, MD
Ryan C. Arnold, MD
Stephen Trzeciak, MD,
Nathan I. Shapiro, MD



Ann Emerg Med. 2010;55:40-46

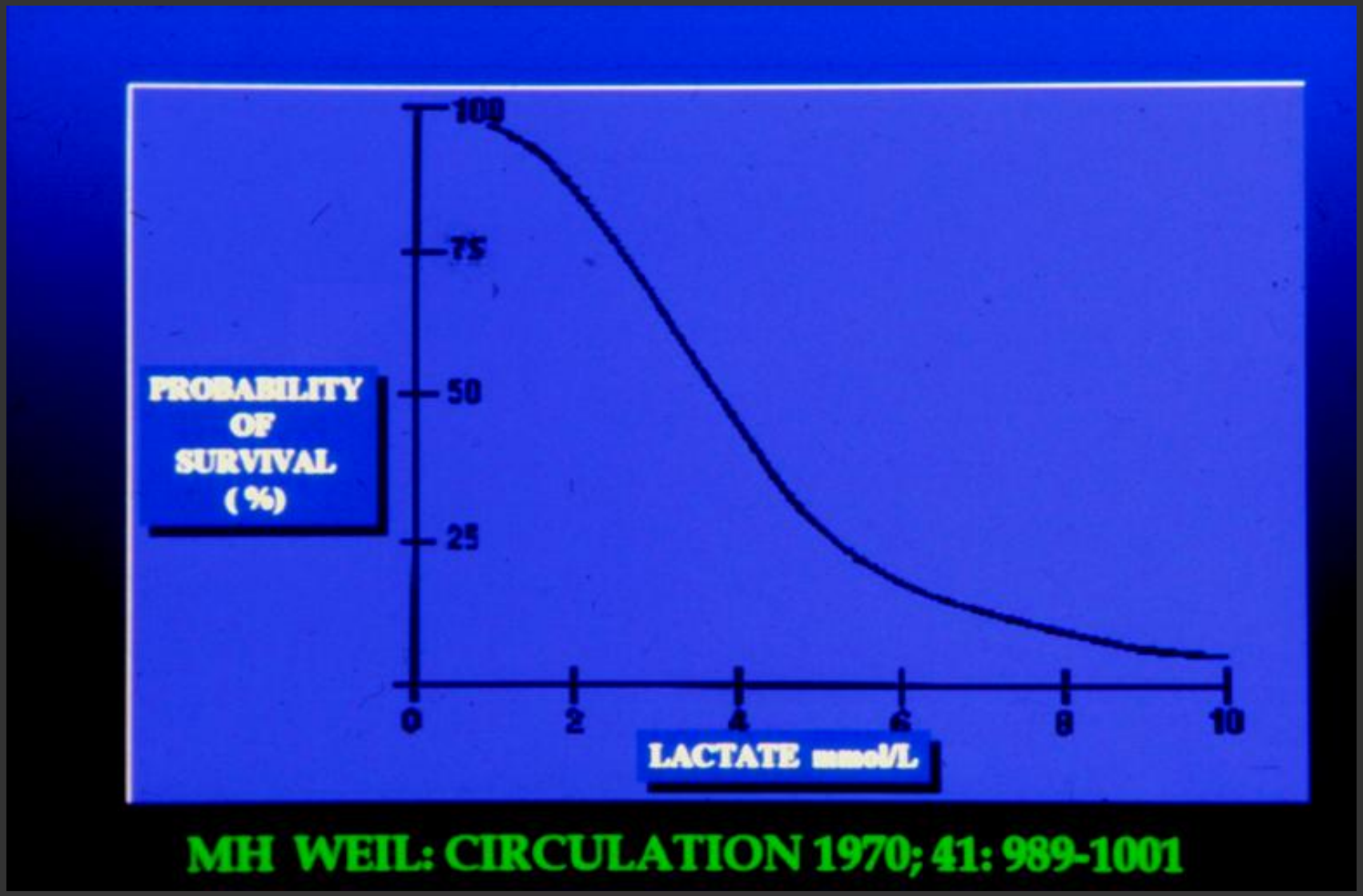
MR PINSKY

BEYOND GLOBAL OXYGEN SUPPLY-DEMAND RELATIONS: IN SEARCH OF MEASURES OF DYSOXIA

INT. CARE MED 1994 20: 1-3

LACT ↑ & = pH → HYPERLACTATEMIA

LACT ↑ & ↓ pH → LACTIC ACIDOSIS

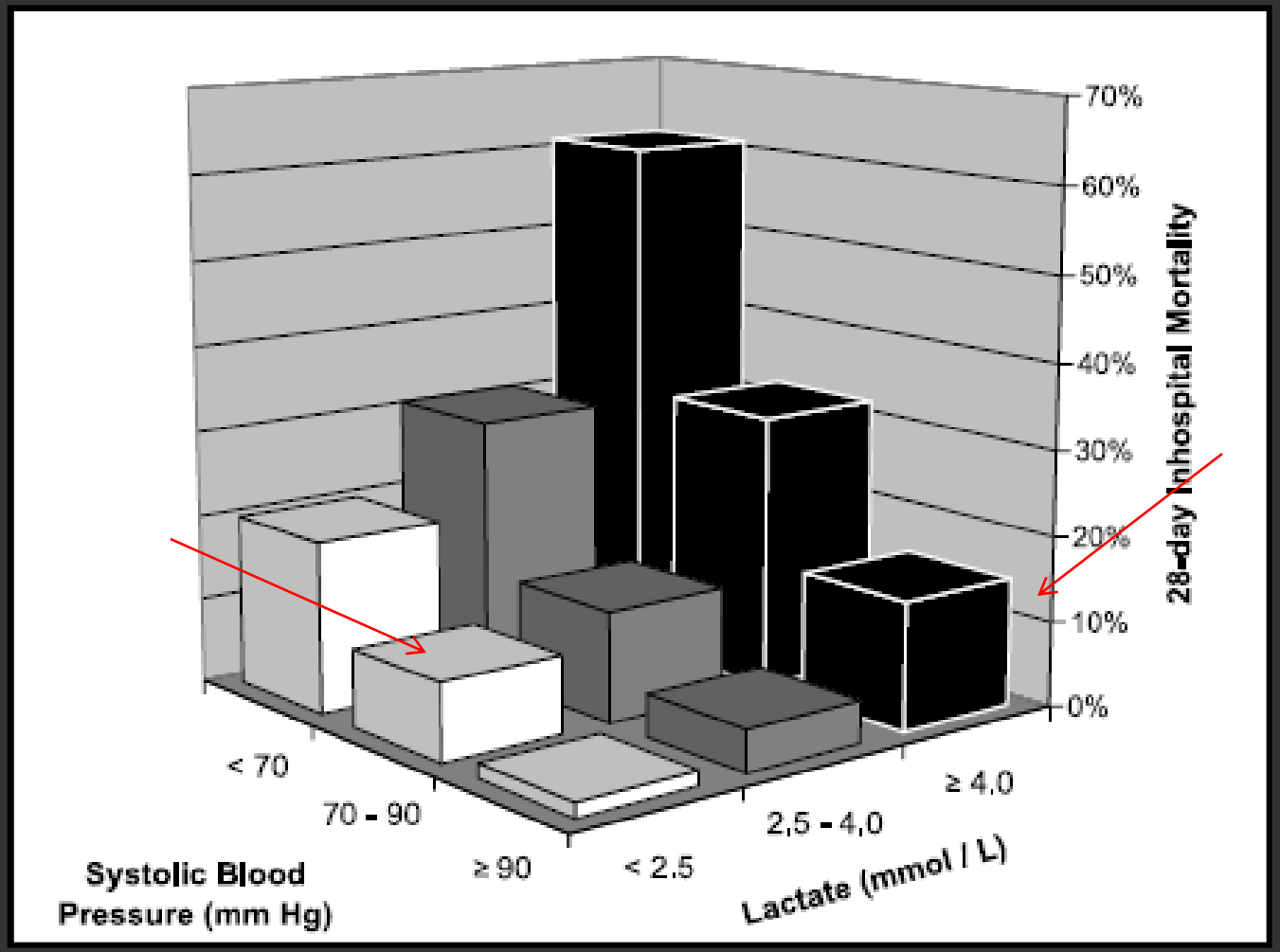

100
75
50
25
PROBABILITY OF SURVIVAL (%)
0
2
4
6
8
10
LACTATE mmol/L
MH WEIL: CIRCULATION 1970; 41: 989-1001

Intensive Care Med (2007) 33:1892–1899
DOI 10.1007/s00134-007-0680-5

ORIGINAL

Michael D. Howell
Michael Donnino
Peter Clardy
Daniel Talmor
Nathan I. Shapiro

Occult hypoperfusion and mortality in patients with suspected infection



"instantaneous" LACTATE CONCENTRATION

PRODUCTION

vs

LIVER & KIDNEY METABOLISM

Research

Open Access

The prognostic value of blood lactate levels relative to that of vital signs in the pre-hospital setting: a pilot study

Tim C Jansen[1], Jasper van Bommel[1], Paul G Mulder[2], Johannes H Rommes[3], Selma JM Schieveld[3] and Jan Bakker[1]

[1]Department of Intensive Care, Erasmus MC University Medical Center, PO Box 2040, 3000 CA, Rotterdam, The Netherlands
[2]Department of Epidemiology & Biostatistics, Erasmus MC University Medical, PO Box 2040, 3000 CA, Rotterdam, The Netherlands
[3]Department of Intensive Care, Gelre Hospital, location Lukas, PO Box 9014, 7300 DS Apeldoorn, The Netherlands

Corresponding author: Jan Bakker, jan.bakker@erasmusmc.nl

Received: 29 Sep 2008 Revisions requested: 6 Nov 2008 Accepted: 17 Dec 2008 Published: 17 Dec 2008

124 pts **SBP < 100** **RR <10 or > 29/min** **GCS < 14**

Conclusions: In a cohort of patients that required urgent ambulance dispatching, pre-hospital blood lactate levels were associated with in-hospital mortality and provided prognostic information superior to that provided by the patient's vital signs. There is potential for early detection of occult shock and prehospital resuscitation guided by lactate measurement.

Intensive Care Med (2007) 33:1863–1865
DOI 10.1007/s00134-007-0679-y

EDITORIAL

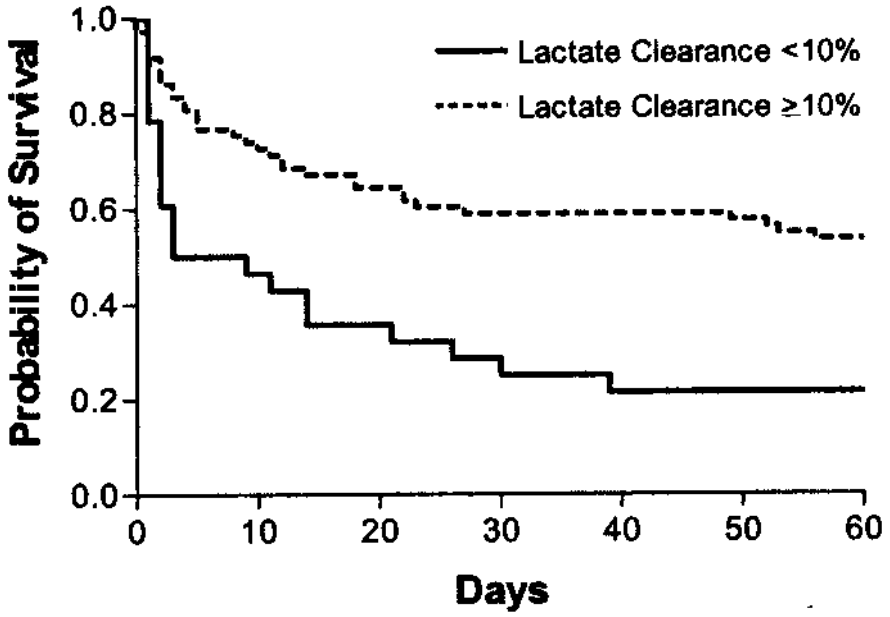
Jan Bakker
Tim C. Jansen

Don't take vitals, take a lactate

many ???

EARLY LACTATE CLEARANCE IS ASSOCIATED WITH IMPROVED OUTCOME

$$\frac{\text{Lactate start} - \text{Lactate 6 H}}{\text{Lactate start}} \times 100$$



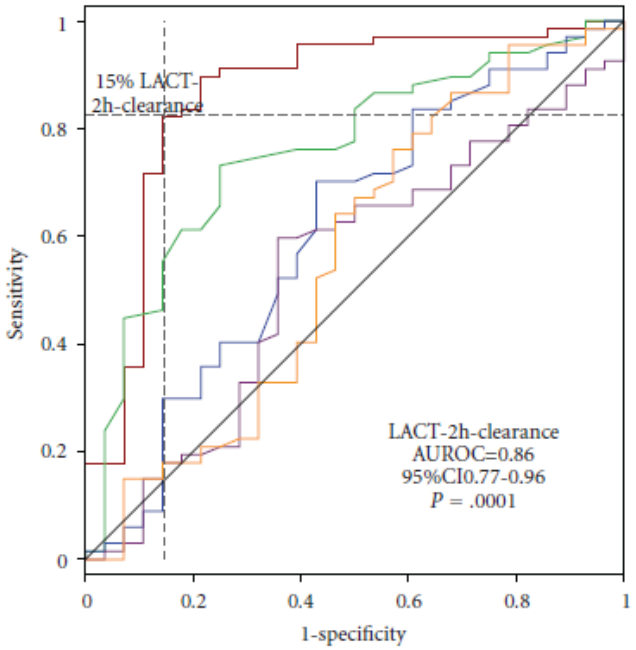
NGUYEN HB, RIVERS EP (2004) CCM 32;8:1637-42

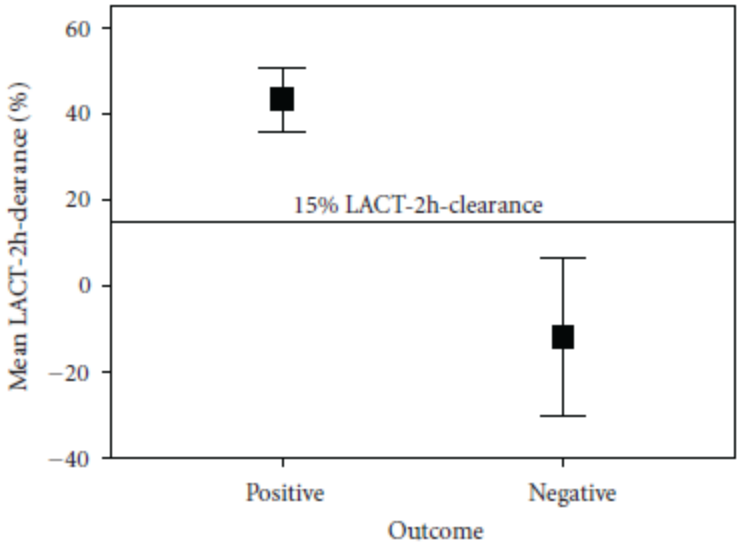
Hindawi Publishing Corporation
Critical Care Research and Practice
Volume 2010, Article ID 917053, 6 pages
doi:10.1155/2010/917053

Research Article

Two-Hour Lactate Clearance Predicts Negative Outcome in Patients with Cardiorespiratory Insufficiency

Sean Scott,[1] Vittorio Antonaglia,[2] Giovanna Guiotto,[3] Fiorella Paladino,[3] and Fernando Schiraldi[3]





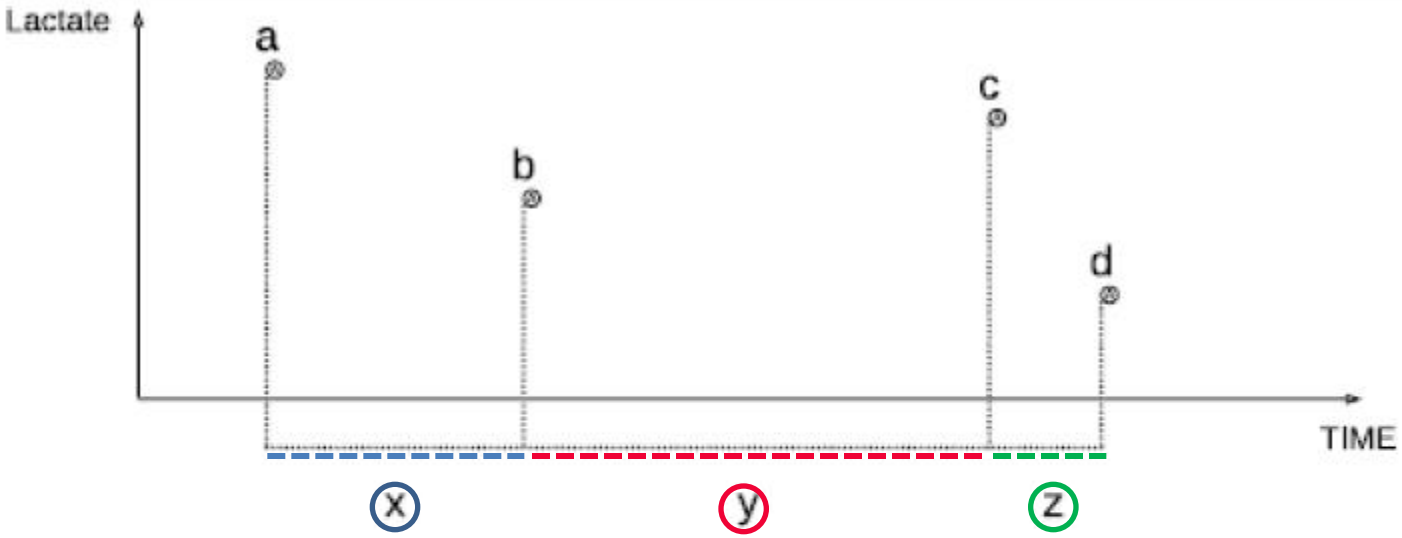
Nichol *et al. Critical Care* 2011, **15**:R242
http://ccforum.com/content/15/5/R242

CRITICAL CARE

RESEARCH Open Access

Dynamic lactate indices as predictors of outcome in critically ill patients

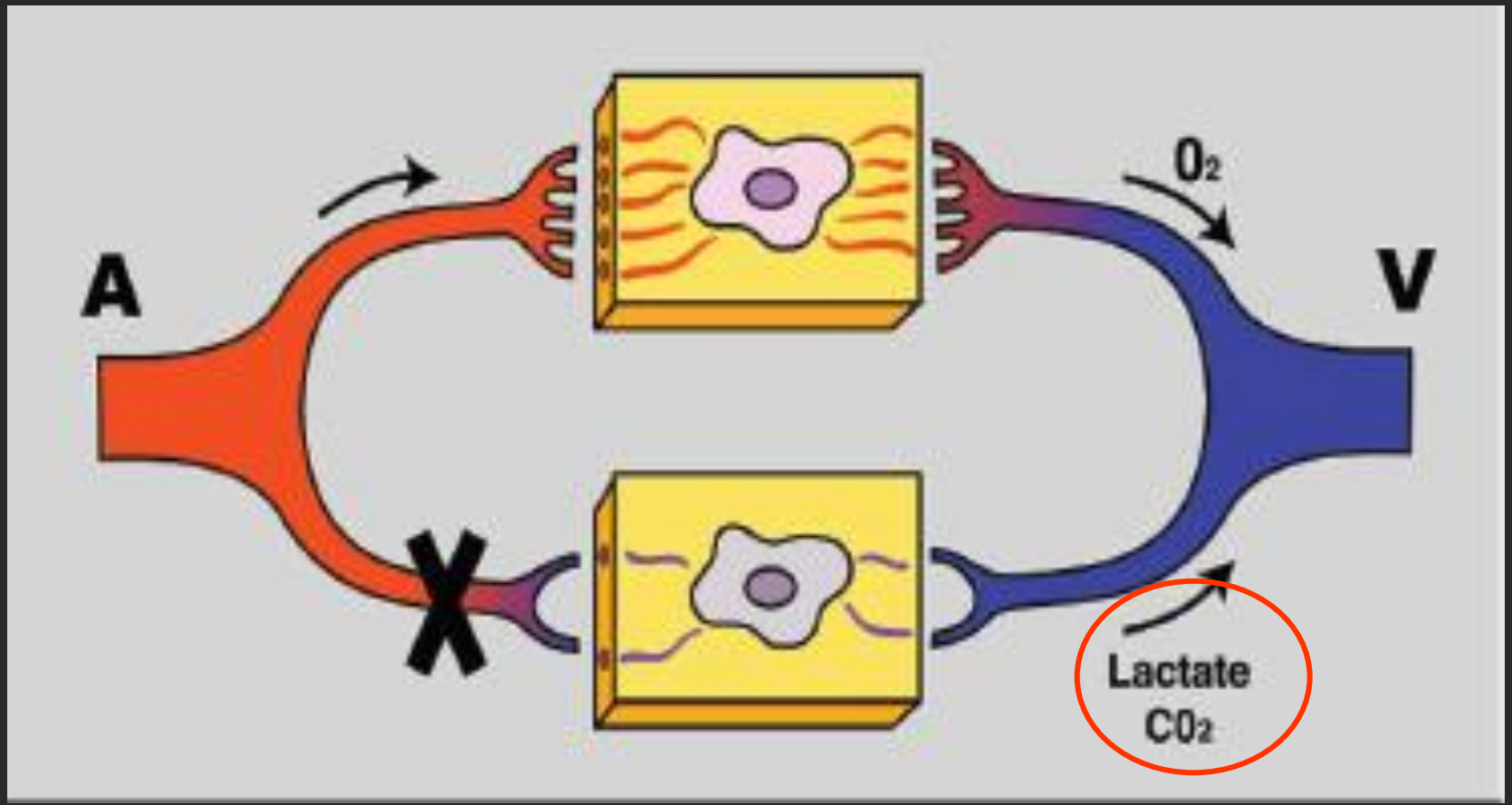
Alistair Nichol[1,3], Michael Bailey[1], Moritoki Egi[2], Ville Pettila[1], Craig French[5,4], Edward Stachowski[6], Michael C Reade[4], David James Cooper[1,3] and Rinaldo Bellomo[1,4,7*]



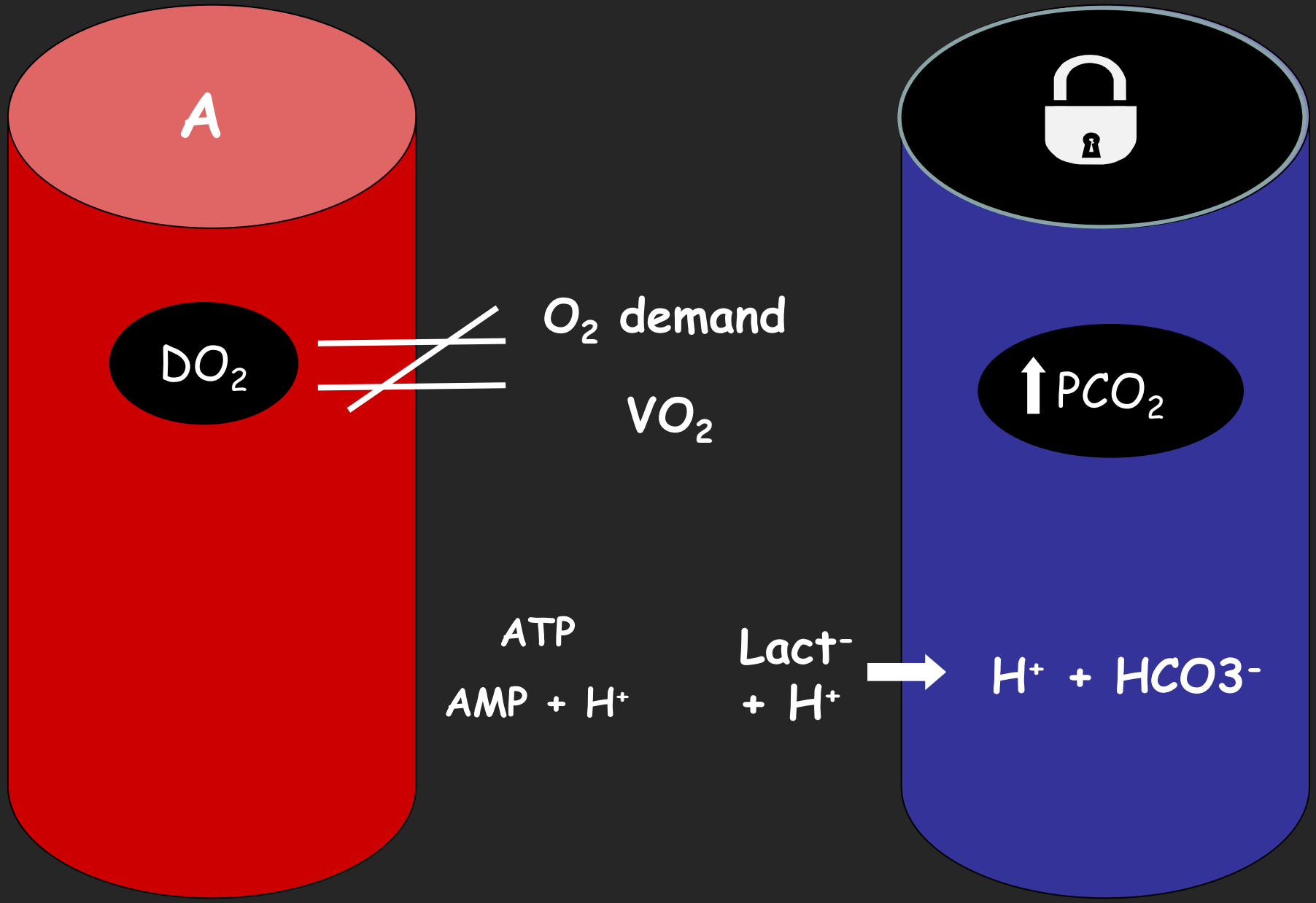
36673 lact in 24 h
5041 pts

Time weighted average = x((a+b)/2))+y((b+c)/2)+z((c+d/2)) / (x+y+z)

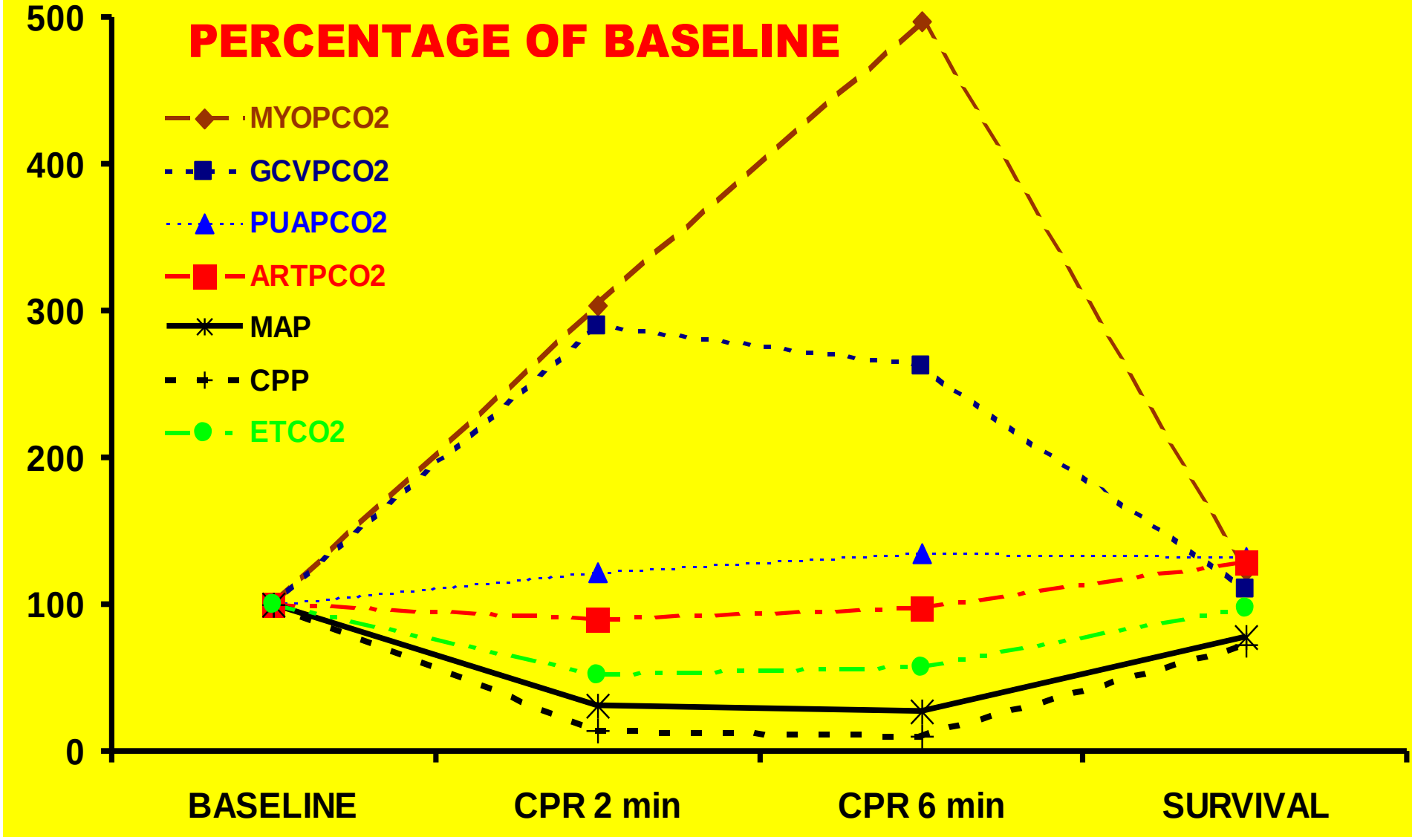
Figure 1 Diagram describing the calculation of time weighted lactate (Lac_{TW}).


A
O_2
V
X
Lactate
CO_2

The CO_2 lung presentation & low flow



CO_2 AS MONITOR OF PERFUSION



P.R. 69 y.♀ 17th OCt 1992

	h. 12.15 art.	h. 12.15 c.ven.		h. 12.30 art.	h. 12.30 c.ven.	
pH	7.14	7.114		7.440	7.393	
PCO_2	30.9	40.1	ΔCO_2 = 9.2	34.7	40	ΔCO_2 = 5.3
PO_2	199.6	45.3		75.3	31.7	
HCO_3	11.8	12.2		23.3	24	
SAT	99.1	63.2	OER = 36	94.5	61.4	OER = 33.5

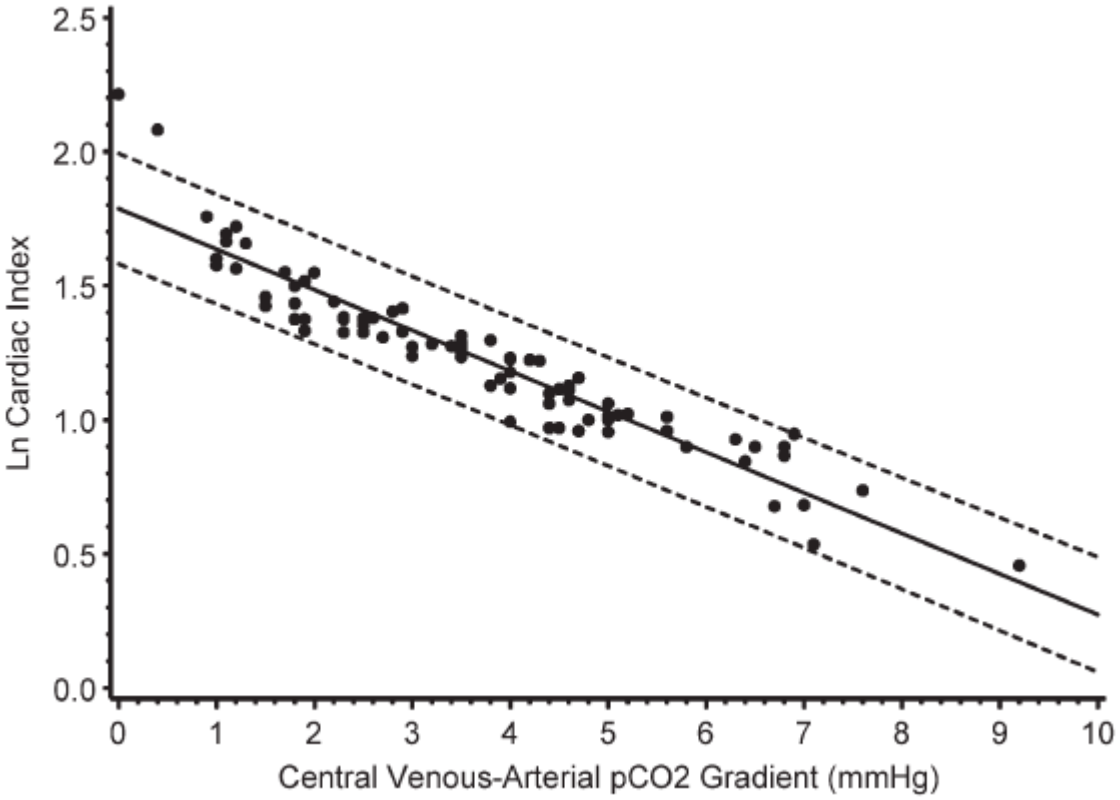
FS 1993

Intensive Care Med (2005) 31:818–822
DOI 10.1007/s00134-005-2602-8

ORIGINAL

Joseph Cuschieri
Emanuel P. Rivers
Michael W. Donnino
Marius Katilius
Gordon Jacobsen
H. Bryant Nguyen
Nikolai Pamukov
H. Mathilda Horst

Central venous-arterial carbon dioxide difference as an indicator of cardiac index



Intensive Care Med (2013) 39:1034–1039
DOI 10.1007/s00134-013-2888-x

ORIGINAL

Paul A. van Beest
Mariska C. Lont
Nicole D. Holman
Bert Loef
Michaël A. Kuiper
E. Christiaan Boerma

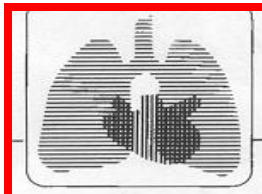
Central venous-arterial pCO_2 difference as a tool in resuscitation of septic patients

(53 patients with severe sepsis or septic shock)

Conclusion

From a practical perspective, i.e. easily obtained and satisfying data, the clinical utility of central pCO_2 values is of potentially great interest in determining the venousarterial pCO2 difference.

A priori, the predictive value for outcome of the central venous pCO_2 difference is questionable but **persistence of an increased central venous pCO_2 difference after 24 h of therapy seems to enhance the likelihood of bad outcome**



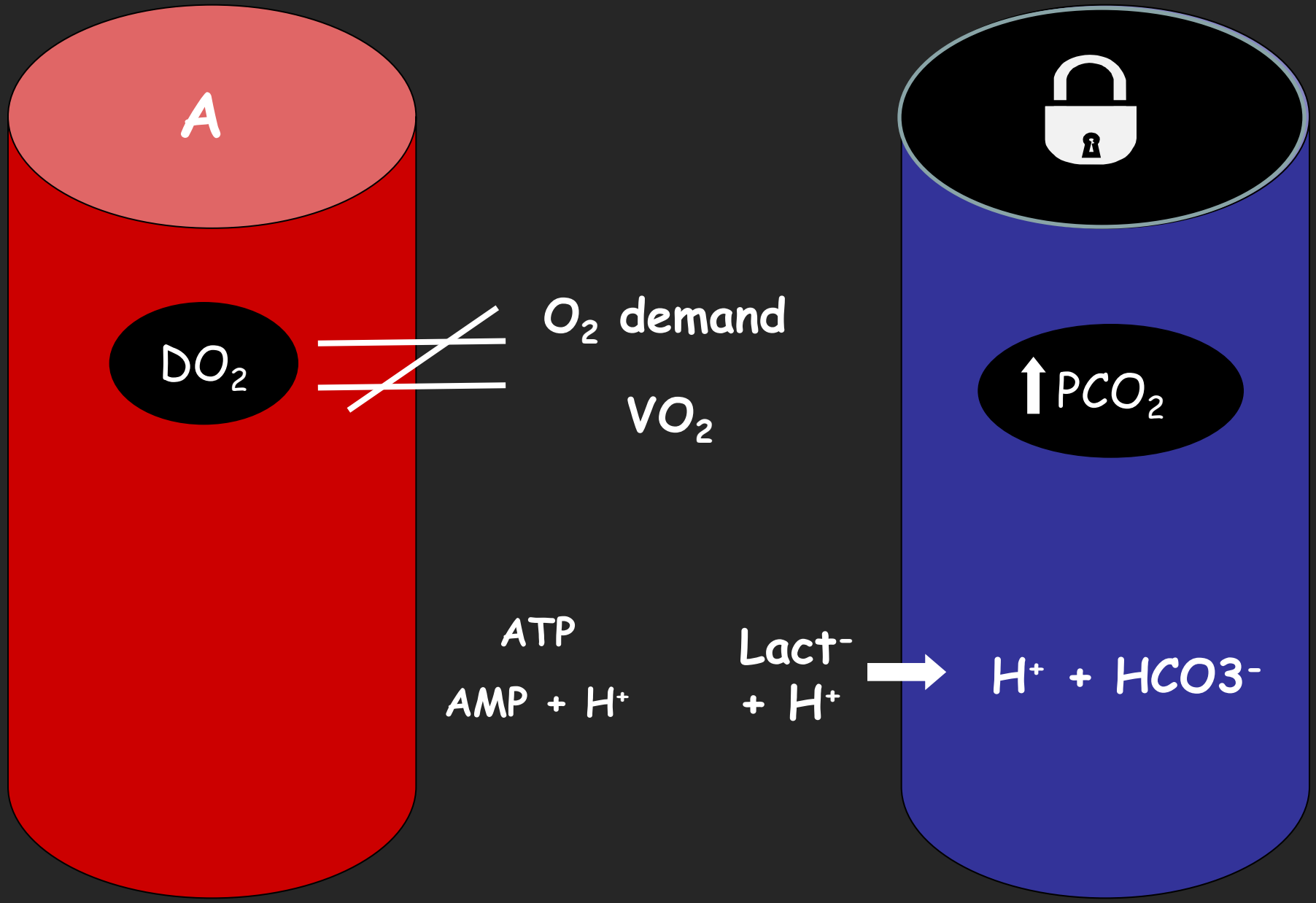
clinical investigations in critical care

Sodium Bicarbonate for the Treatment of Lactic Acidosis*

Sean M. Forsythe, MD; and Gregory A. Schmidt, MD, FCCP

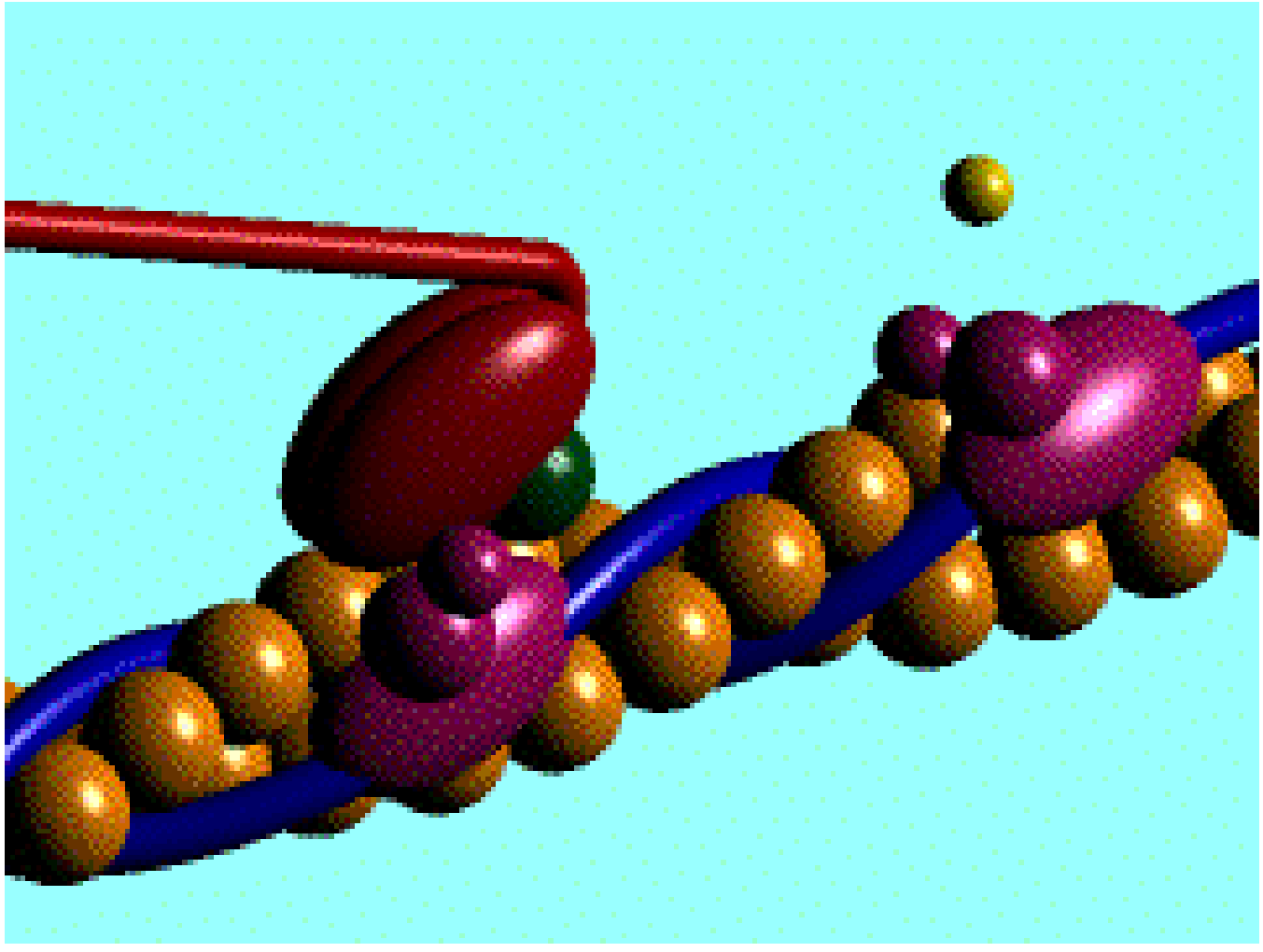
- IS A LOW pH BAD ?
- CAN ALKALI RAISE pHi ?
- IF (VENOUS) pH IS RAISED BY $NaHCO_3$, IS THERE ANY SALUTARY EFFECT ?
- DOES $NaHCO_3$ HAVE NEGATIVE SIDE EFFECTS?

The CO_2 lung presentation & low flow



IS A NEAR-NORMAL pH IMPORTANT ?

2. H^+ vs Ca^{++} & troponins



Therapeutic Strategies

RESP ACIDOSIS

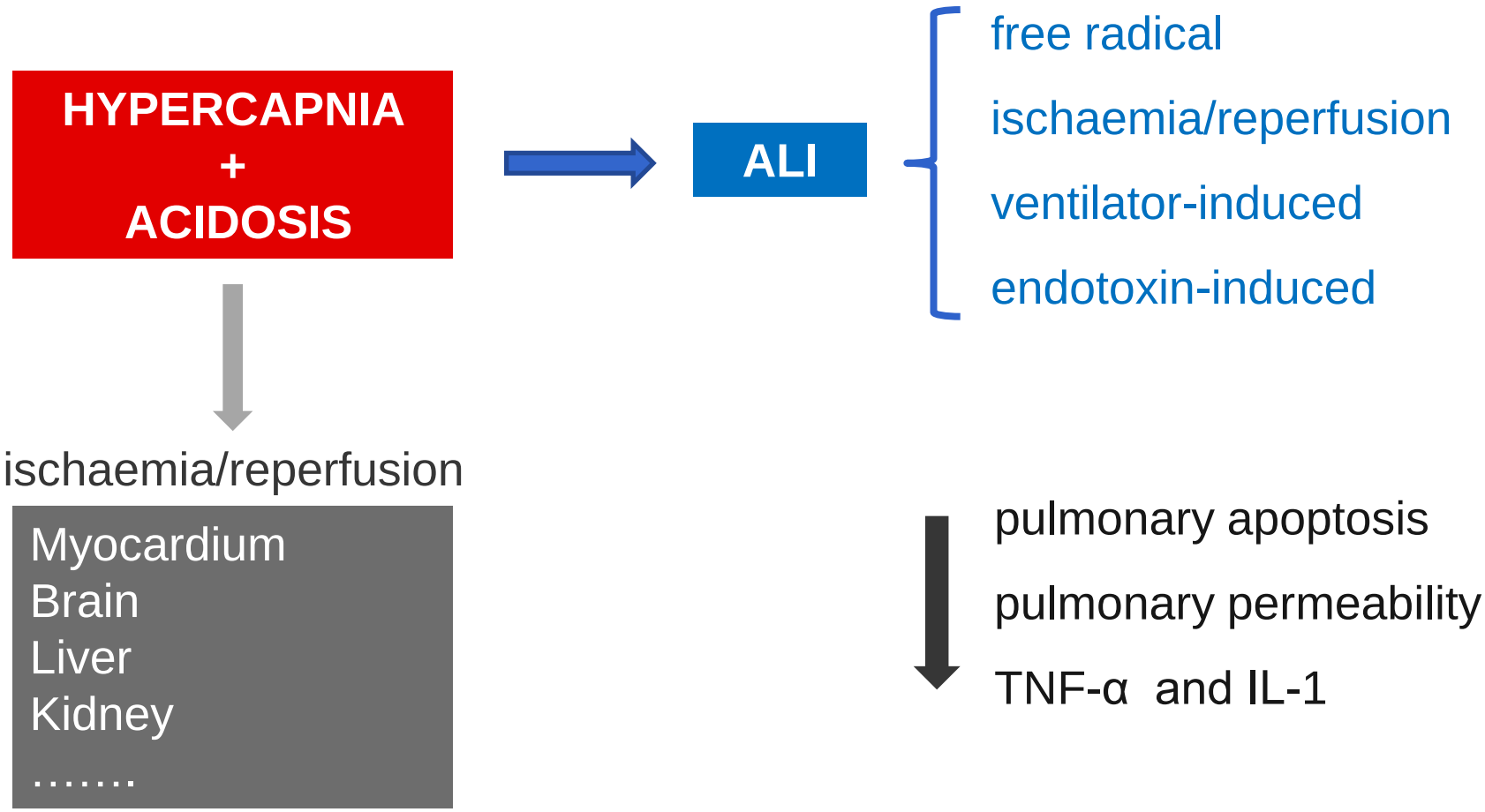
- PO_2
- PCO_2
- pH

Permissive ?

Review

Bench-to-bedside review: Permissive hypercapnia

Donall O' Croinin[1], Martina Ni Chonghaile[2], Brendan Higgins[3] and John G Laffey[4]



Critical Care 2005, 9:51-59

Heming *et al. Critical Care* 2012, 16:318
http://ccforum.com/content/16/4/318

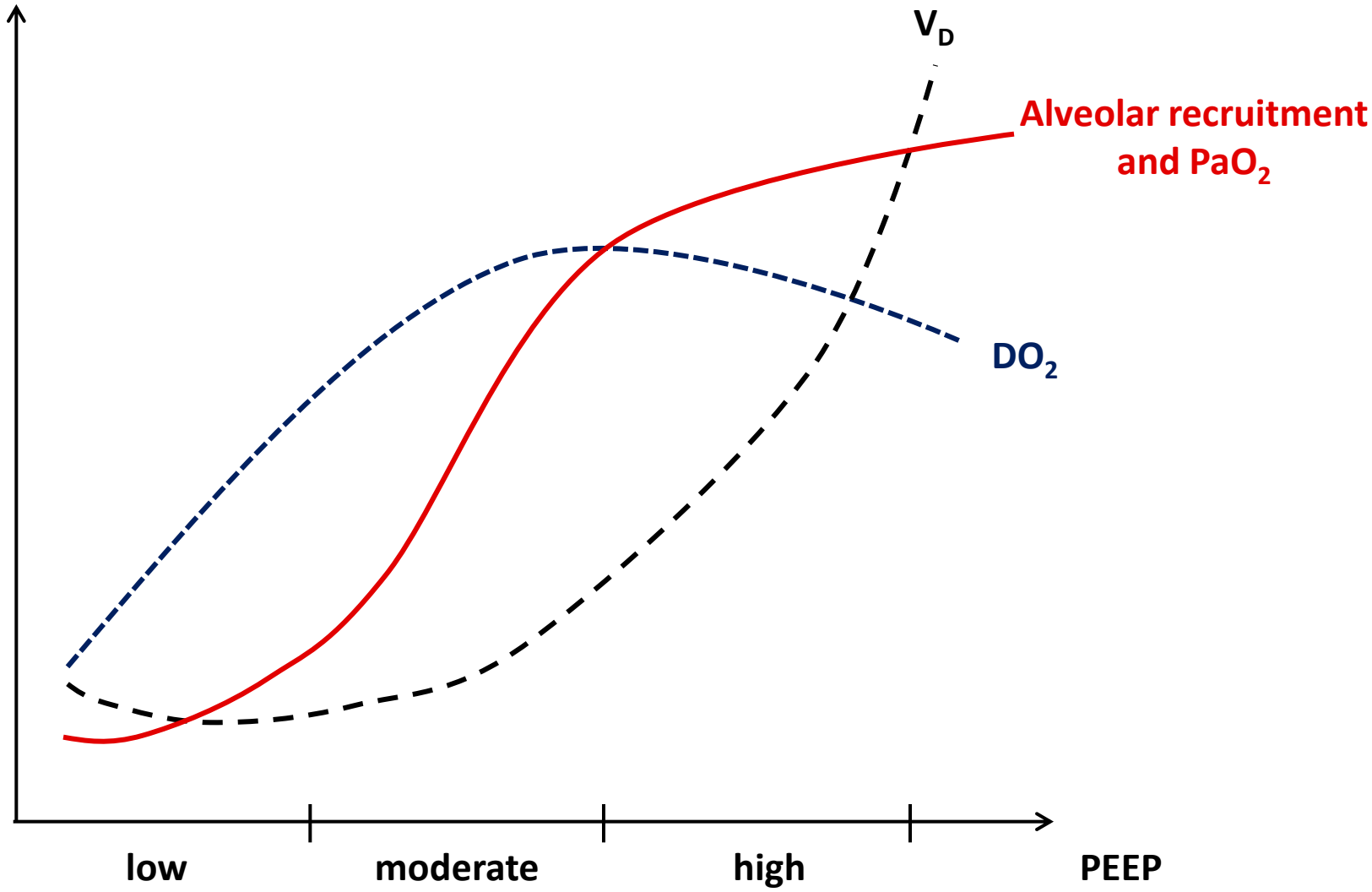
CRITICAL CARE

VIEWPOINT

Acetazolamide: a second wind for a respiratory stimulant in the intensive care unit?

Nicholas Heming*[1], Saïk Urien[2] and Christophe Faisy[1]

THE BEST PEEP



KEY POINTS

- BGA = FIRST LINE DIAGNOSTIC TOOL
- FLUIDS & ELECTROLYTES STRICTLY LINKED
- LOOK FOR FINE "TUNING" in ↓ PO_2 ↑ PCO_2
- IN MET. ACIDOSIS LOOK FOR CAUSES NOT FOR COSMESIS


DON'T RESCUE ME
UNTIL AFTER MY
LACTATE TEST