BEWARE THE "MAGIC" BOX

Clinical case

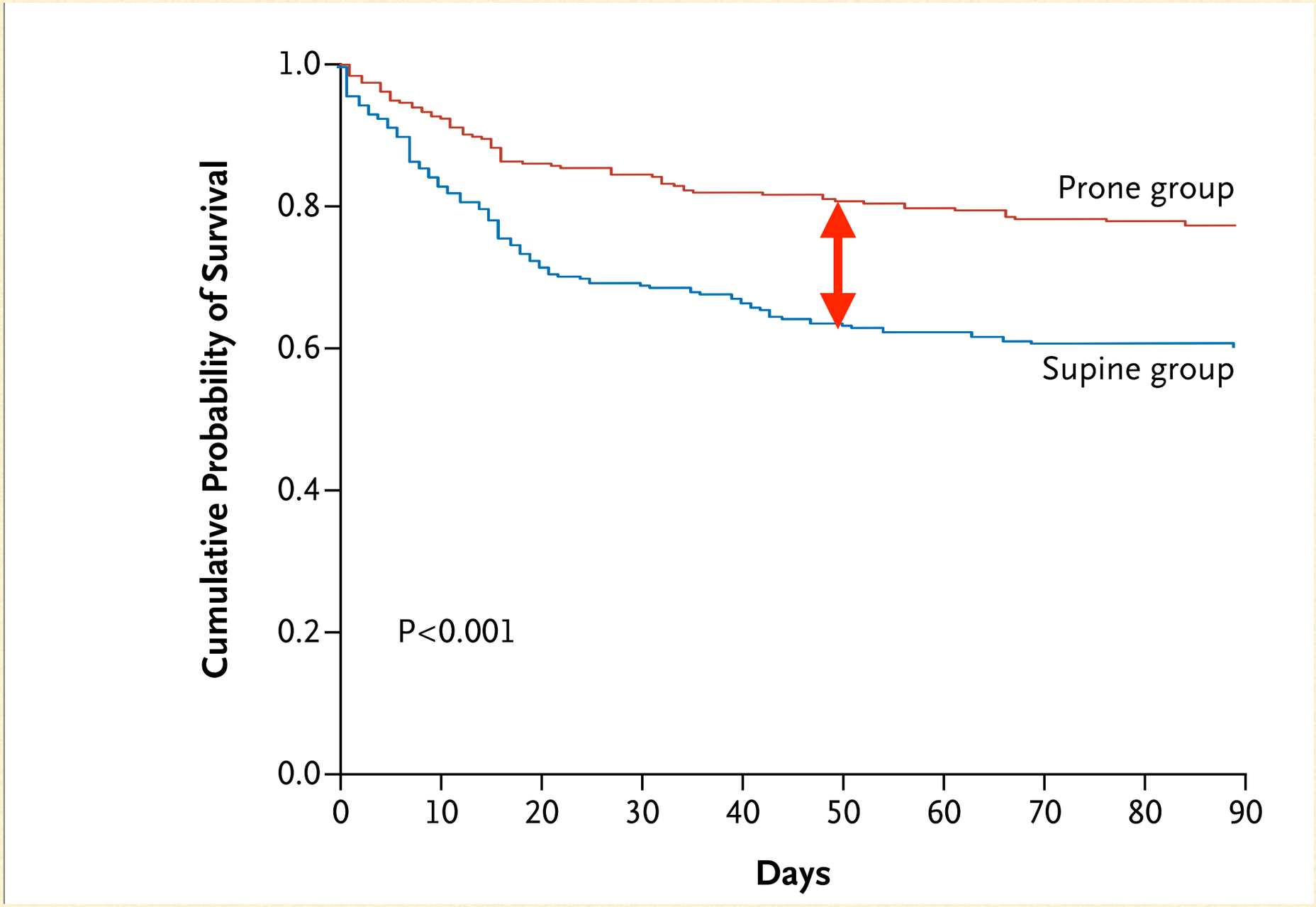
70 yr old woman transferred from Hillingdon Hospital in respiratory failure

History of present complaint:

- Developed a mild chest infection while in India, worsened while in Dubai on return flight
- Admitted to Hillingdon - after failed NIV, intubated, paralysed and ventilated with respiratory failure as well as suspected PE (dilated RV +/- ACS raised troponins)
- Rx: Therapeutic heparin, ACS and broad spectrum antibiotics plus Oseltamivir
- Tx to Ealing where over next 1 1/2 days condition worsened
  - P/F 11 on PEEP 14 and Vt 450 ml (protective lung ventilation ~ 320mL)
  - ELWI is 24 on PICCO
  - Lactate 7 + ScvO2 61%
  - BP 80/35
- 2 episodes of SVT at 180-200 /minute, Rx Amiodarone and digoxin
- Cautious introduction of Noradrenaline, Dobutamine, Hydrocortisone

Any ideas what to do next ?????

THE LADY IS FOR TURNING…

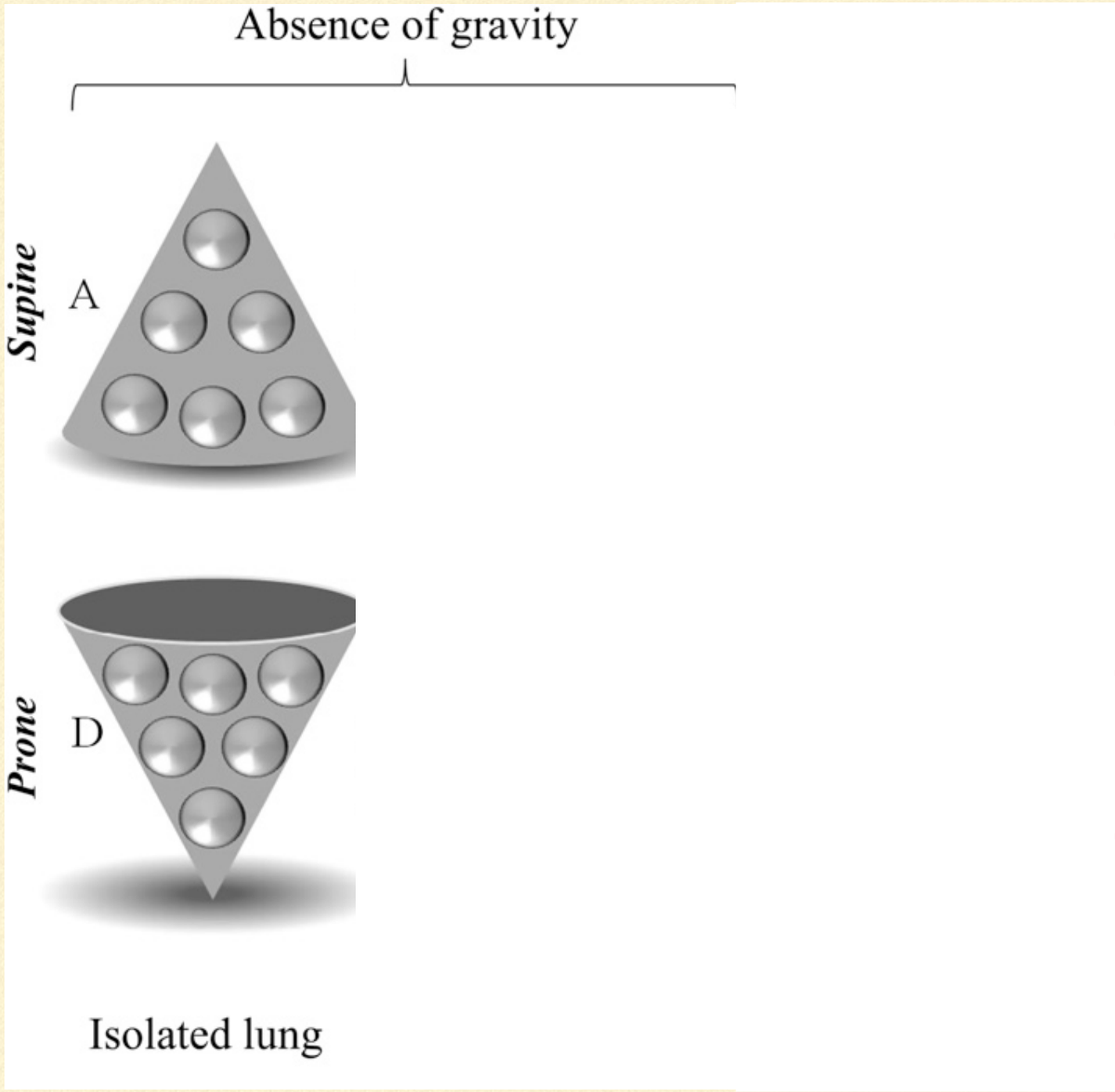


NEJM May 20, 2013

HOW DOES PRONING WORK?

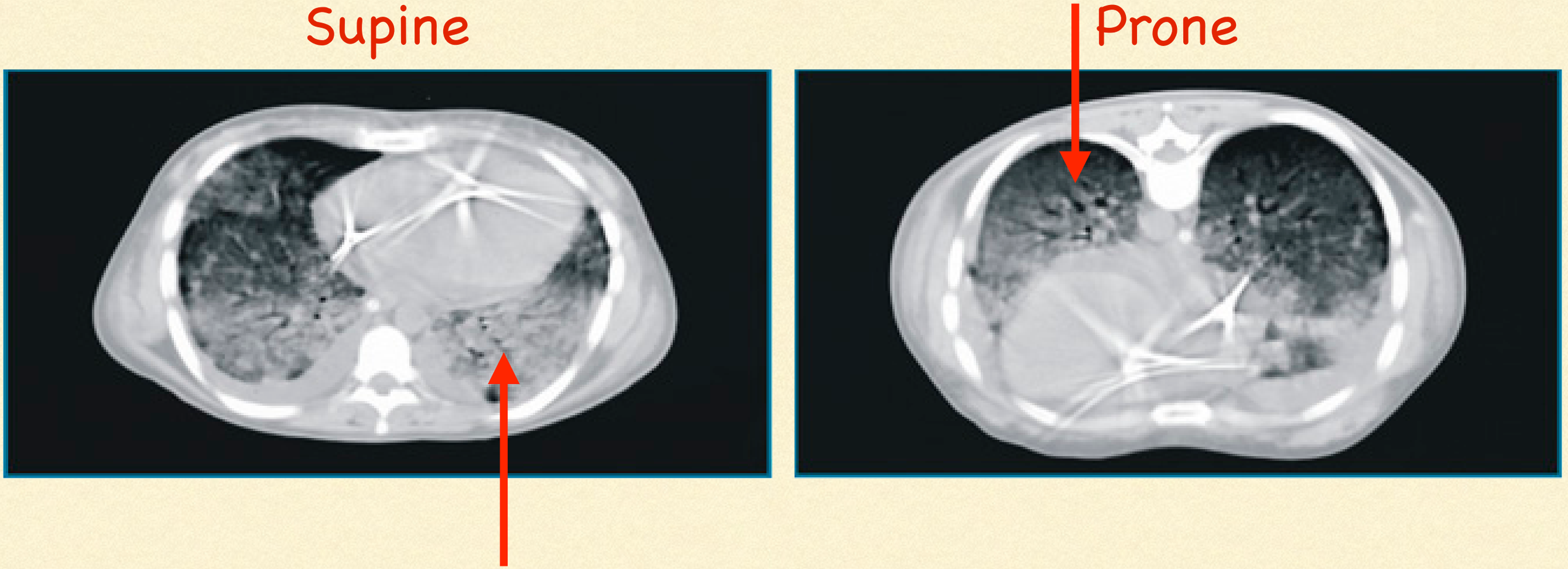
2 forces on alveoli:

- **shape mismatch**
- **gravity**



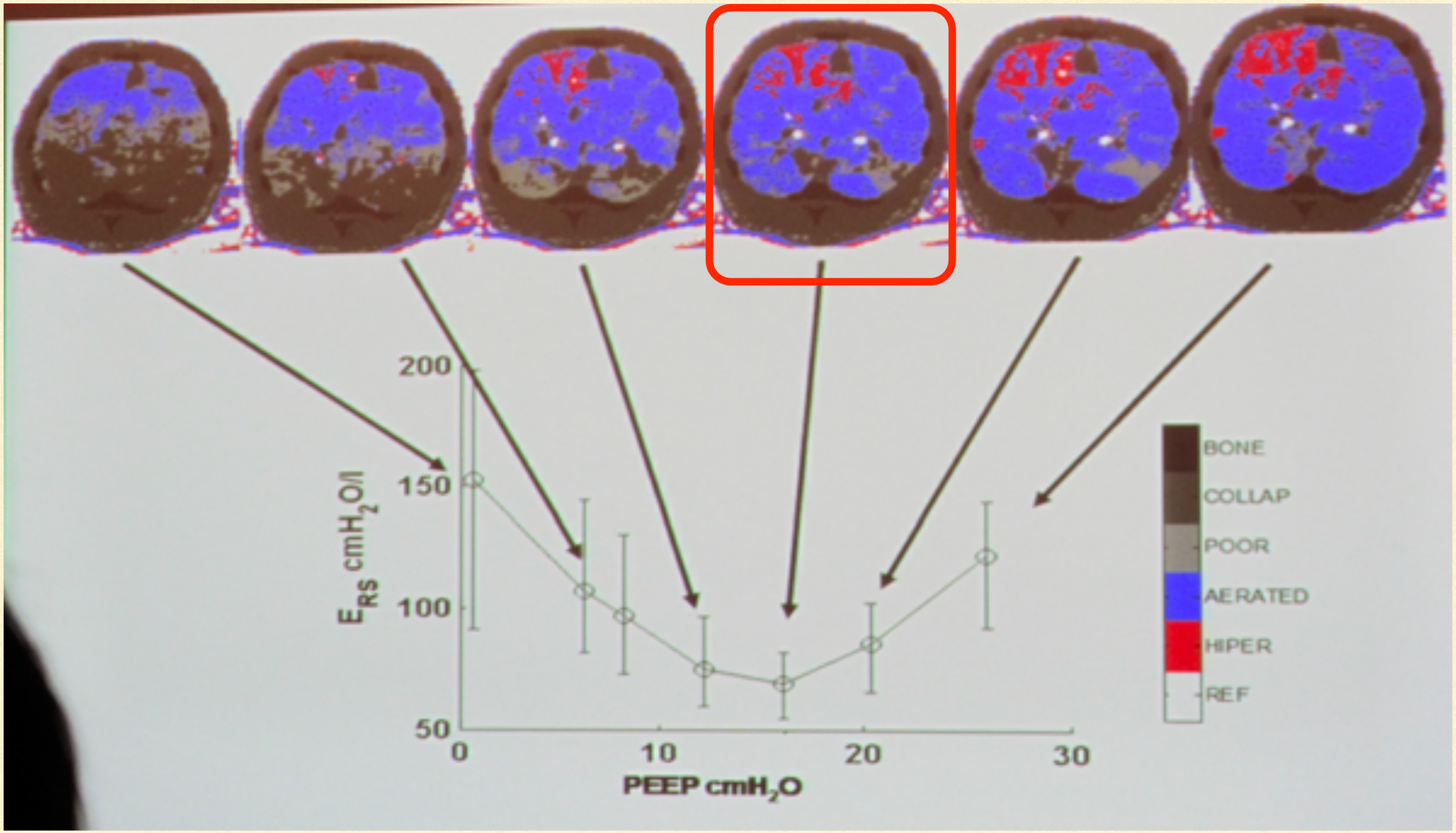
AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 188 2013

Prone position in ARDS



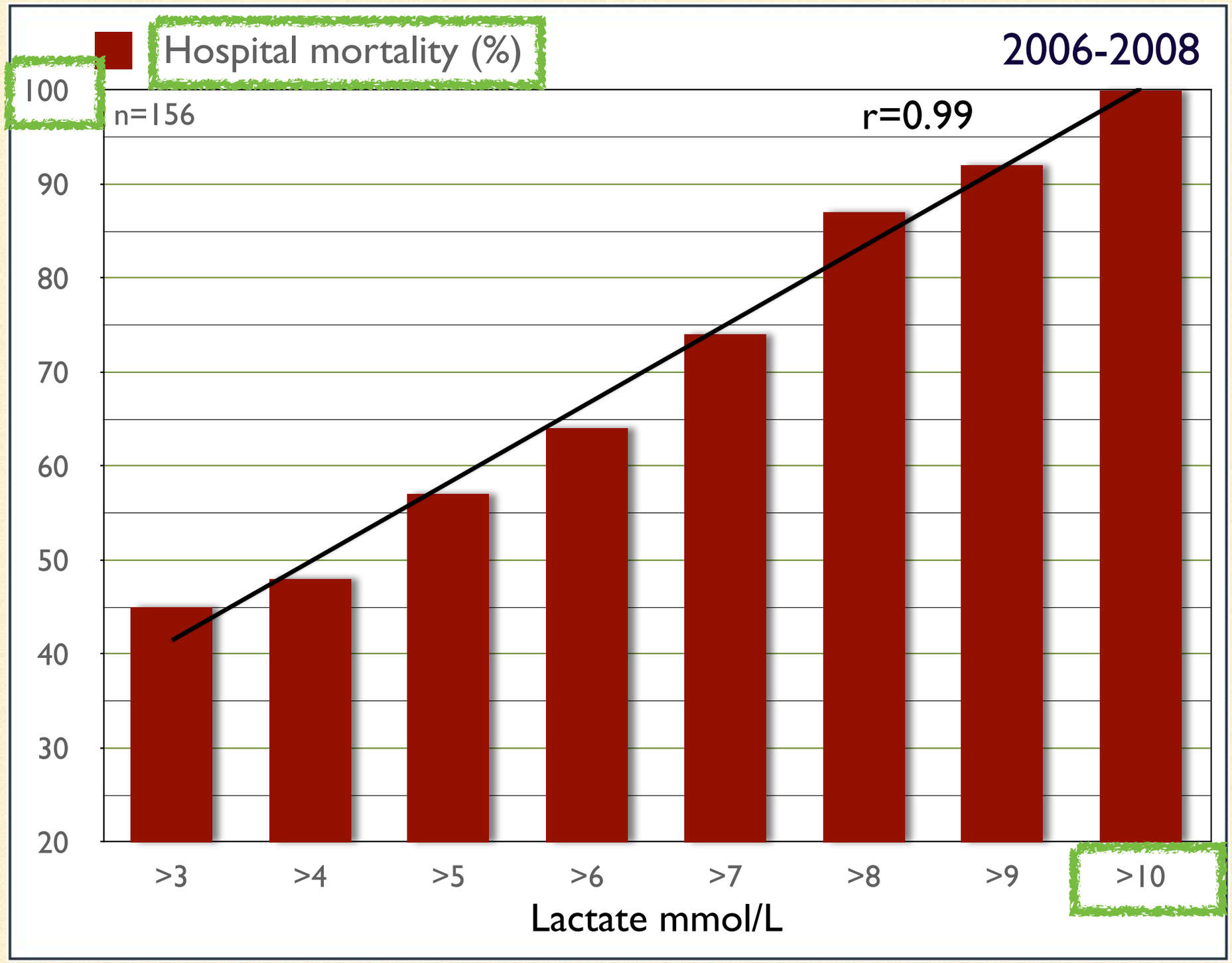
Am J Respir Crit Care Med Vol 188, Iss. 11, pp 1286–1293, Dec 1, 2013

More homogeneity = less stress and strain = less damage



Carvalho AR et al. Intensive care medicine 2008 Dec; 34(12):2291-9

Raising lactate…dropping ScV02



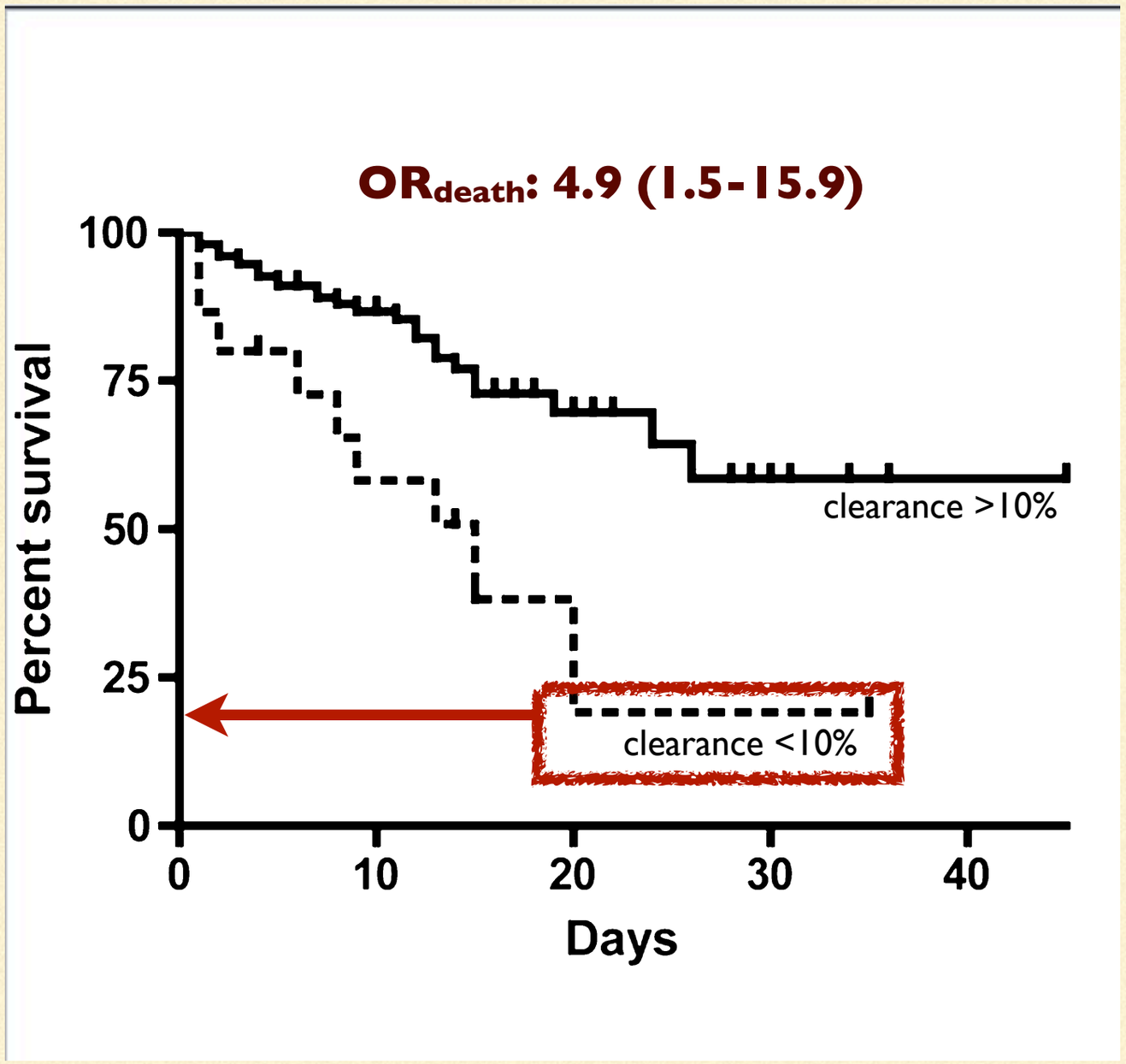
Prof. Jan Bakker MD, PhD
Chair dept Intensive Care Adults
Erasmus MC
University Medical Center Rotterdam

Personal communication

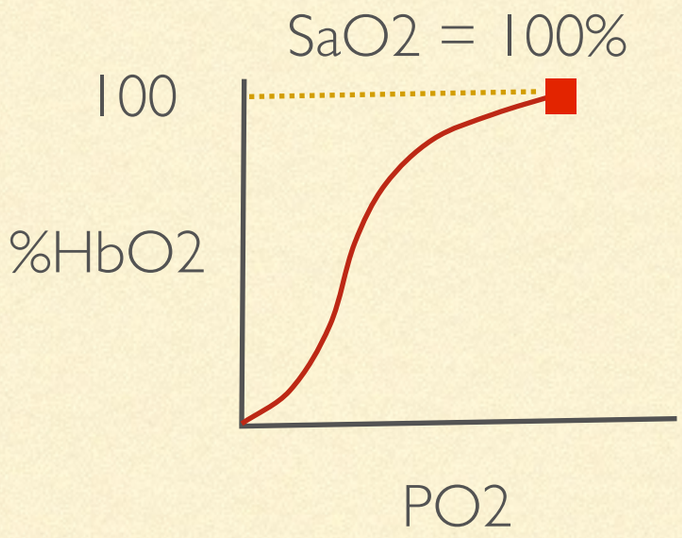
MULTICENTER STUDY OF EARLY LACTATE CLEARANCE AS A DETERMINANT OF SURVIVAL IN PATIENTS WITH PRESUMED SEPSIS

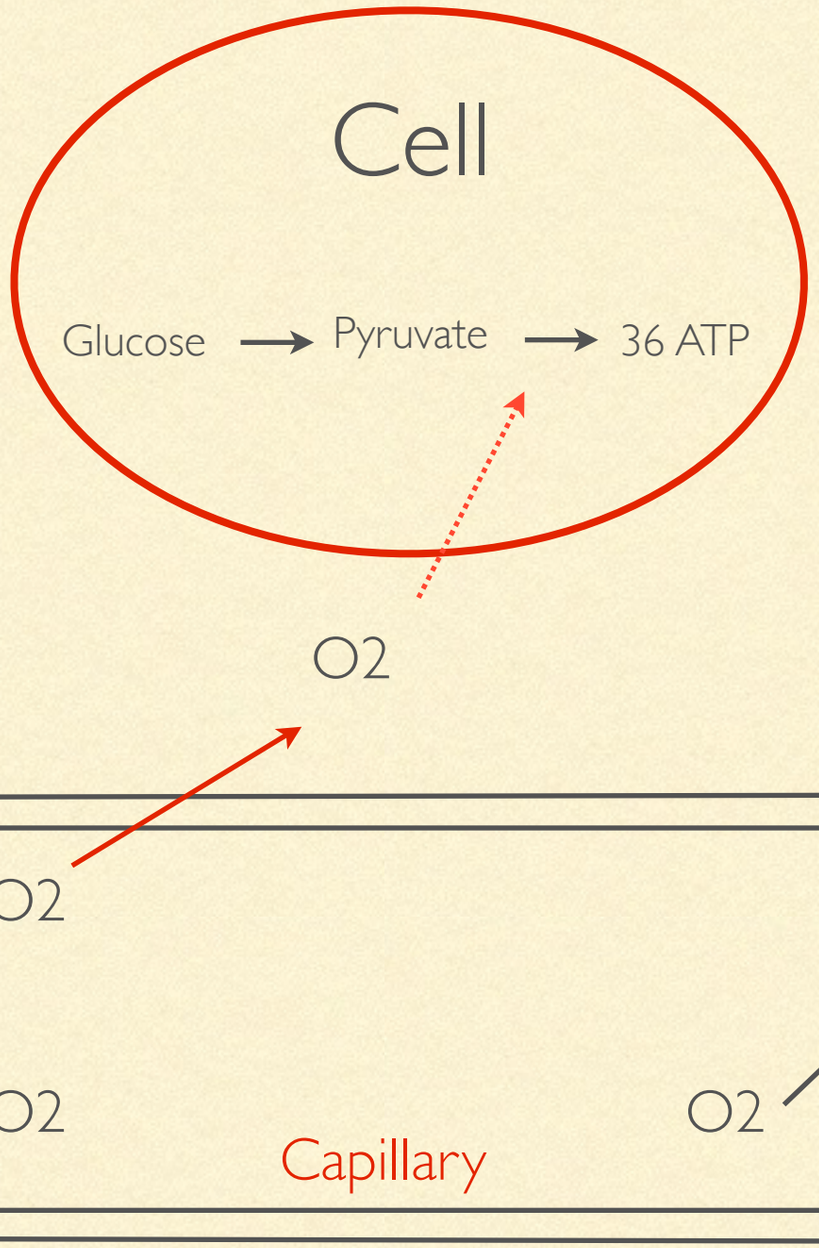
Ryan C. Arnold,* Nathan I. Shapiro,† Alan E. Jones,‡ Christa Schorr,§ Jennifer Pope,† Elisabeth Casner,‡ Joseph E. Parrillo,§ R. Phillip Dellinger,§ Stephen Trzeciak,* and on behalf of the Emergency Medicine Shock Research Network (EMShockNet) Investigators

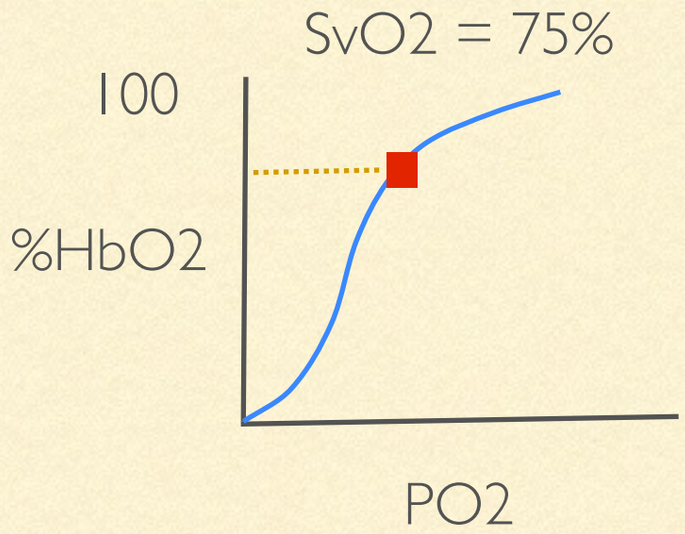
SHOCK, Vol. 32, No. 1, pp. 35–39, 2009



Increased **Oxygen Extraction**-
The Last Gasp



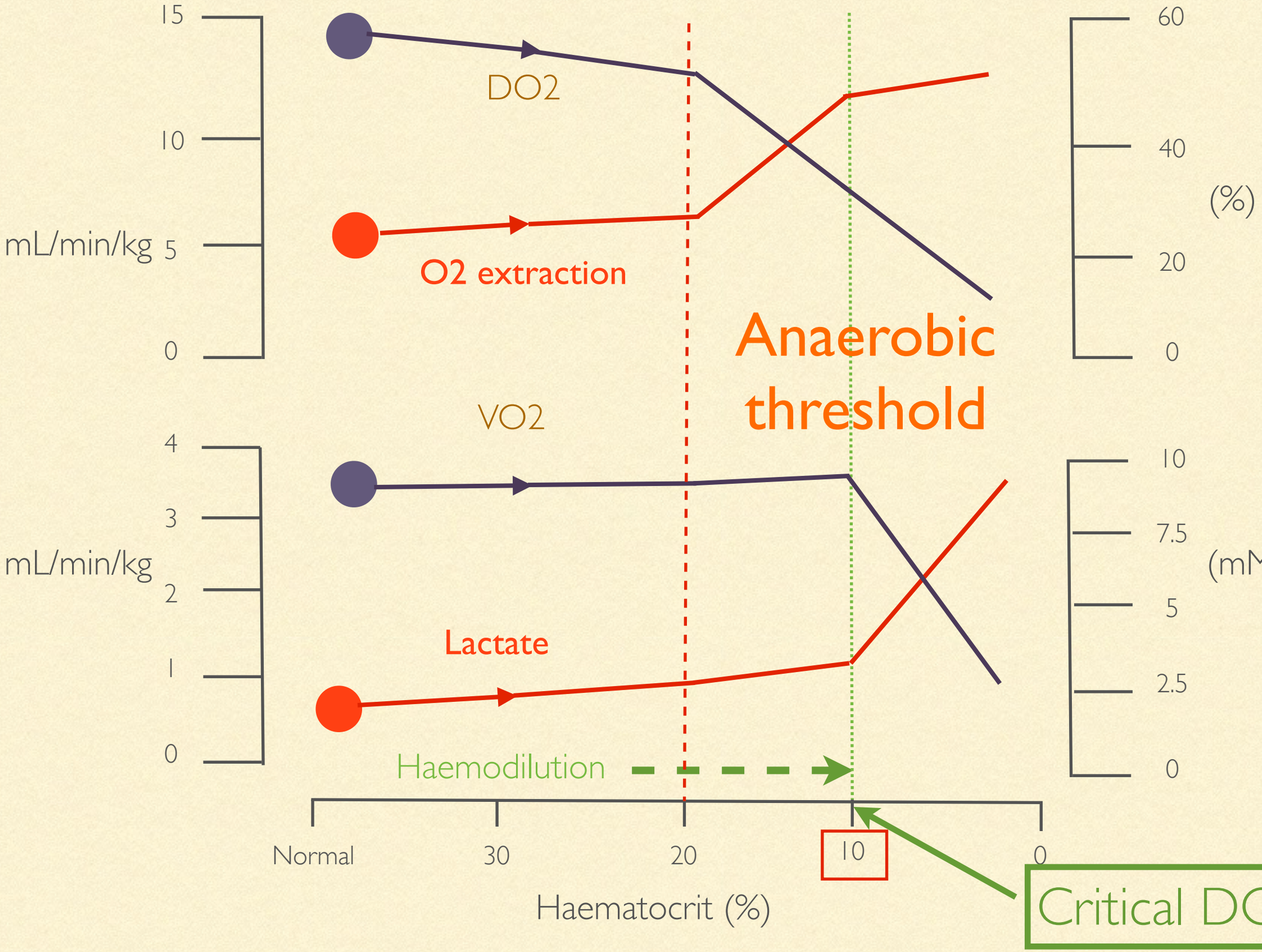




Arterial inflow

Venous outflow

VO2 = DO2 x O2 Extraction



J Surg Res 1987; 42 : 629-634

Resuscitation of the Critically Ill in the ED: Responses of Blood Pressure, Heart Rate, Shock Index, Central Venous Oxygen Saturation, and Lactate

Rady MY, Rivers EP, Nowak RM:Am J Emerg Med 1996, 14:218–225.

"… up to **50%** of patients resuscitated from shock may have continued global **tissue hypoxia** (ie, decreased ScvO2) even with **normalization** of vitals signs…"

Clinical case

Gas exchange and oxygen delivery seem better after 18 hours prone

P/F ratio is 25 (FiO2 is .40 with saturations of 93%)

But…

PICCO says C.O. is ~ 2.5 - 3.0 L /min

despite a now normal lactate and an ScVO2 of 74%

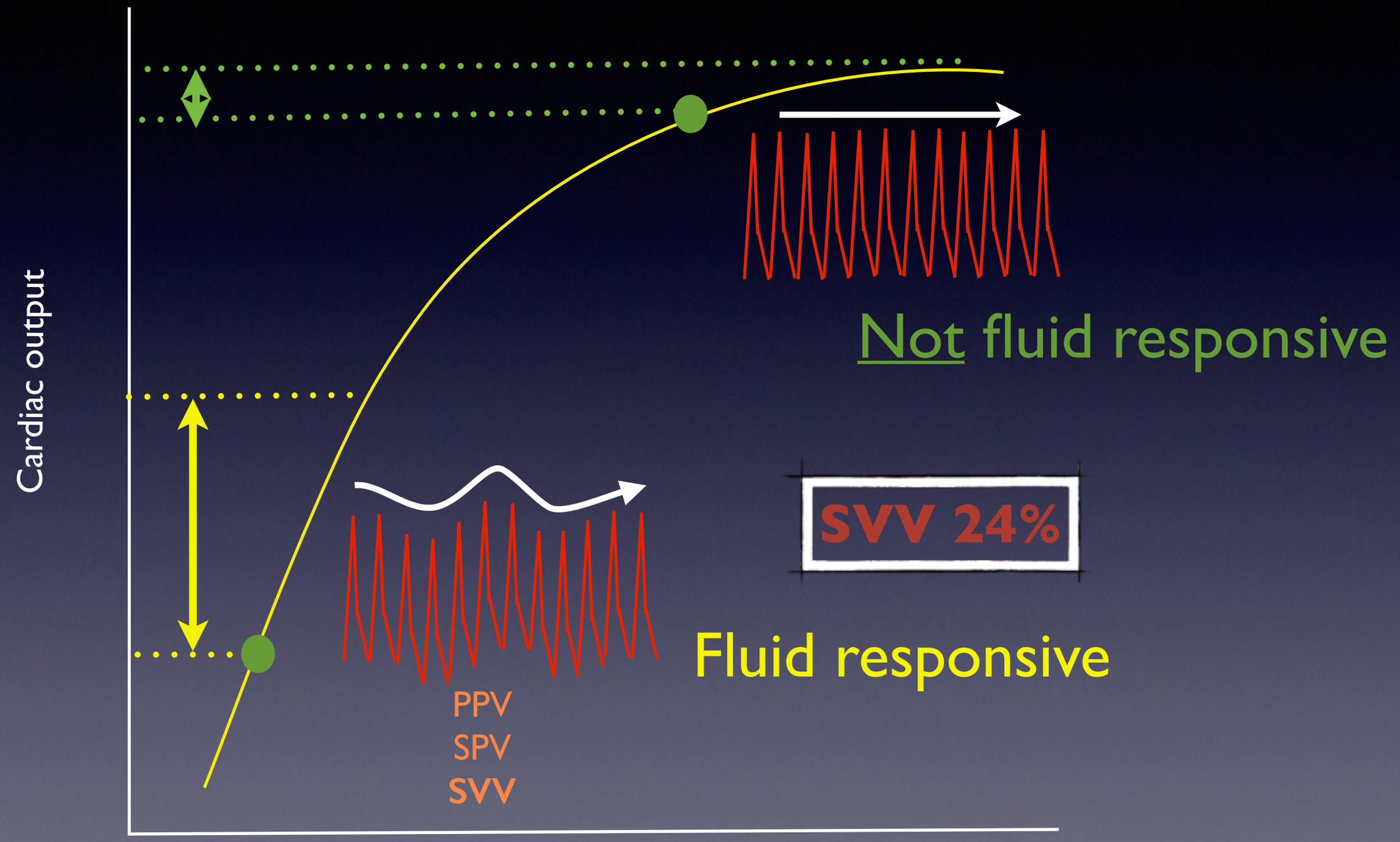
with a BP of 145/90 with a HR of 90/min (still on Nor, Dobut)

SVV is 24.

A cautious fluid bolus does <u>not</u> change the C.O.

Any ideas what's going on ????

Response to IPPV tells you where you are on Starling Curve



Michard *et al*. *Critical Care* 2010, **14**:451
http://ccforum.com/content/14/6/451

CRITICAL CARE

LETTER

Using pulse pressure variation or stroke volume variation to diagnose right ventricular failure?

Frederic Michard[1], Guy Richards[2], Matthieu Biais[3], Marcel Lopes[4] and Jose Otavio Auler[5]

"…the **lack of response** to a volume load while PPV or **SVV is high** should be seen as an indicator of **RV dysfunction**."

"help clinicians to **diagnose** quickly and treat properly shock states related to **RV failure**!"

ECHO:

Good LV function (EF~76%)

Large, dilated RV

Moderate-severe Tricuspid regurgitation

est. PAP 38

With the PICCO system showing a cardiac output of 3L/min,

should we increase the dobutamine?

OESOPHAGEAL DOPPLER

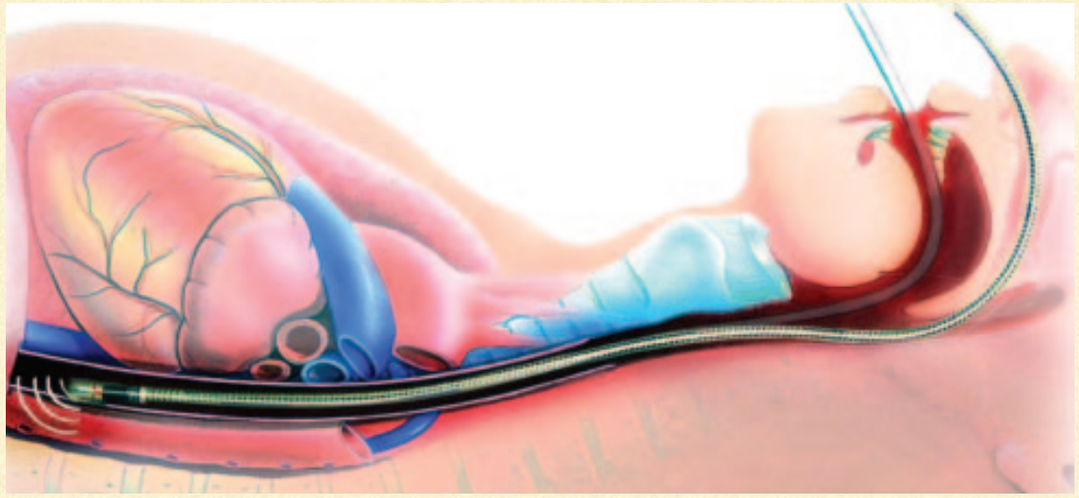
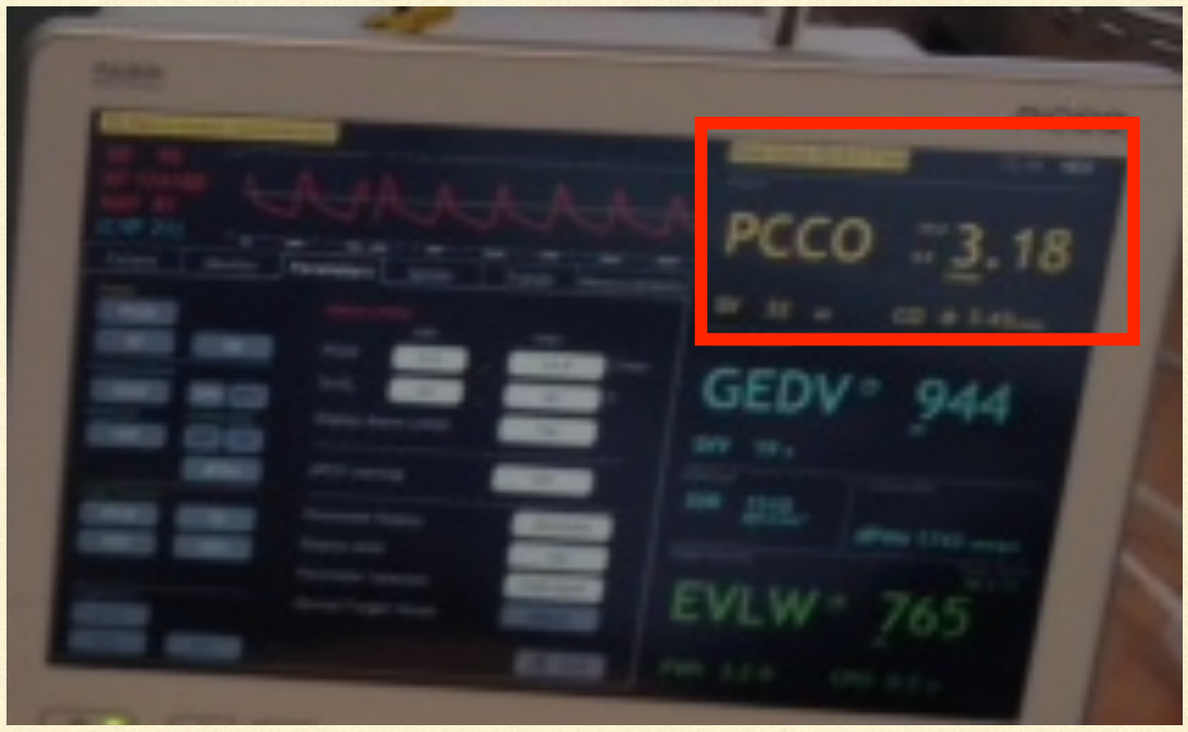
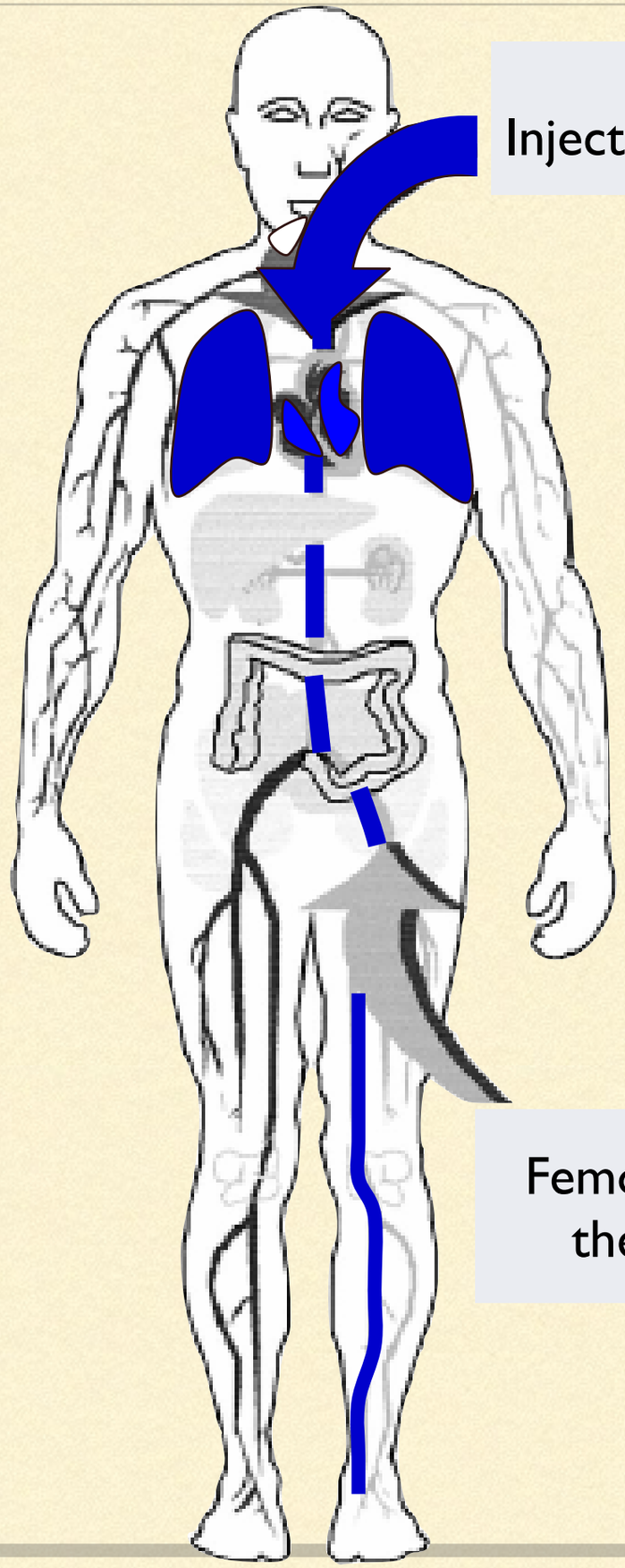


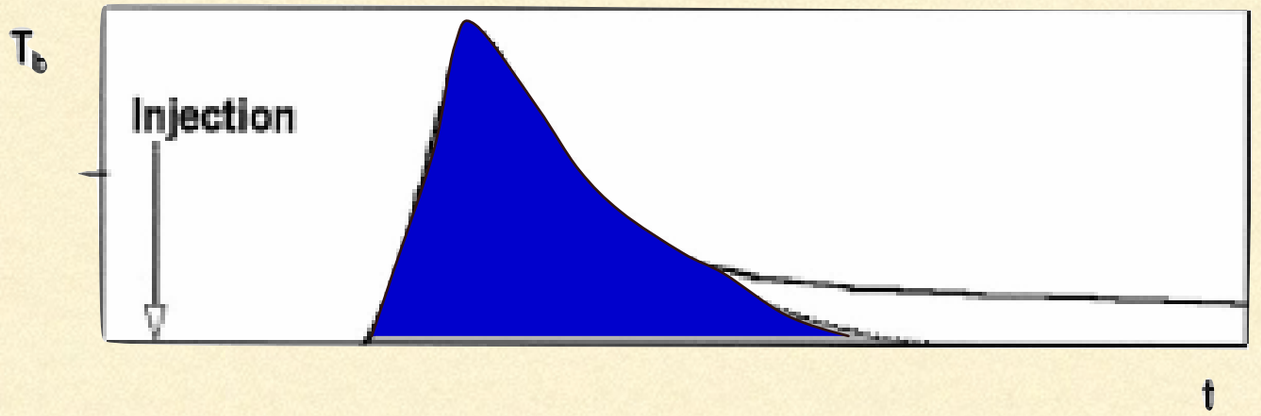
PHOTO OF THE 2 RESULTS (PICCO V DOPPLER)

Why the short FTc ?

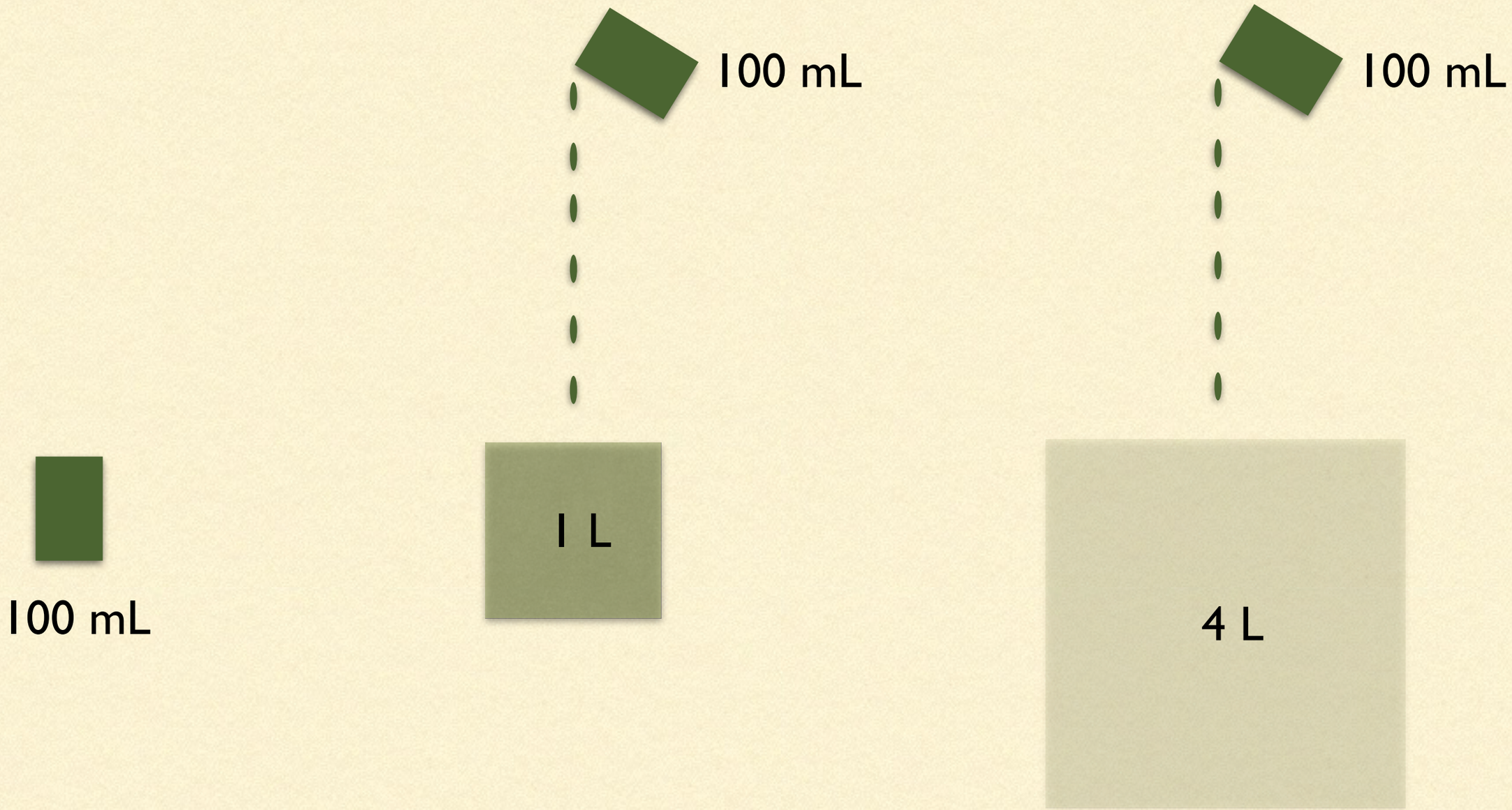


Transpulmonary Thermodilution



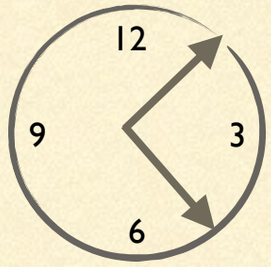


Determination of Thermodilution Cardiac Output

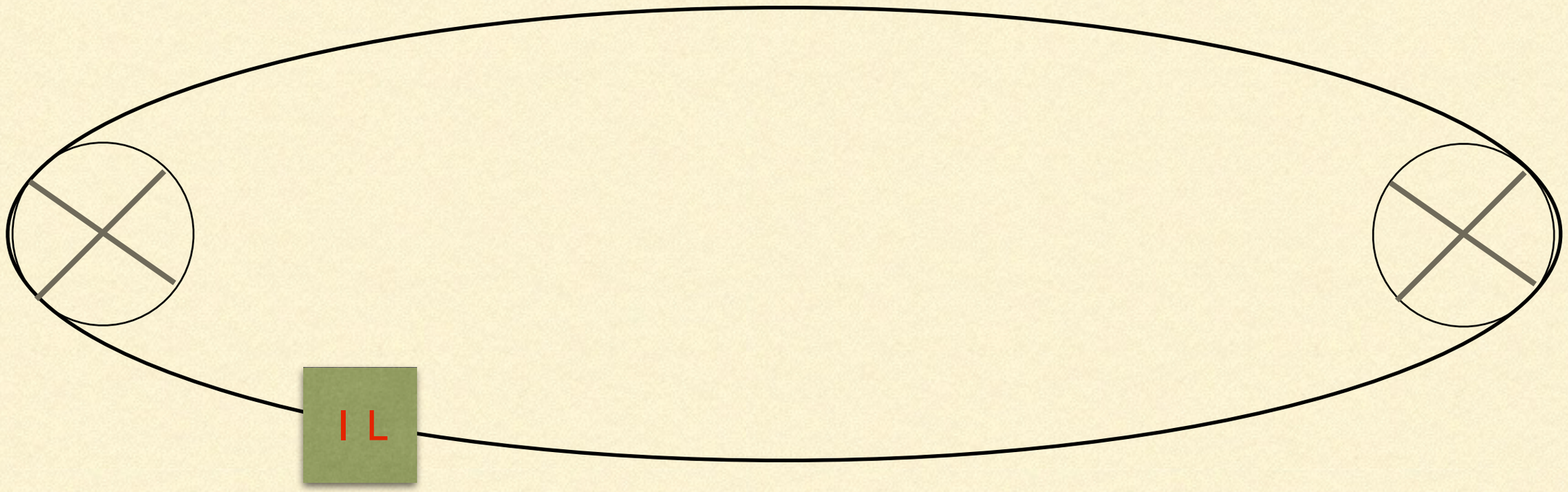


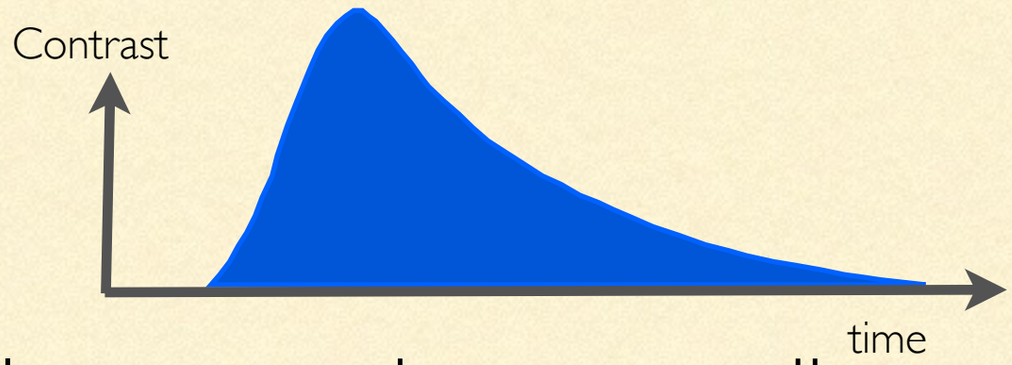
The more dilute the "dye", the larger the volume

Determination of Thermodilution Cardiac Output



1 min

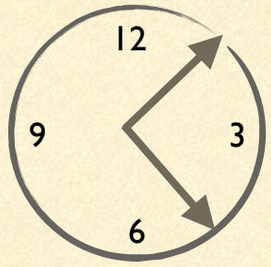




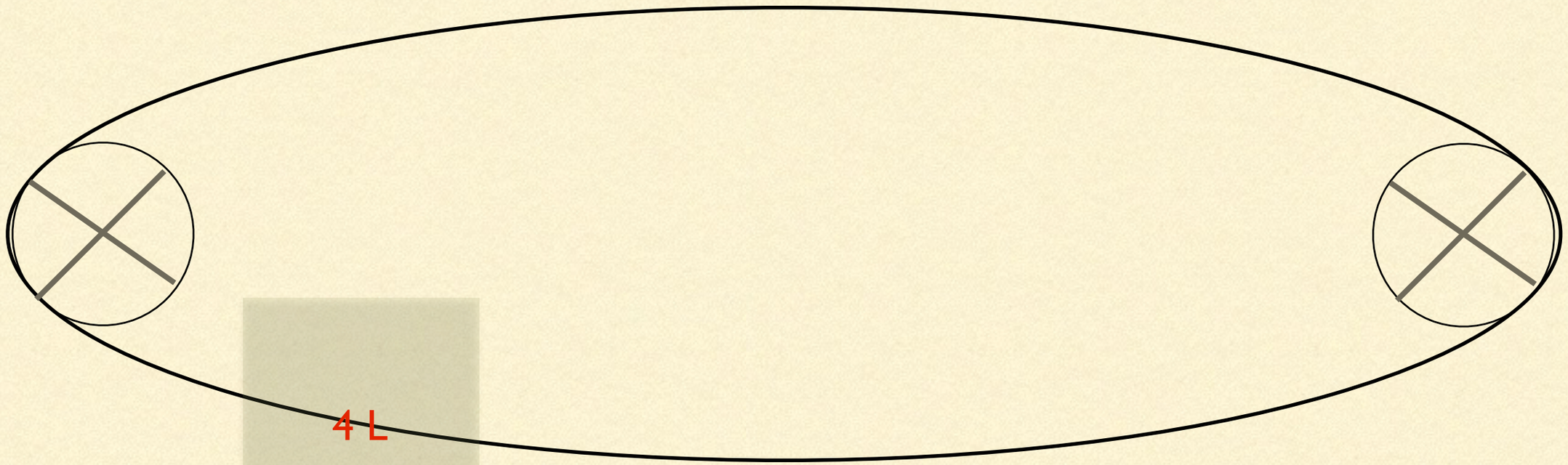
Low CO: **1.0** l/min

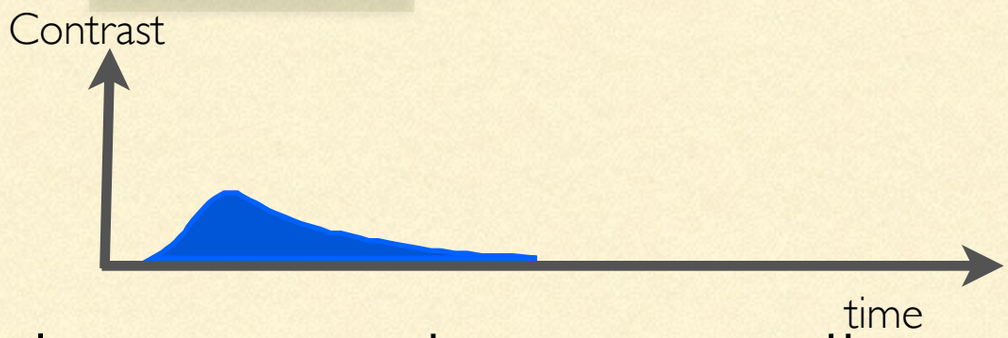
Volume per time = cardiac output = 1 L/min

Determination of Thermodilution Cardiac Output



1 min



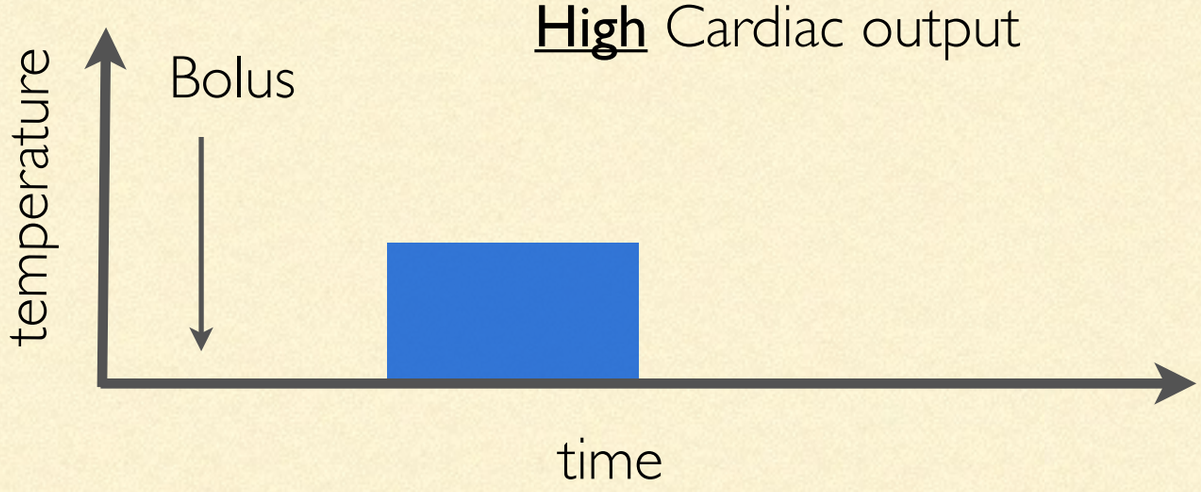


High CO: **4** l/min

Volume per time = cardiac output = 4 L/min

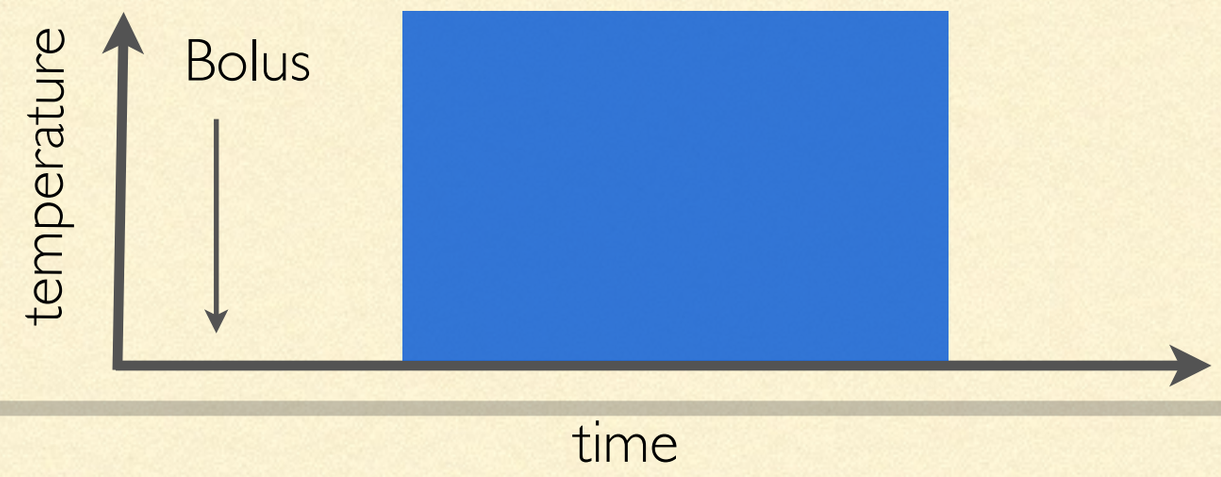
Determination of Thermodilution Cardiac Output

<u>High</u> Cardiac output



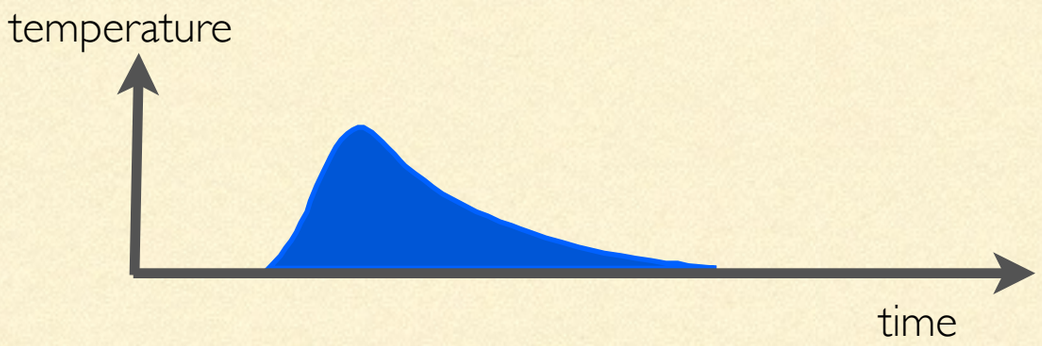
Cardiac output relates **<u>inversely</u>** to the indicator **concentration** and transit **duration**

<u>Low</u> Cardiac output

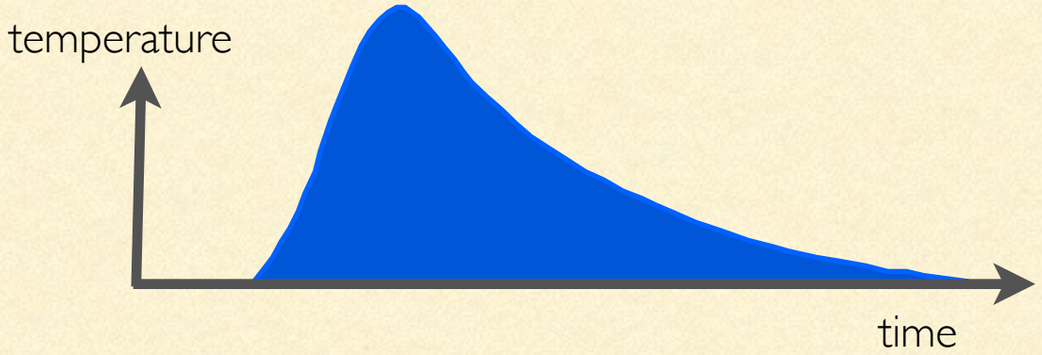


Area under the thermodilution curve is **inversely** proportional to **CO**

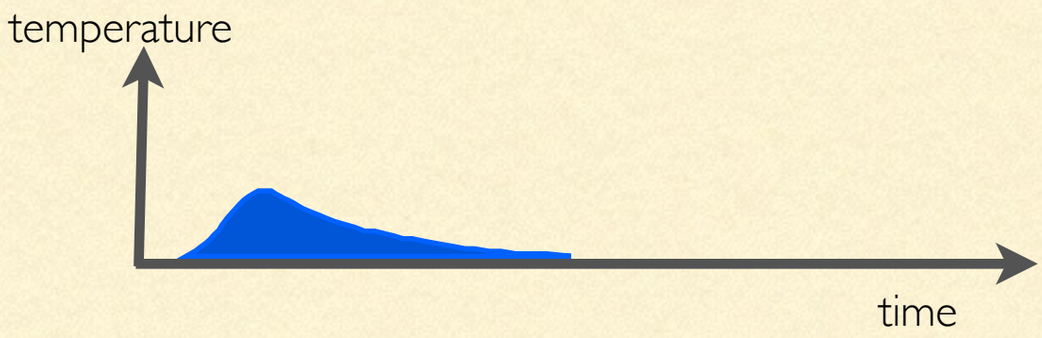
The Area under the curve is inversely proportional to the C.O.



Normal CO: **5** l/min

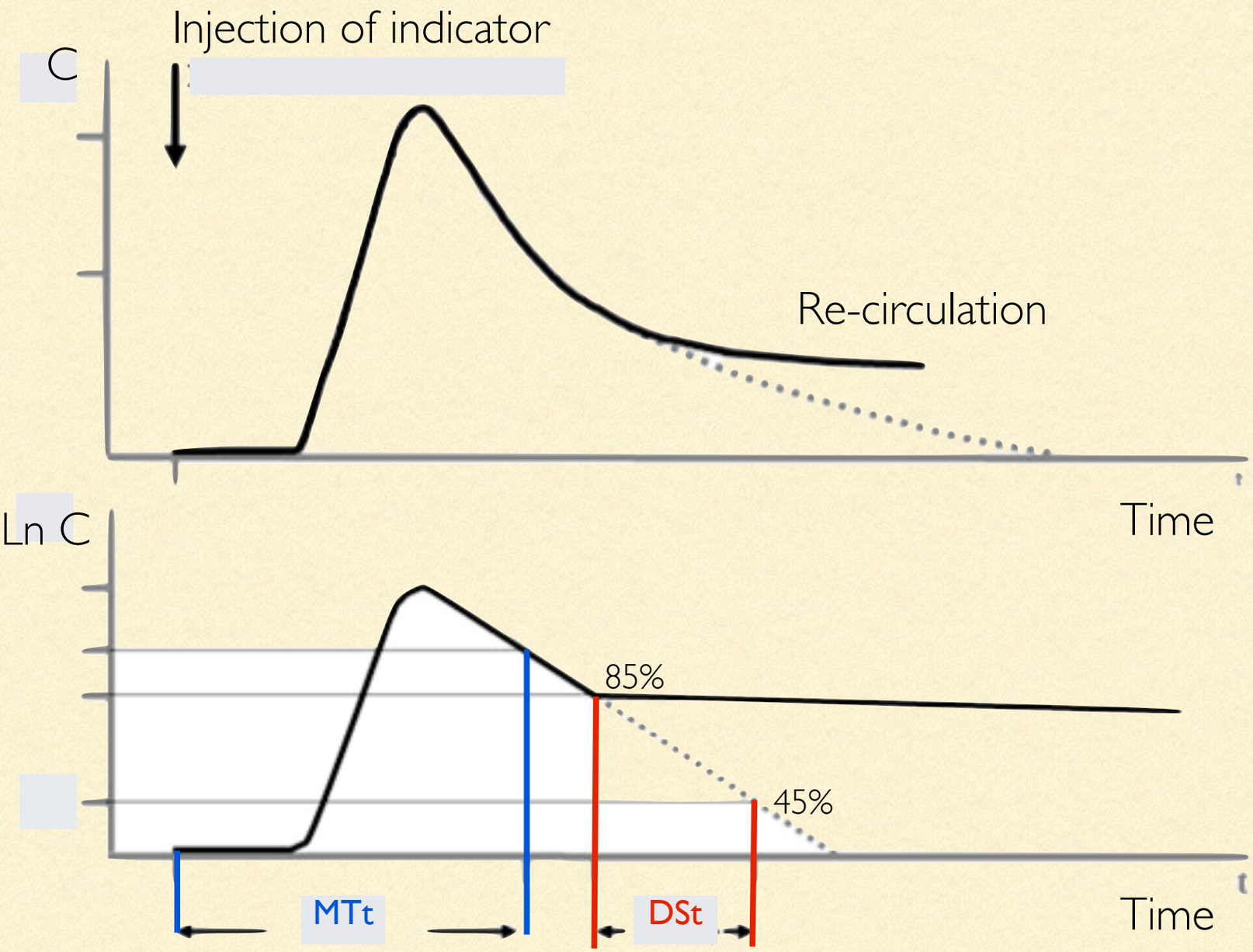


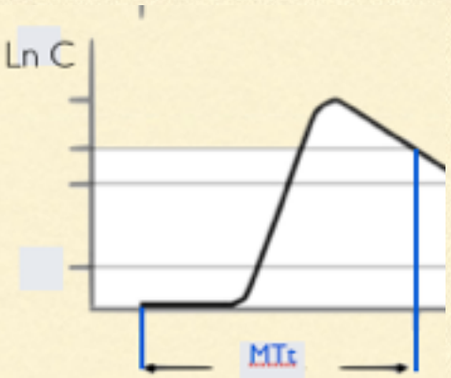
Low CO: **1.9** l/min

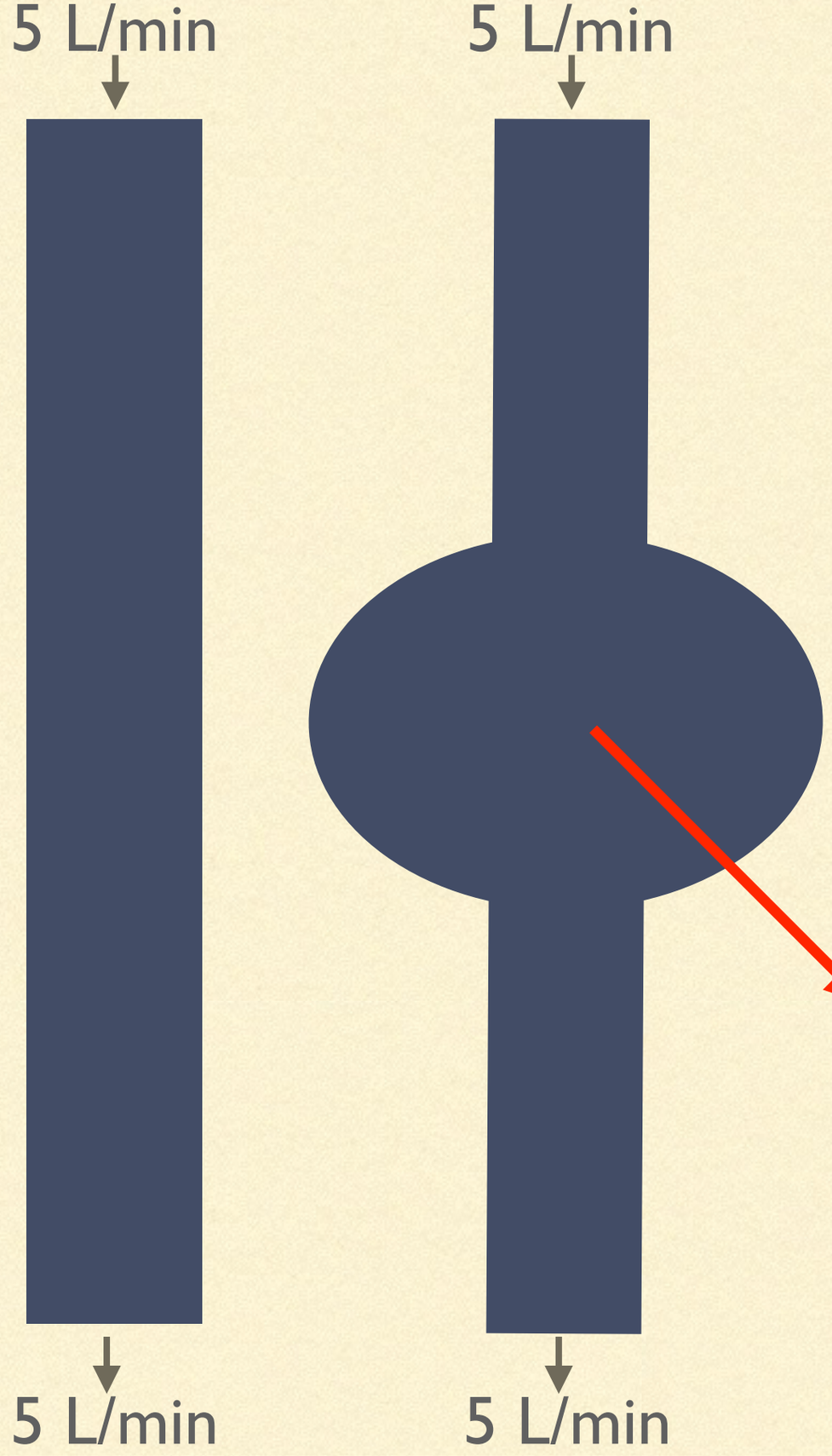


High CO: **12** l/min

Calculation of ITTV and PTV

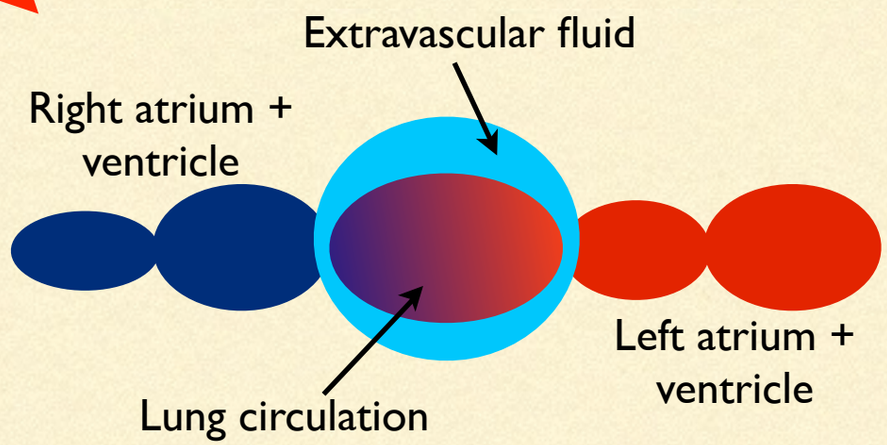




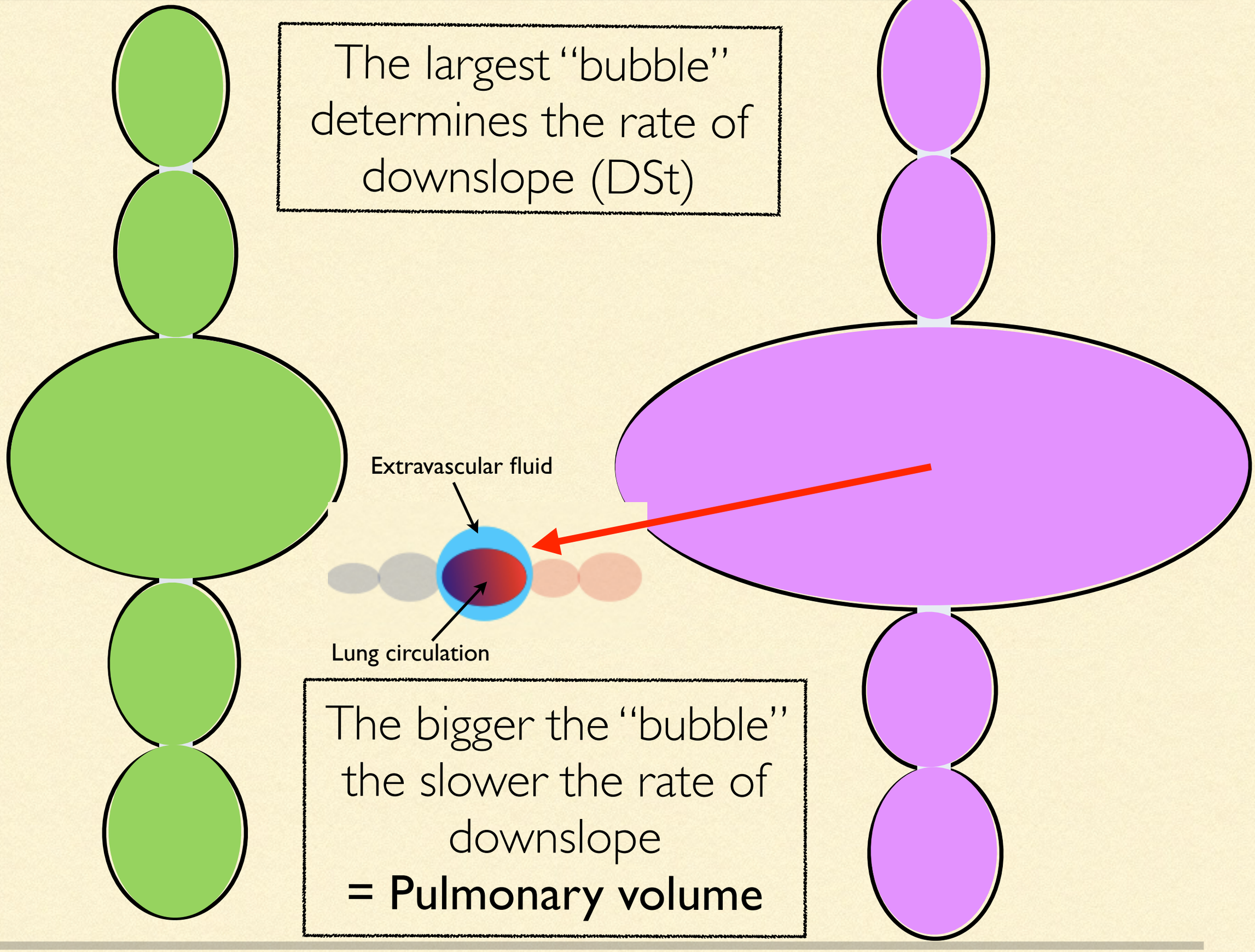


The **larger** the "bubble" the **longer** the Mean Transit Time (MTt)

The "bubble" = **Intra-thoracic volume**



The largest "bubble" determines the rate of downslope (DSt)



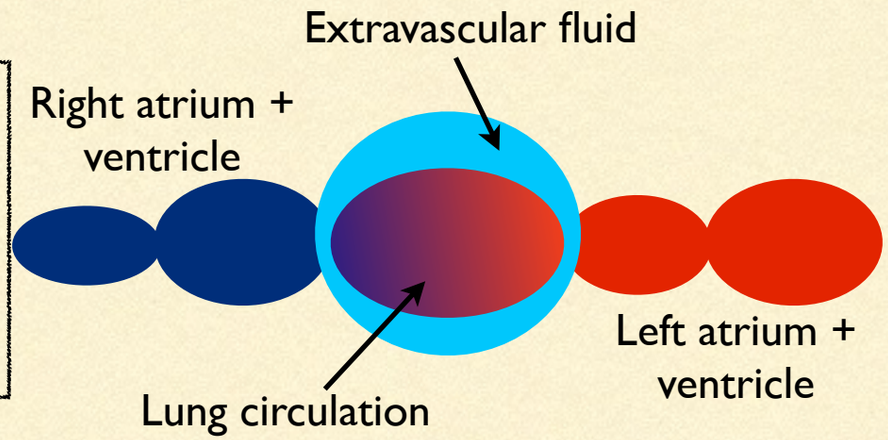
The bigger the "bubble" the slower the rate of downslope

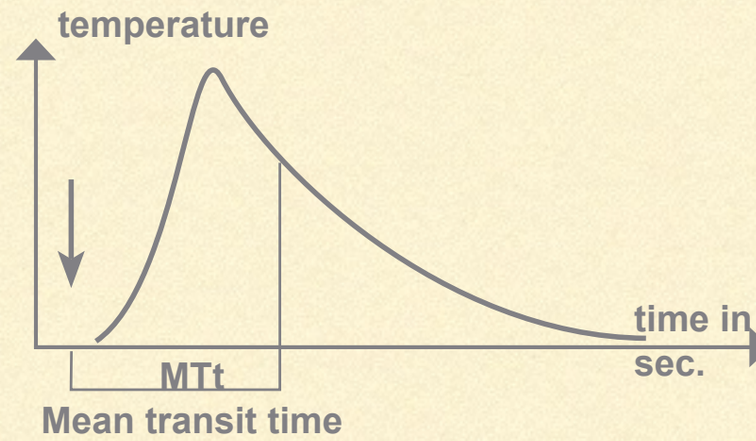
= Pulmonary volume

Calculation of Volumes

Intra-thoracic Thermal Volume

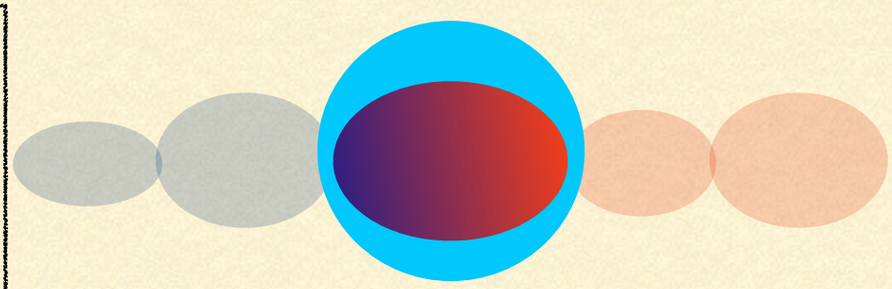
ITTV=CO x MTt

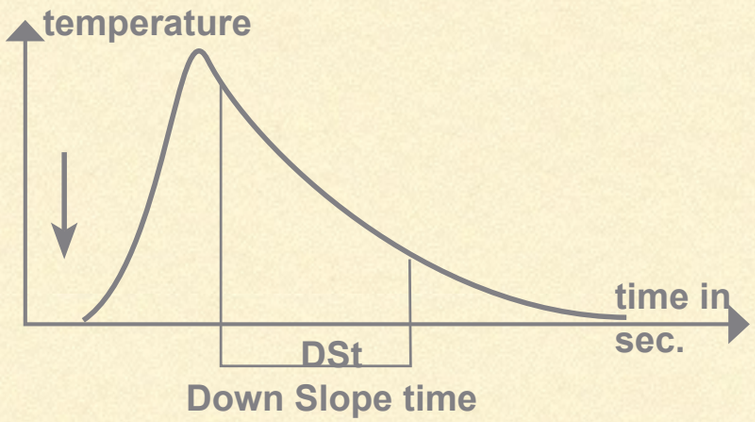




Pulmonary Thermal Volume

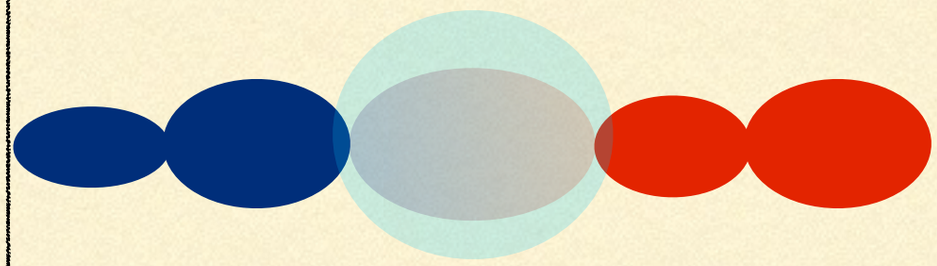
PTV=CO x DSt





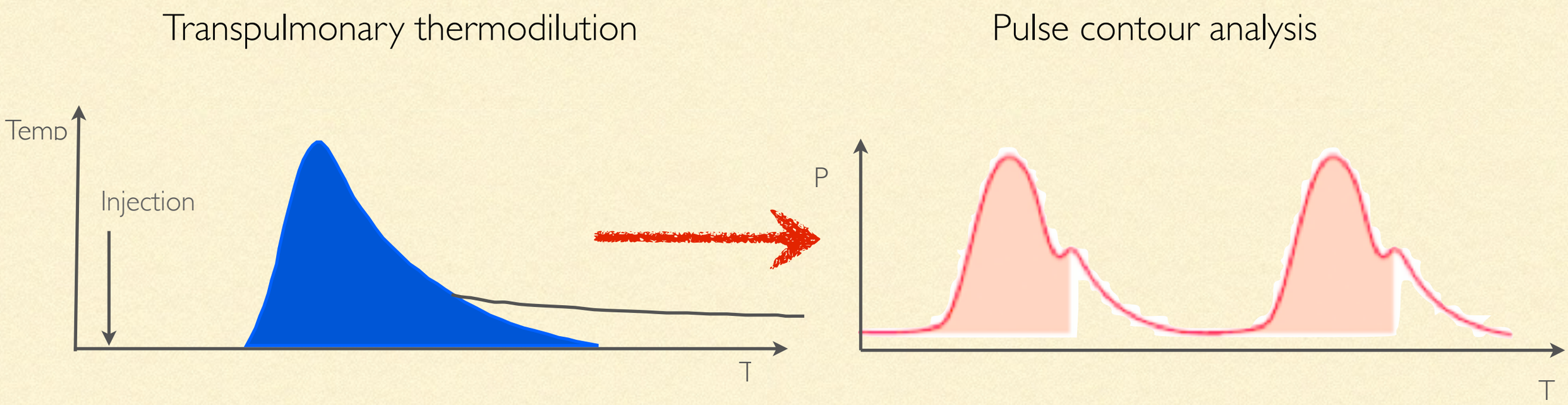
Global End Diastolic Volume

GEDV =ITTV-PTV



Calibration of the Pulse Contour Analysis

The PCA is calibrated through the transpulmonary thermodilution and is a beat to beat real time analysis of the arterial pressure curve



Pitfalls in Measurement

Consider:

All volumes **calculated** from :

Time (MT time and DS time) X **Cardiac output** (volume / time)

If C.O. incorrect this **magnifies** any error.

All volumes thus inaccurate

Anesth Analg 2010;110:799–811

Valvular regurgitation-effect on PICCO

Tends to **overestimate** C.O.

increased transit times (increases its dissipation)

or

Flat prolonged curve gives an **underestimation** of C.O.

(i.e., large area under curve)

IMPACTS CALCULATED VOLUMES :

ITBV

GEDVI

EVLW

Anesth Analg 2010;110:799–811

Valvular regurgitation-effect on PICCO

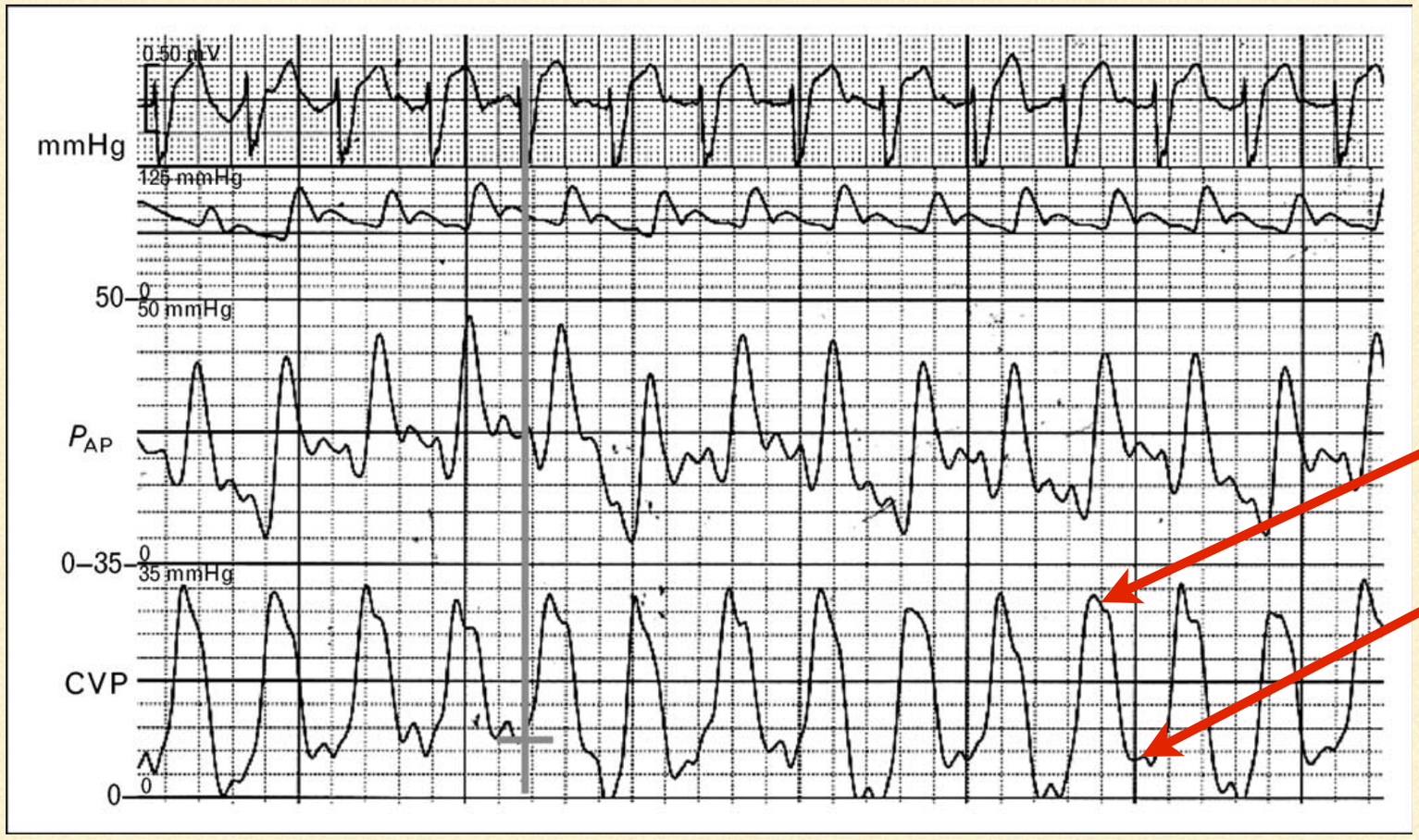
PULSION PiCCO

The PiCCO-Technology may give incorrect thermodilution measurements in patients with intracardiac shunts, aortic aneurysm, aortic stenosis, mitral or tricuspid insufficiency, pneumonectomy, macro lung embolism and extracorporeal circulation (if blood is either extracted from or infused back into the cardiopulmonary circulation).

Clinical case

Look at the waveform!

Why the large “c-v” wave ?



Clinical case

The intra-abdominal pressure

from the bladder - 11 mmHg.

from the femoral venous catheter - 24mm Hg

Why the difference?

Could this have deleterious effects on other organs?

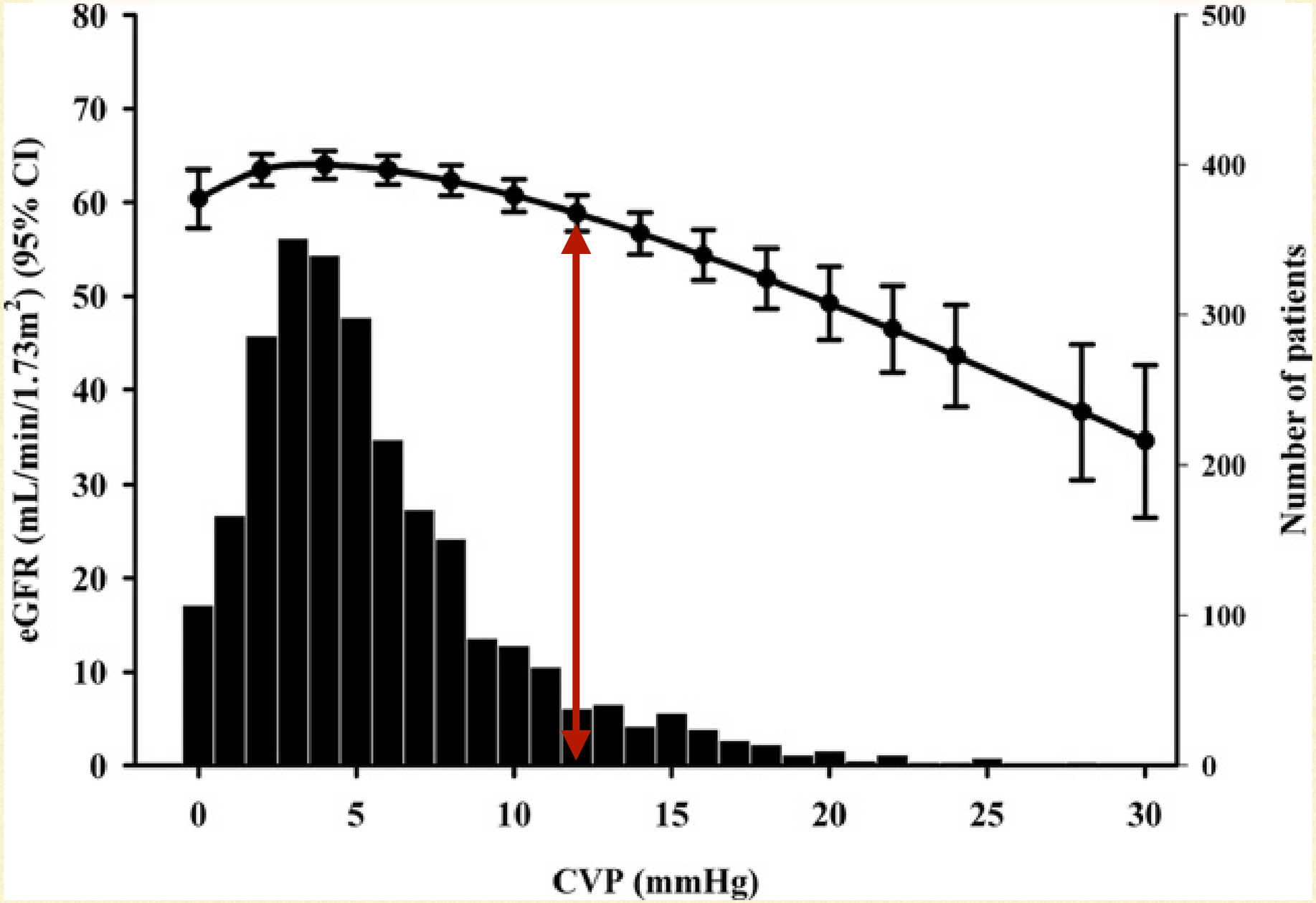
Does femoral venous pressure measurement correlate well with intrabladder pressure measurement? A multicenter observational trial

"..potential influencing factors … right heart function (e.g., **tricuspid incompetence**) might have helped explain the differences found between the FVP and the bladder pressure."

Intensive Care Med (2011) 37:1620–1627

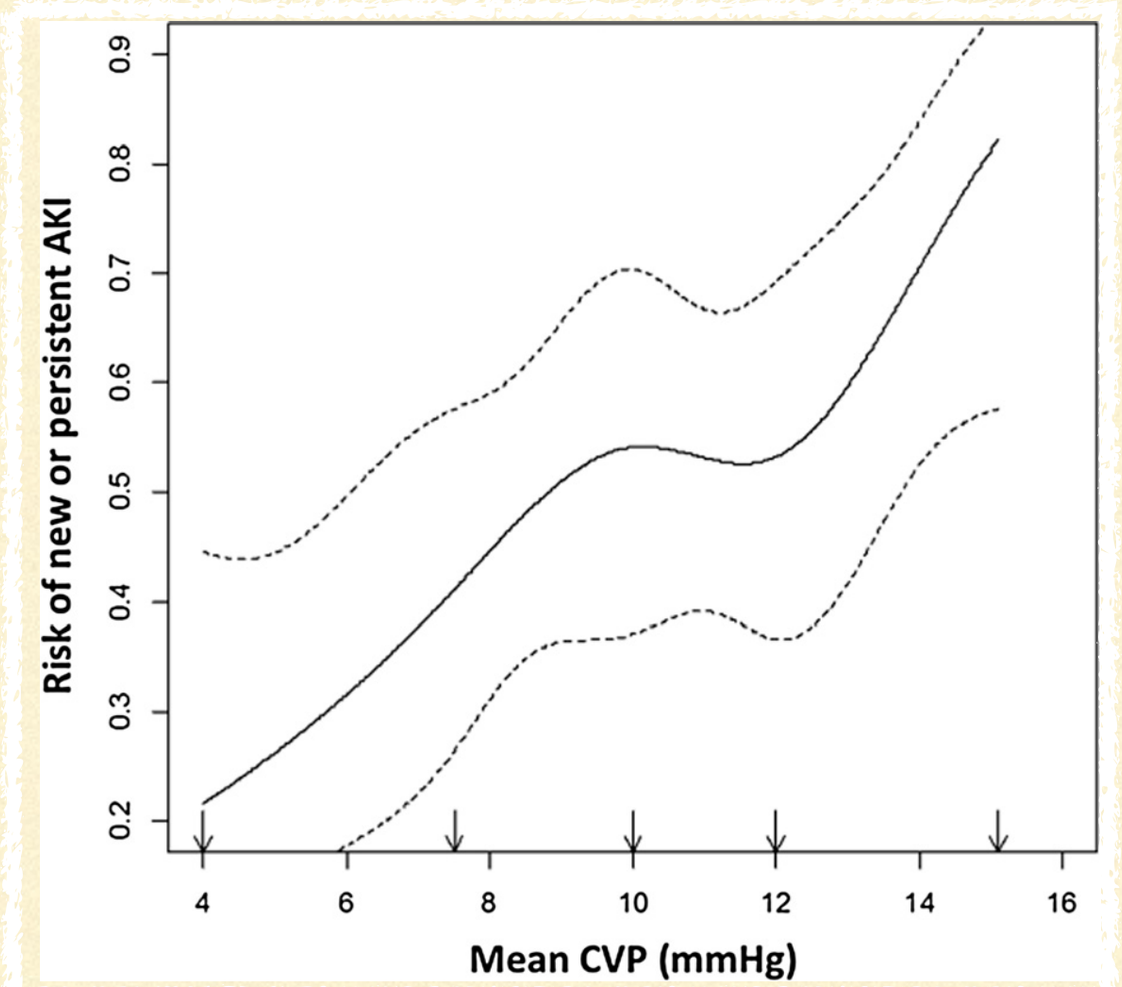
IS THIS HIGH CVP HARMLESS OR EVEN DESIRABLE?

Increased Central Venous Pressure Is Associated With Impaired Renal Function and Mortality in a Broad Spectrum of Patients With Cardiovascular Disease



J Am Coll Cardiol 2009;53 582-6

Venous congestion: are we adding insult to kidney injury in sepsis?



"…association between CVP and AKI …

a **5 mmHg increase in CVP** predicted **2.7-fold odds** of new or persistent AKI."

"Renal outcomes were **worse** for all CVPs from **4 mm Hg and above**"

Critical Care 2014, 18:104

And yet……

Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock: 2012

MANAGEMENT OF SEVERE SEPSIS

Initial Resuscitation and Infection Issues (Table 5)

A. Initial Resuscitation

a) CVP 8–12 mm Hg
b) MAP ≥ 65 mm Hg
c) Urine output ≥ 0.5 mL·kg·hr
d) Superior vena cava oxygenation saturation ($ScvO_2$) or mixed venous oxygen saturation (SvO_2) 70% or 65%, respectively.

RCS
ADVANCING SURGICAL STANDARDS

Care of the Critically Ill Surgical Patient (CCrISP)

"resuscitate with fluids, pushing the CVP up to a maximum of 17 mm Hg"!!!

RECAP

- Proning
- Prognostic value of lactate and SCV02
- Inappropriate CO with PICCO ("Beware the Black Box")
  - How it works
  - How a high SVV unresponsive to fluids can indicate RVF
  - Tricuspid regurgitation
  - Deleterious effects of a high CVP
    - Effect on renal function
    - Discrepancy between IAP in bladder and femoral vein

Any ????