Putting it all together

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✓Introduction to 02 delivery

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    - Types of fluids

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✓Cardiac output

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- The Pump - Inotropes/Vasopressors

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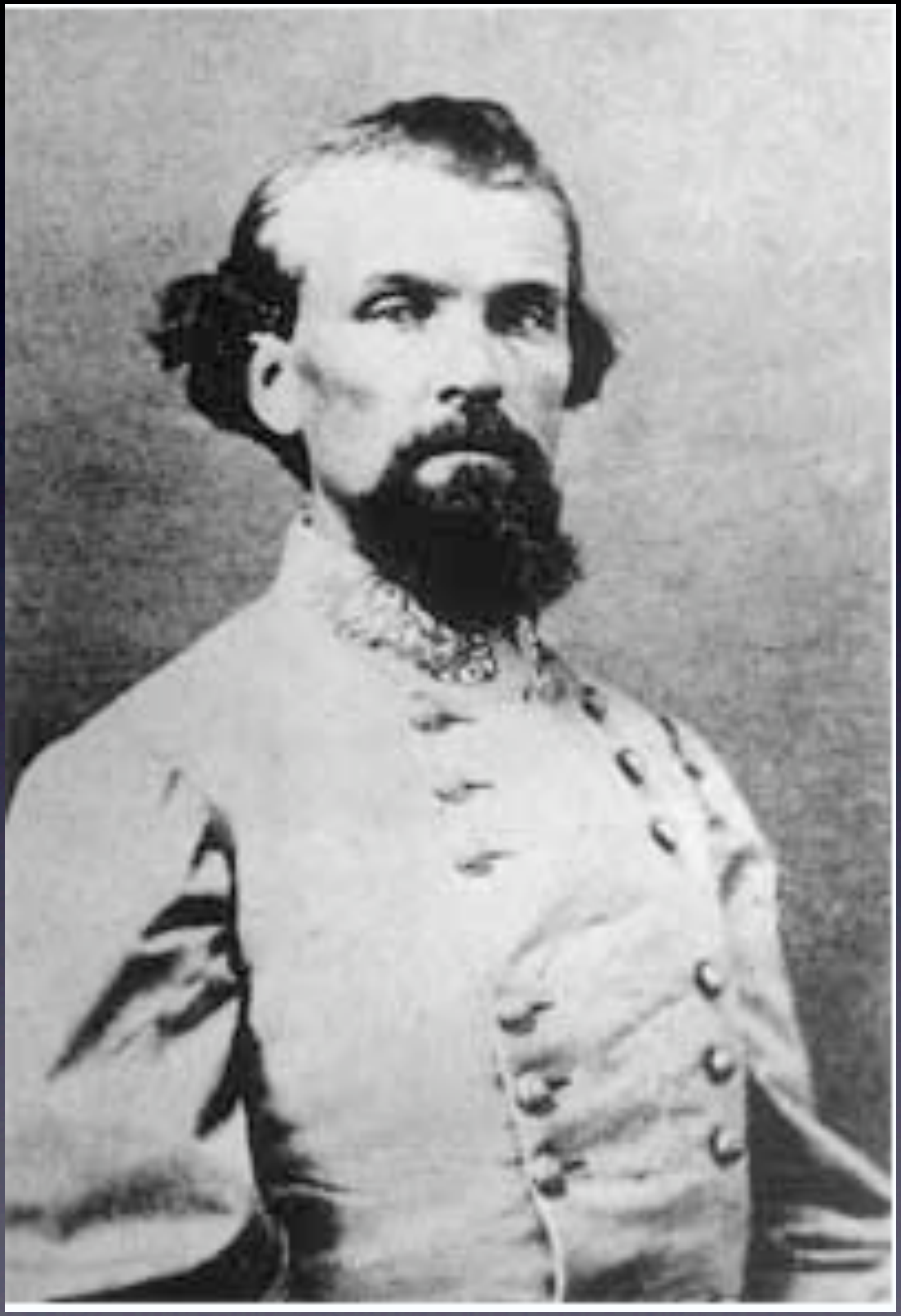
- ✓Cardiac output
  - Types of fluids
  - Optimising haemodynamics with fluids
  - The Pump - Inotropes/Vasopressors
- ✓Haemoglobin

Putting it all together

We have covered:

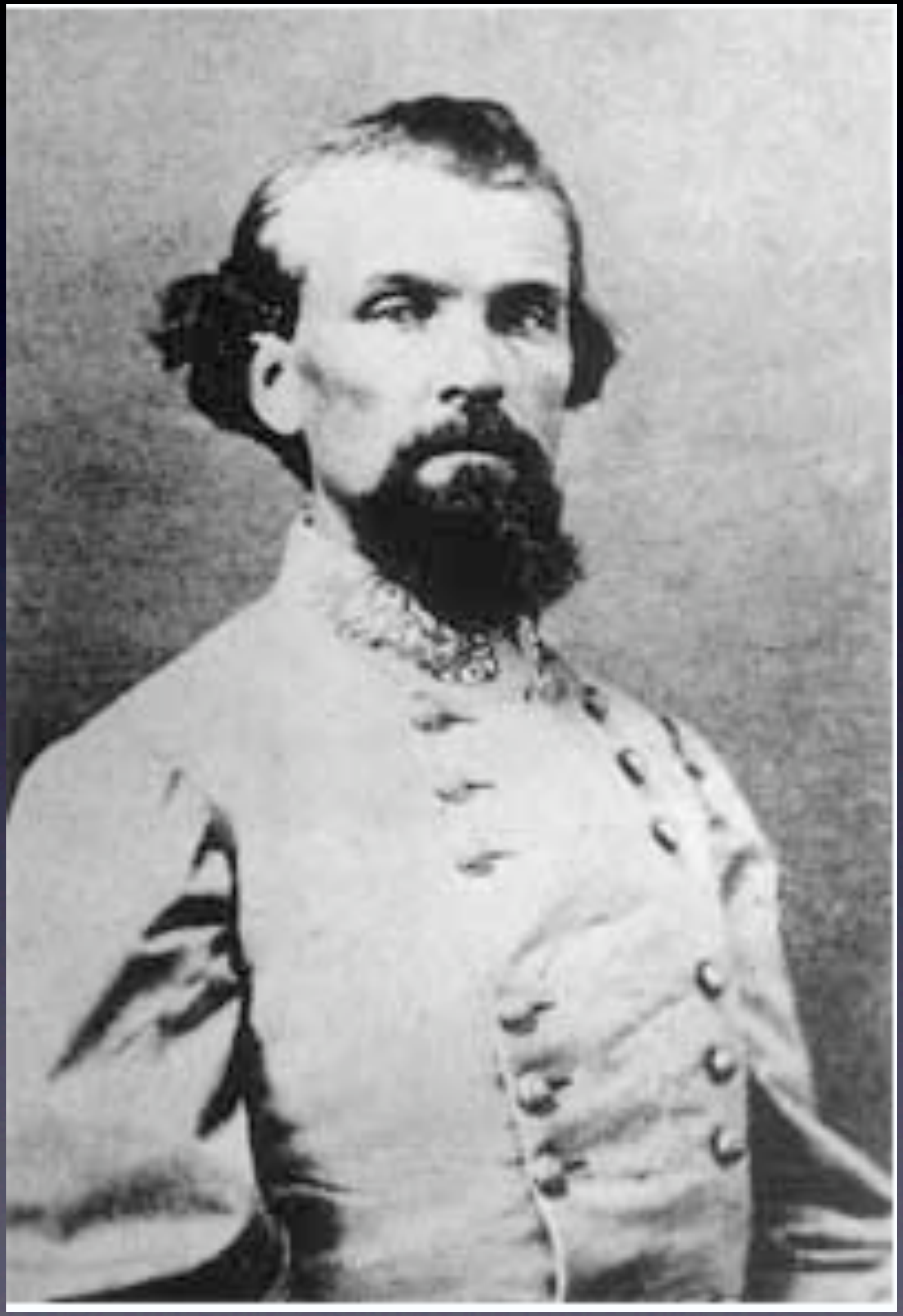
- ✓Introduction to 02 delivery
- ✓Cardiac output
    - Types of fluids
    - Optimising haemodynamics with fluids
    - The Pump - Inotropes/Vasopressors
- ✓Haemoglobin
- ✓O2 Saturation

General Nathan Bedford Forrest (Gump)



General Nathan Bedford Forrest (Gump)

- founder of the Ku Klux Klan



Clinical Case

Bad move, Nathan

Clinical Case

Clinical Case

38 year old male vs. lead projectiles

BP = 75/45   HR = 122

Cold peripheries

RR = 37   Sat 02=90%

Clinical Case

38 year old male vs. lead projectiles

BP = 75/45 HR = 122

Cold peripheries

RR = 37 Sat 02=90%

What are your priorities ?

Oxygen delivery ~

Cardiac output x Hb x % Sat O2

Oxygen delivery ~

Cardiac output x Hb x % Sat O2

5 litre/min x 15 gm/dl (x1.34) x 100%

Oxygen delivery ~

Cardiac output x Hb x % Sat O2

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Oxygen delivery ~

Cardiac output x Hb x % Sat O2

5 litre/min x 15 gm/dl (x1.34) x 100%

5 litre/min x 200 ml O2 / litre

Oxygen delivery ~

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Oxygen delivery ~

Cardiac output x Hb x % Sat O2

5 litre/min x 15 gm/dl (x1.34) x 100%

5 litre/min x 200 ml O2 / litre

= 1000 ml O2 /min delivered

Body needs ~ 250 ml oxygen / min

Body needs ~ 250 ml oxygen / min

$\boxed{\text{1000 ml O2 /min delivered}}$

Cardiac output x Hb x % Sat O2

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- If one variable is halved, the oxygen delivery is reduced to 1/2

Cardiac output x Hb x % Sat O2

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- If two variable is halved, the oxygen delivery is reduced to 1/4

Cardiac output x Hb x % Sat O2

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- If two variable is halved, the oxygen delivery is reduced to 1/4
- If all three variables are halved, the oxygen delivery is reduced to 1/8th

Cardiac output x Hb x % Sat O2

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= 125 ml/min O2 delivered

Cardiac output x Hb x % Sat O2

- If one variable is halved, the oxygen delivery is reduced to 1/2
- If two variable is halved, the oxygen delivery is reduced to 1/4
- If all three variables are halved, the oxygen delivery is reduced to 1/8th

= 125 ml/min O2 delivered

this is **incompatible** with life

Cardiac output x Hb x % Sat O2

Preload

Effective blood volume
Capacitance
Obstruction
Septal shift
IV fluid
- volume
- C.O.P.

Pump failure

Arrhythmias
Ischaemia
Valvular problems
Septal shift

Afterload

RAA adaptaion
Sepsis
Valvular problems
Pulmonary embolism
Hypertension
Shunts

Heart rate

Anaemia

Fe def
Dilutional
Inflammatory
Vitamin deficiency
Aplastic

Abnormal Hb

Sickle cell
Thalassaemia
met Hb
CO Hb

Hemolysis

free Hb and NO
Pulmonary hypertension
Hypercoagulability

Hyperviscosity

PRV
Acclimatisation

Inspired O2

Altitude
Hyperbaric O2

Hypoventilation

Decreased respiratory drive
- drug induced

CVA
Fatigue (asthma)
Obstruction
- Sleep apnoea syndrome
- Decreased consciousness

Ventilation/perfusion abnormalities

Shunt
- Pneumonia
- Pulmonary oedema

Dead space
- Pulmonary embolism
- Fat embolism

Mixed
- ARDS
- COPD
- Asthma

02 Delivery Compensation - 2 Phases

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- Phase 1 - The *"Big 3"* compensate each other
    - Cardiac Output
    - Hb
    - O2 Saturation

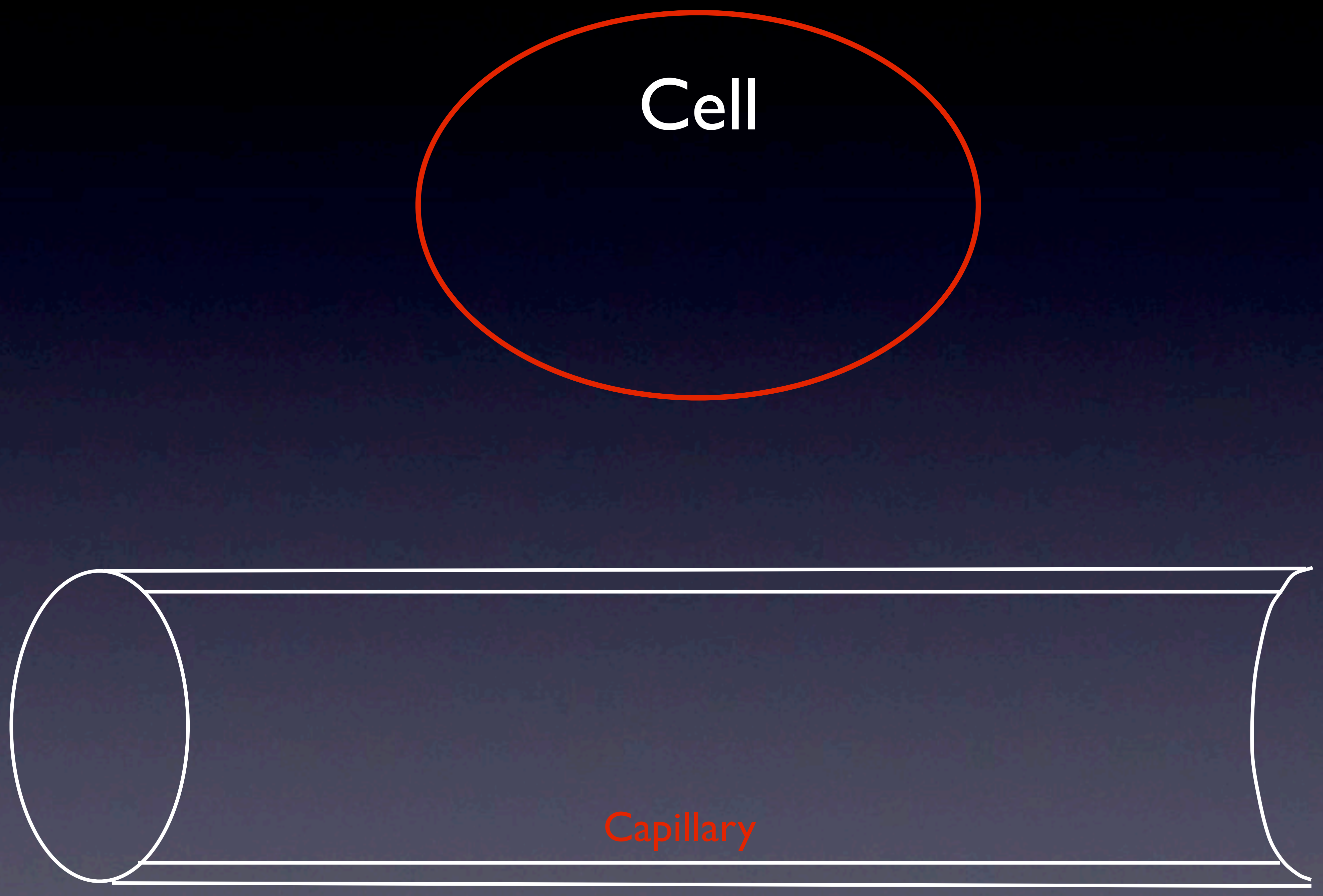
02 Delivery Compensation - 2 Phases

- Phase I - The *"Big 3"* compensate each other
  - Cardiac Output
  - Hb
  - O2 Saturation
- Phase 2 - *Oxygen Extraction*
  - If O2 delivery decreases, O2 extraction increases

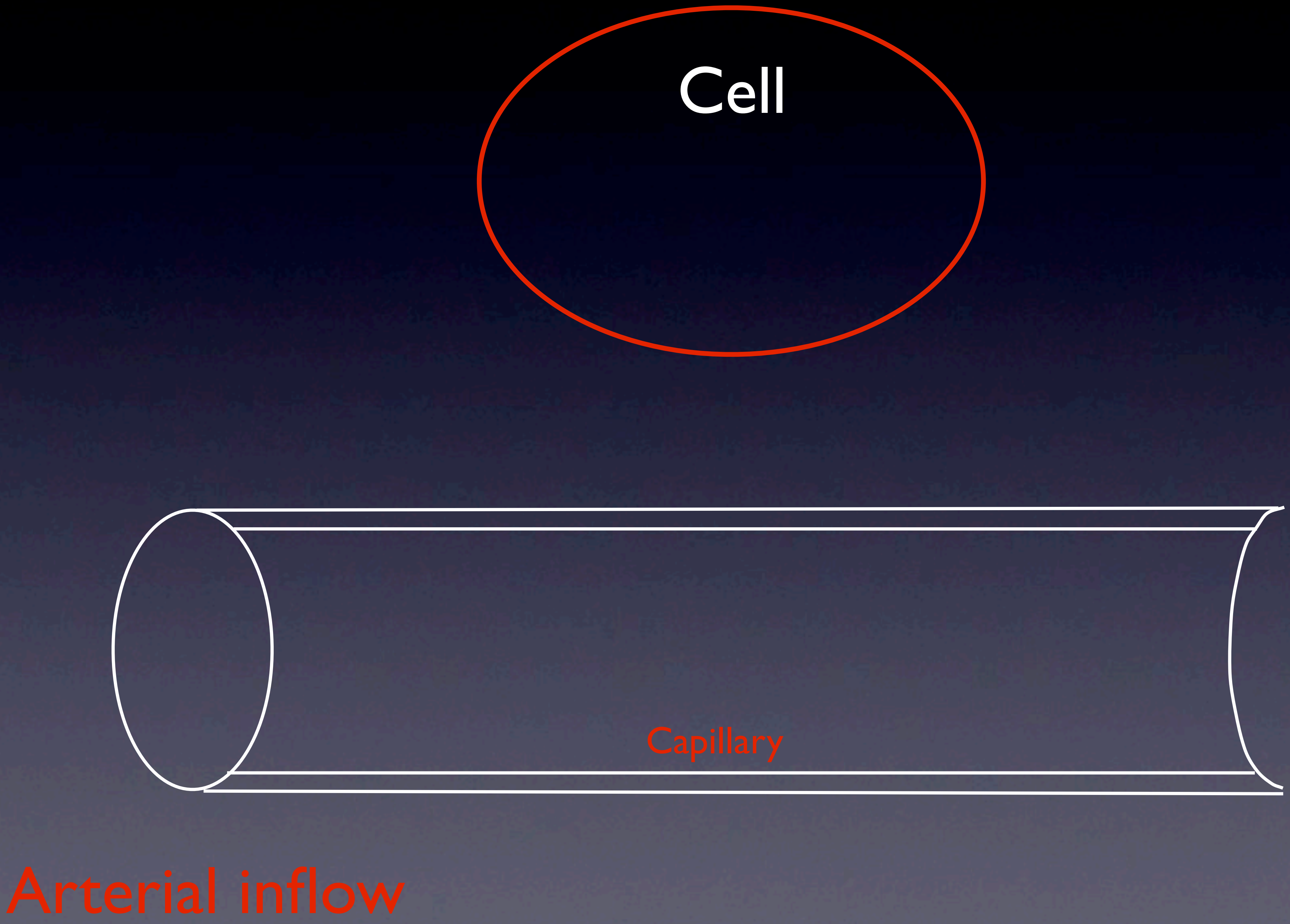
Oxygen extraction

Oxygen extraction

Oxygen extraction



Oxygen extraction



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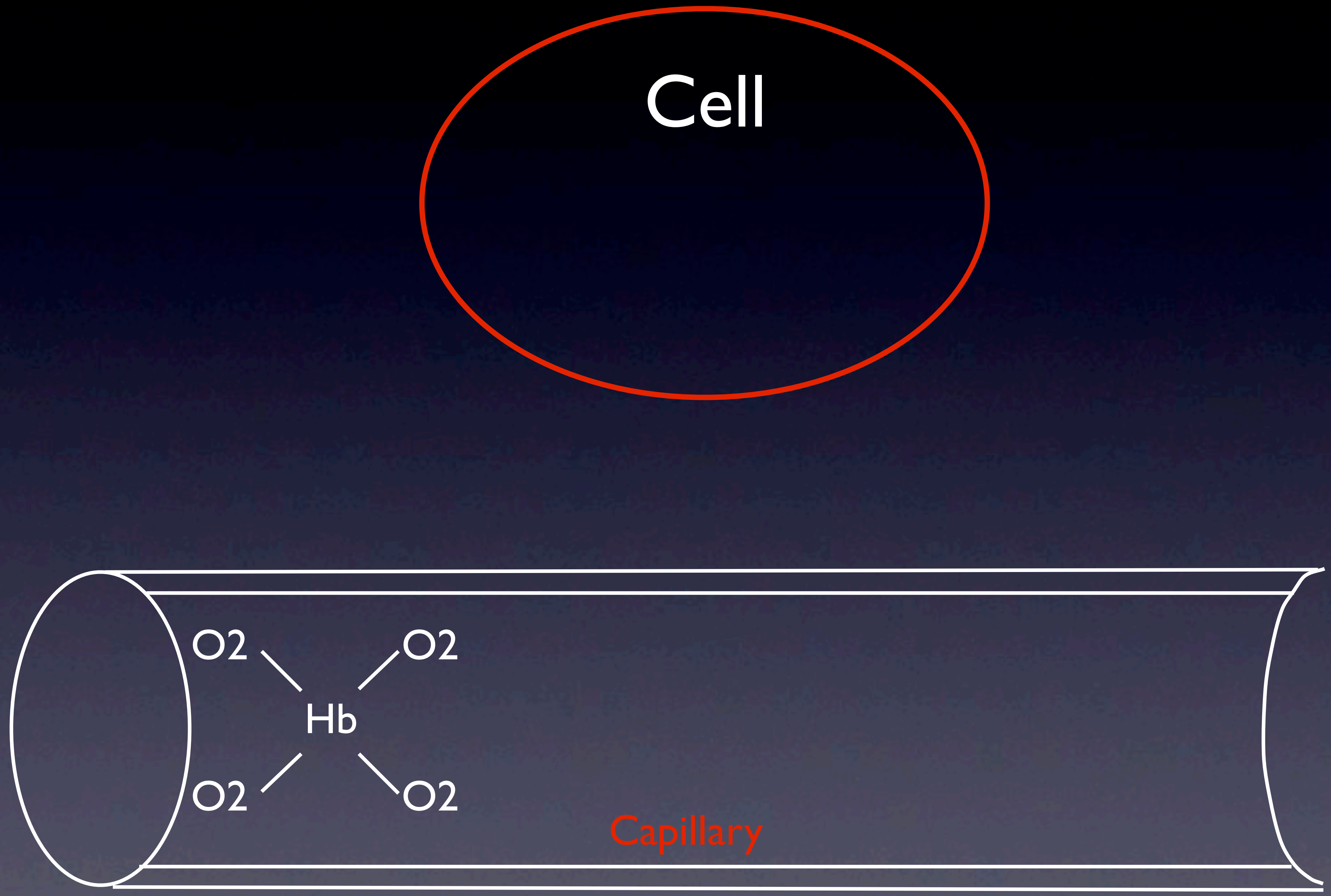
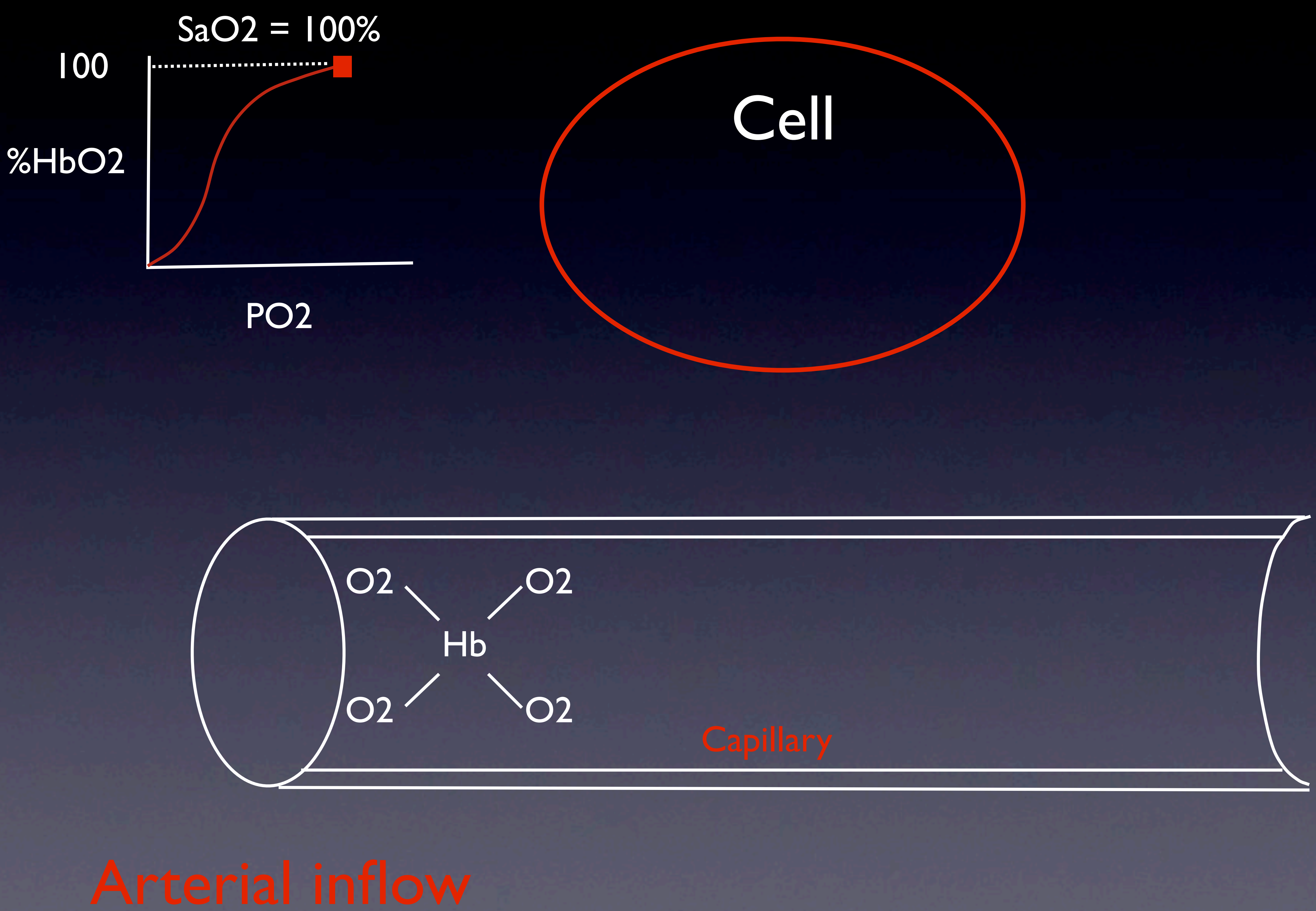


Arterial inflow

Oxygen extraction



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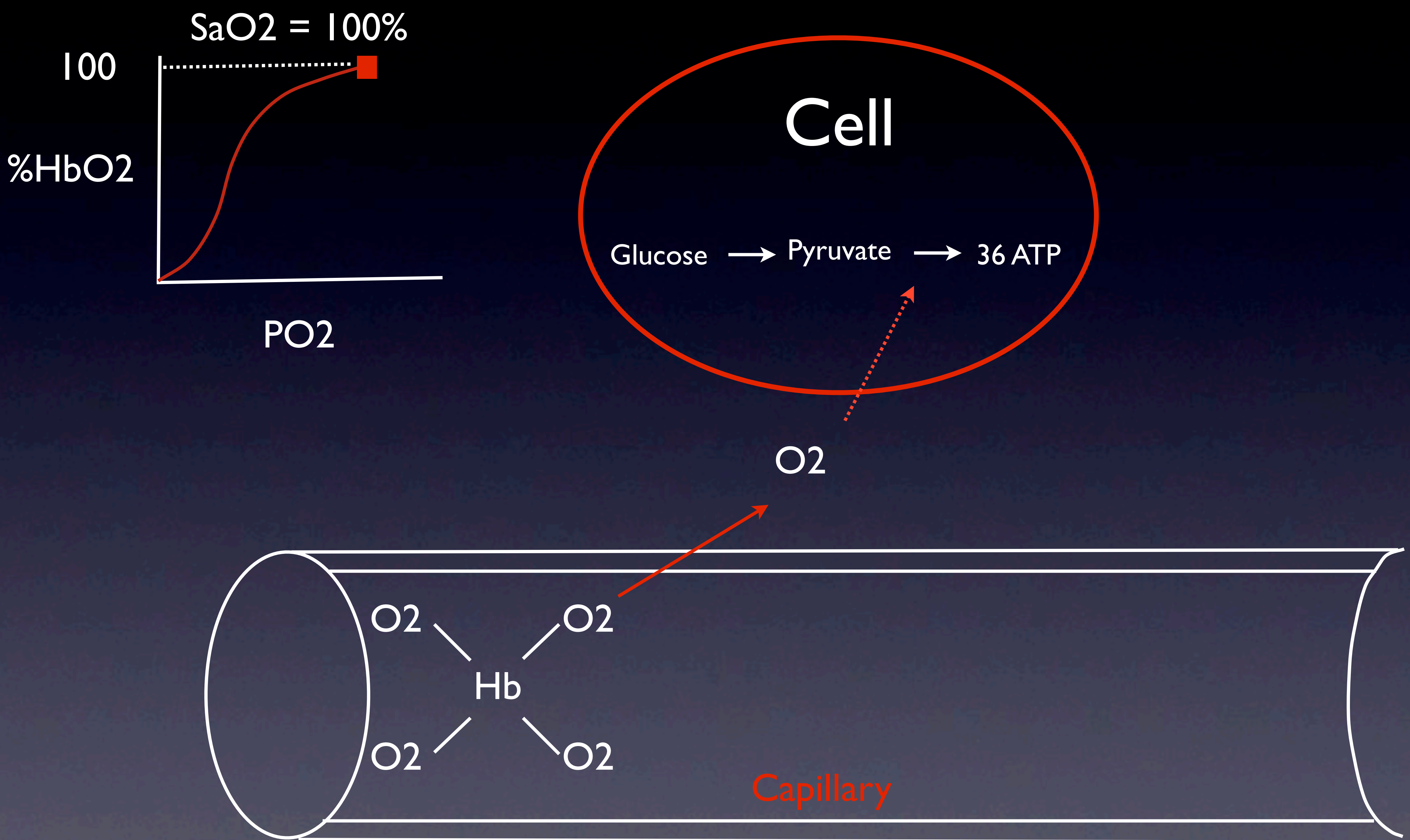
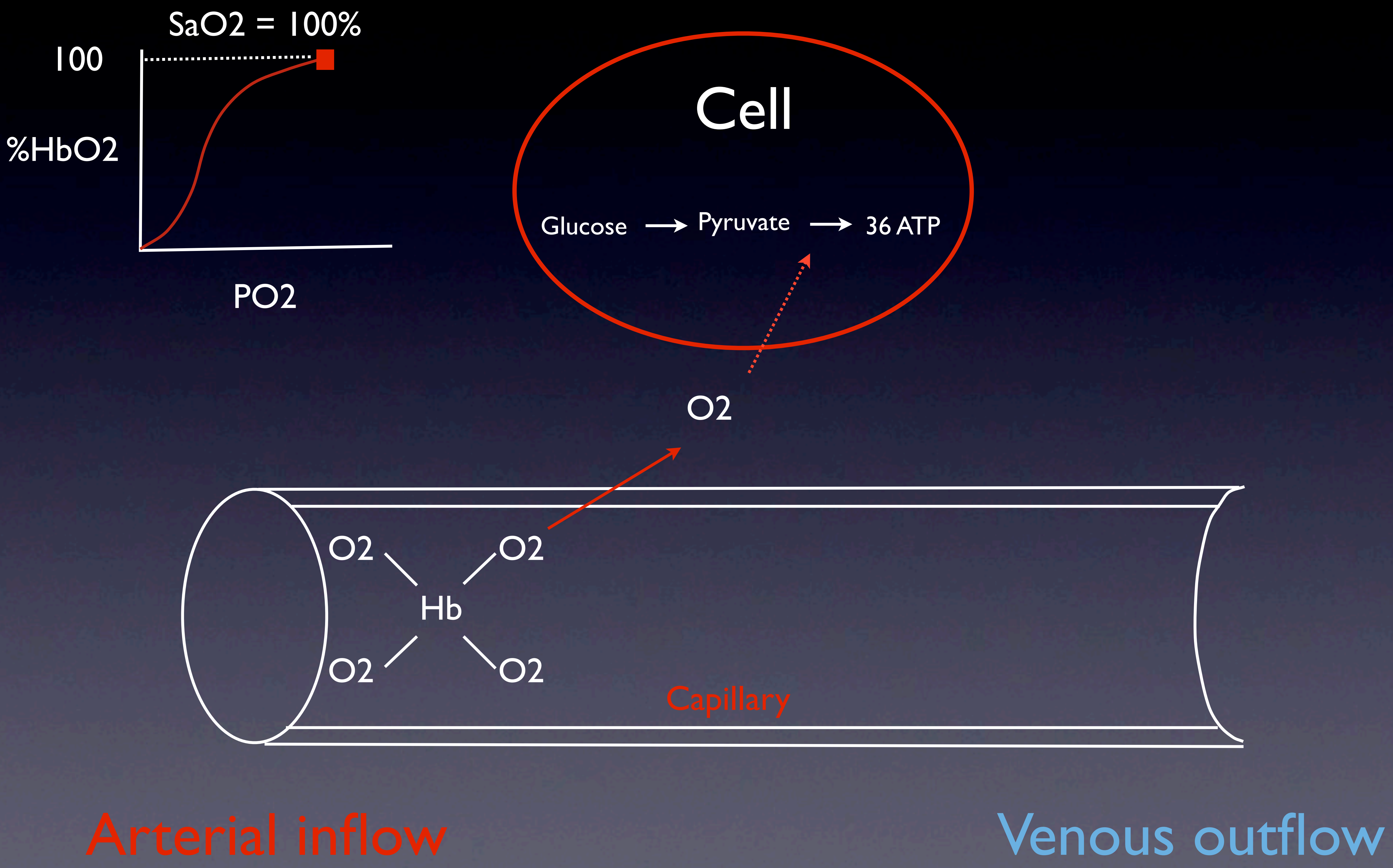


Arterial inflow

Oxygen extraction



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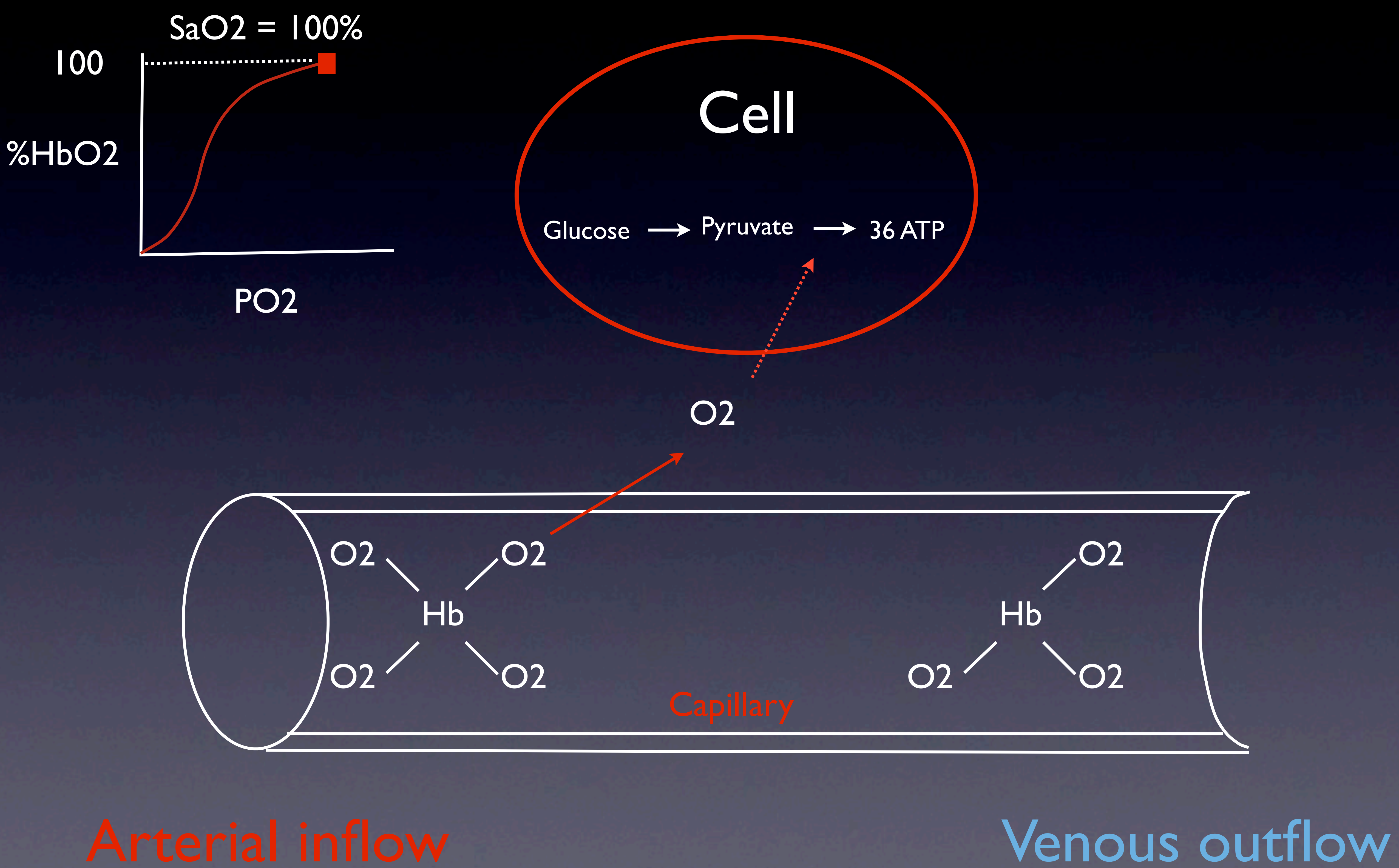
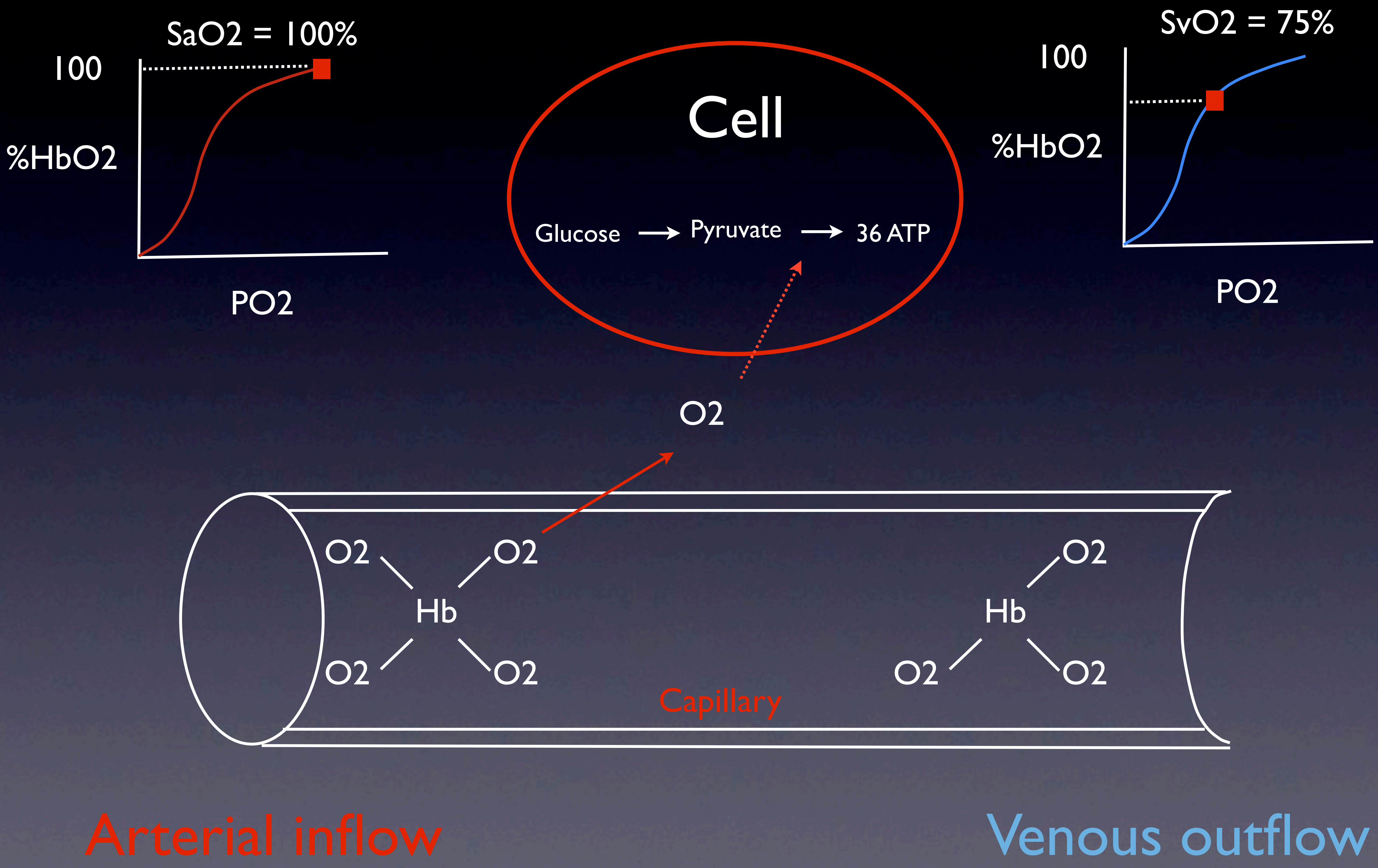
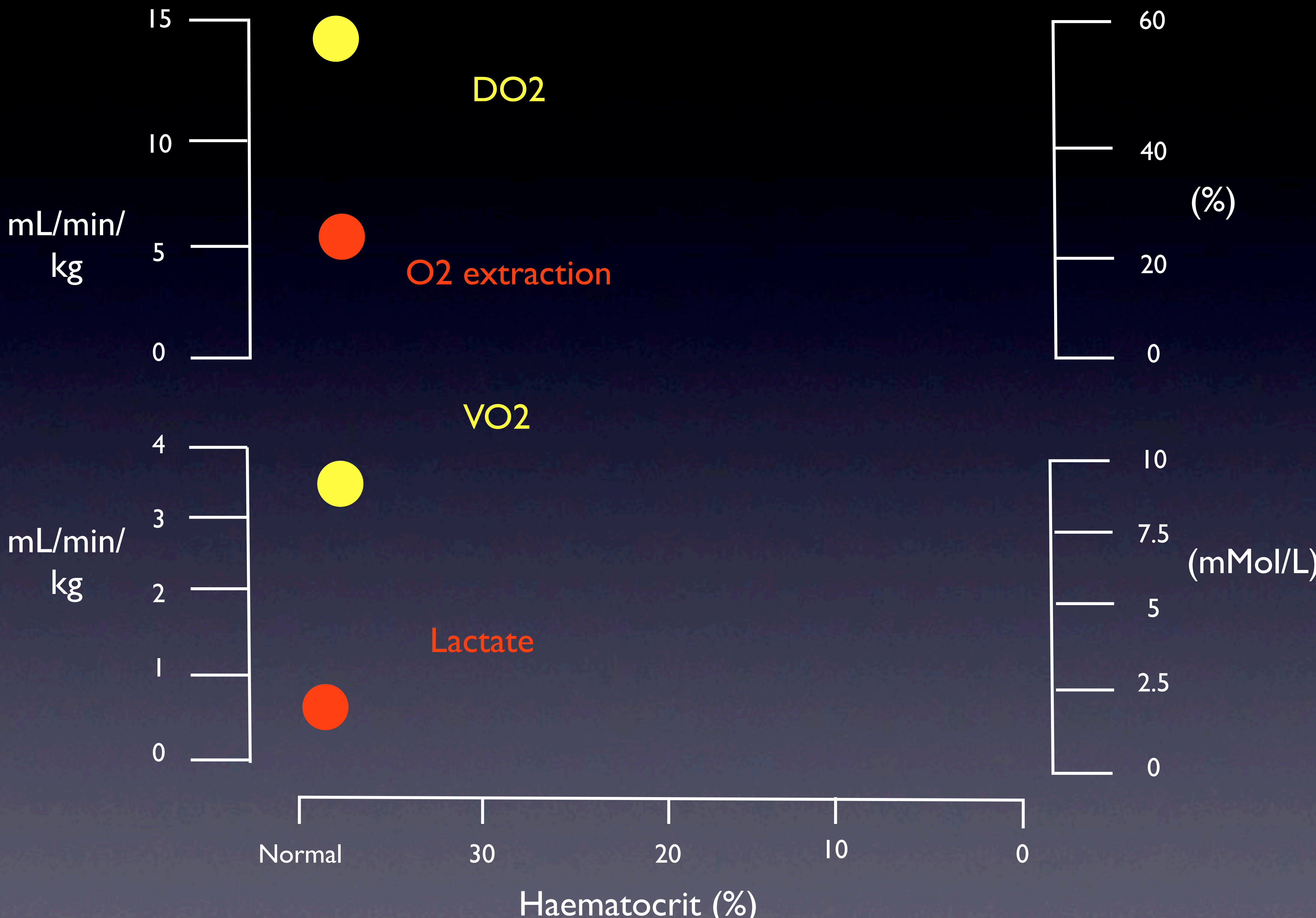


Oxygen extraction



VO2 = DO2 x O2 Extraction



J Surg Res 1987; 42 : 629-634

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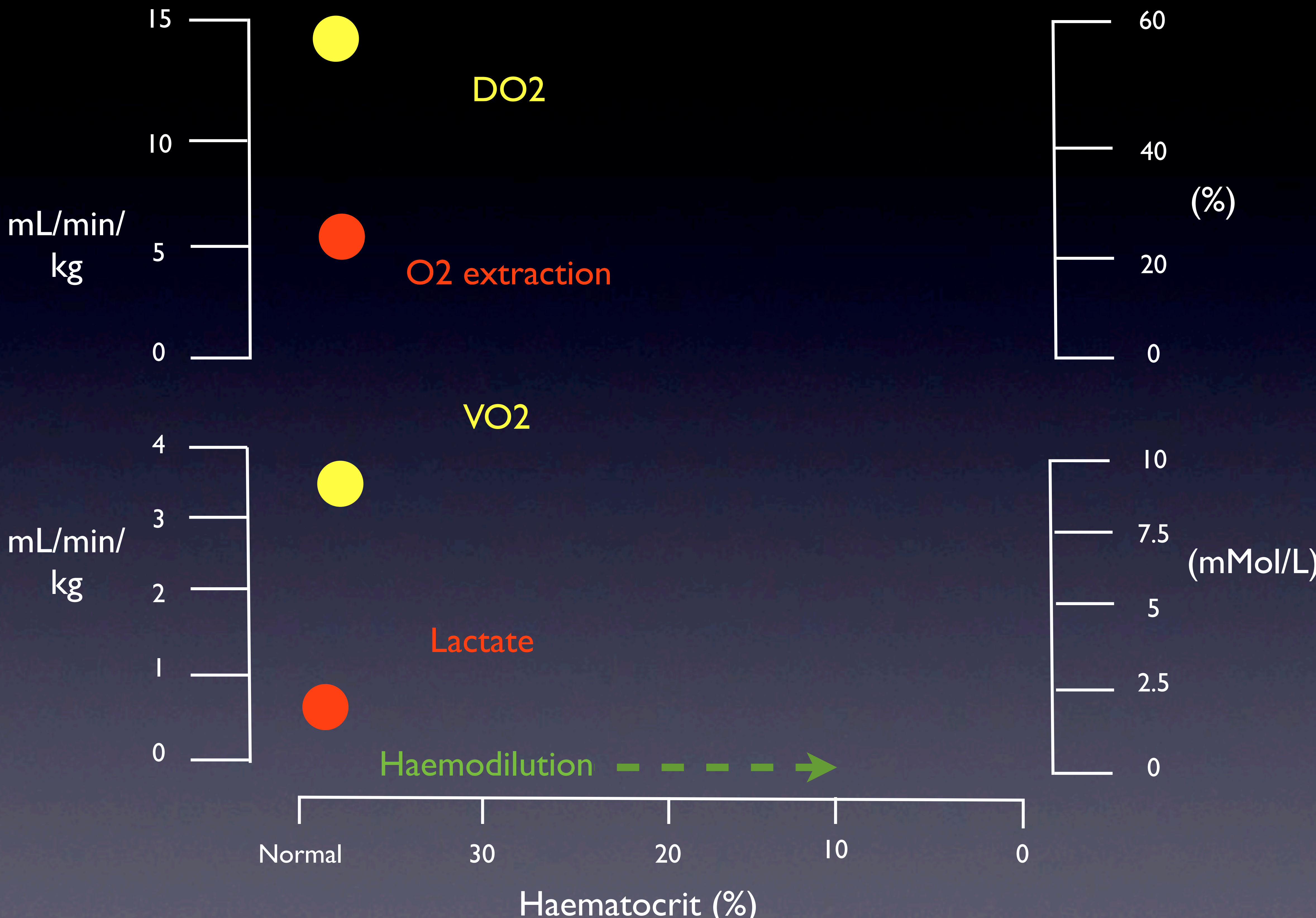

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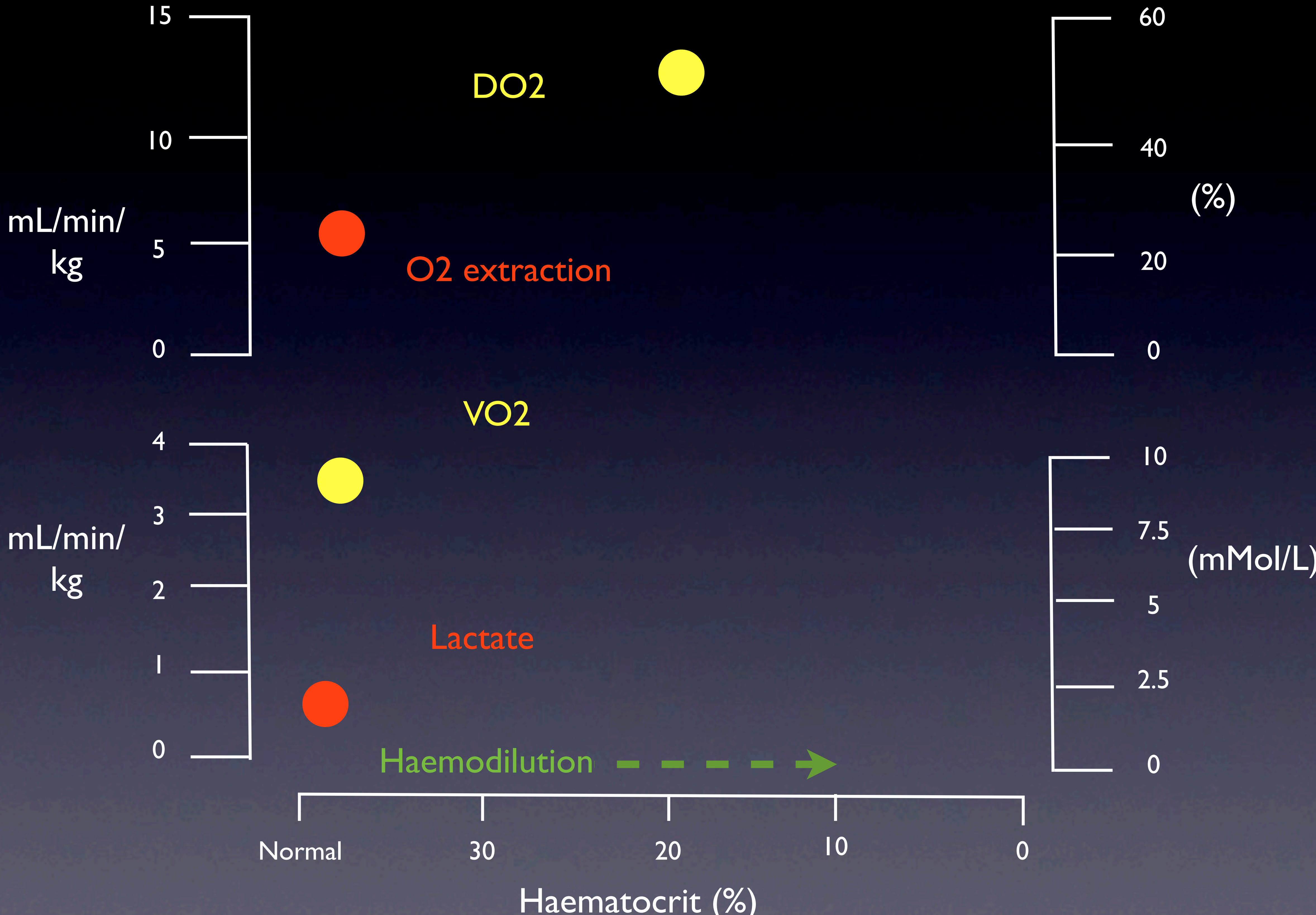

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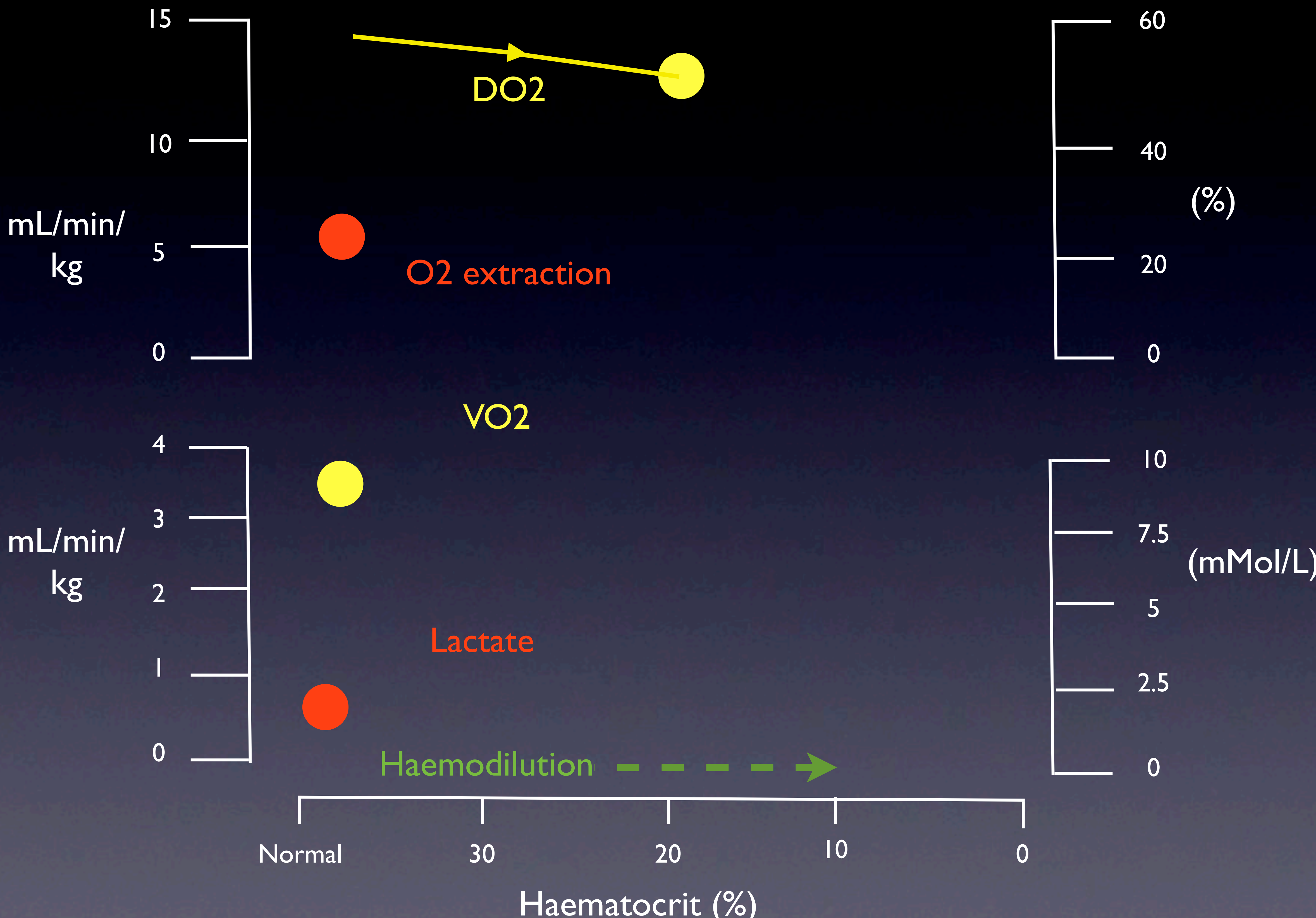

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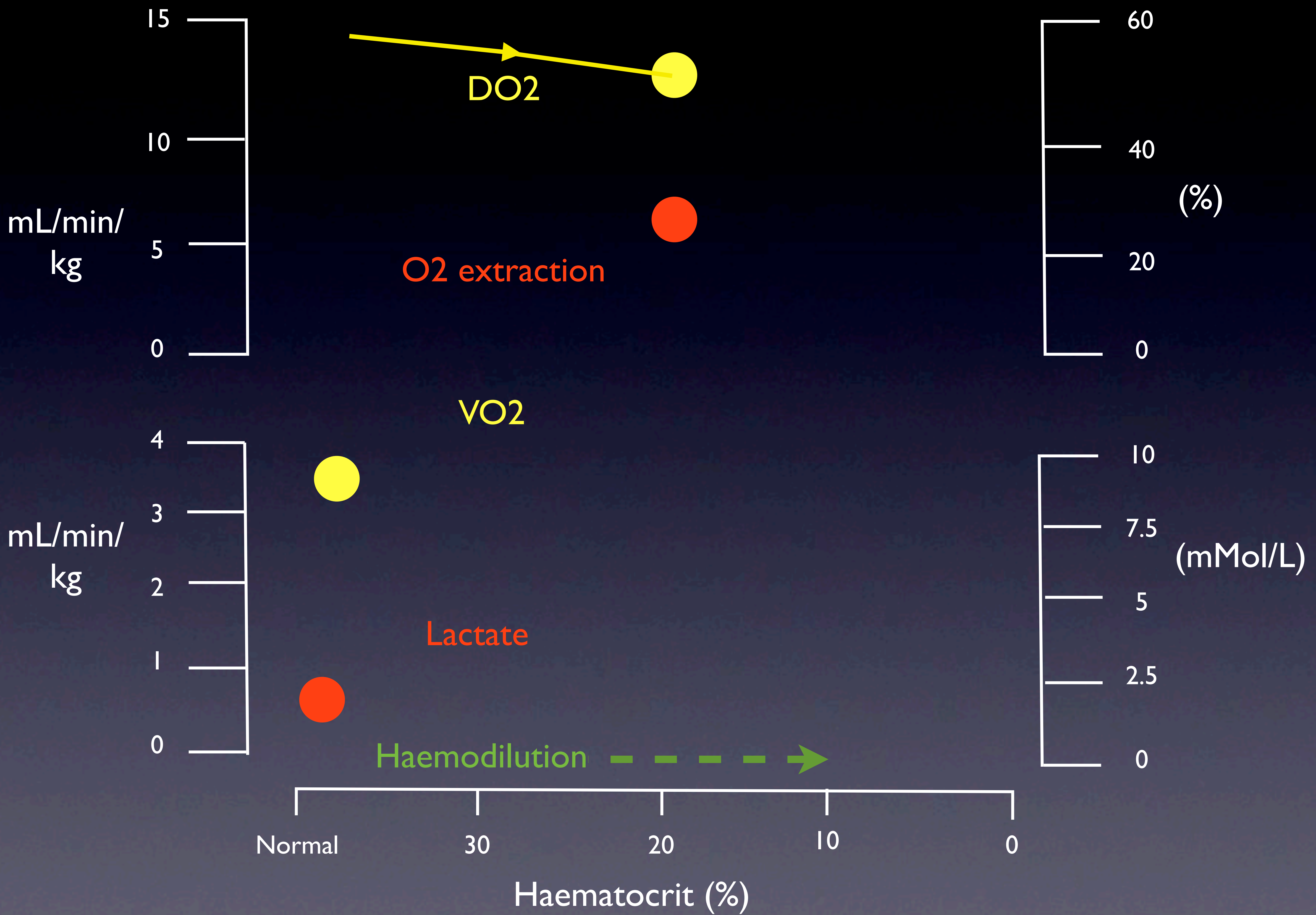

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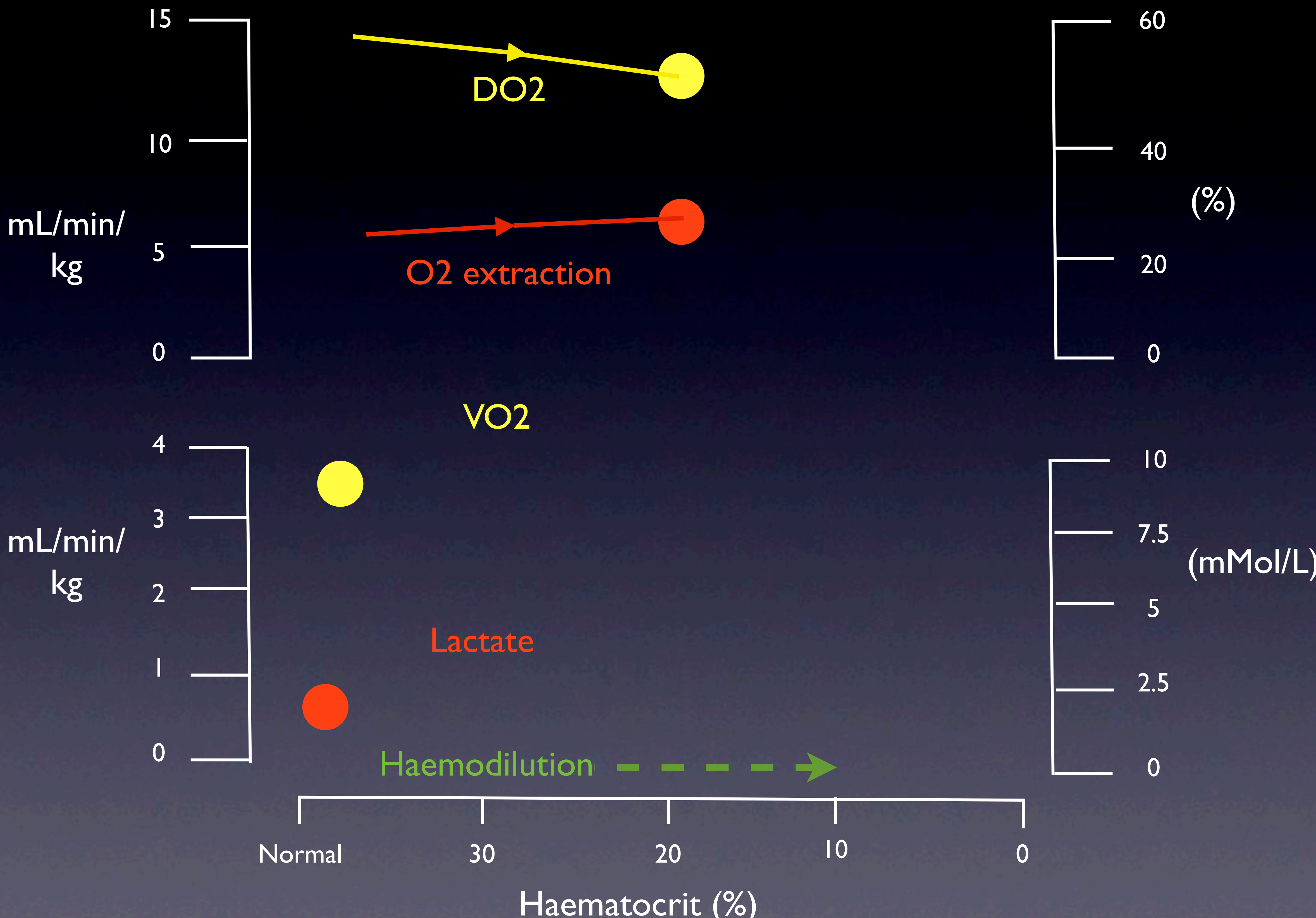

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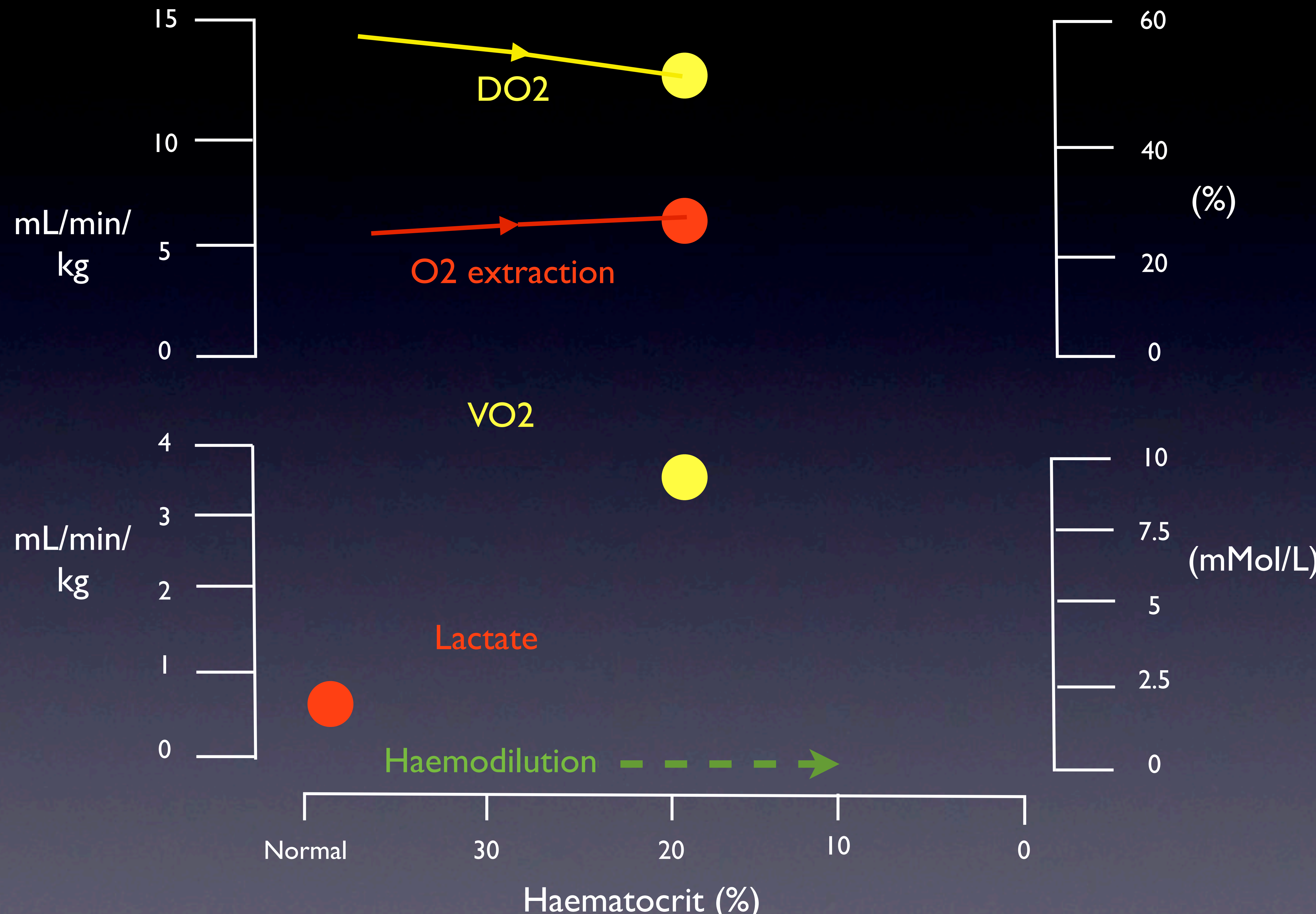

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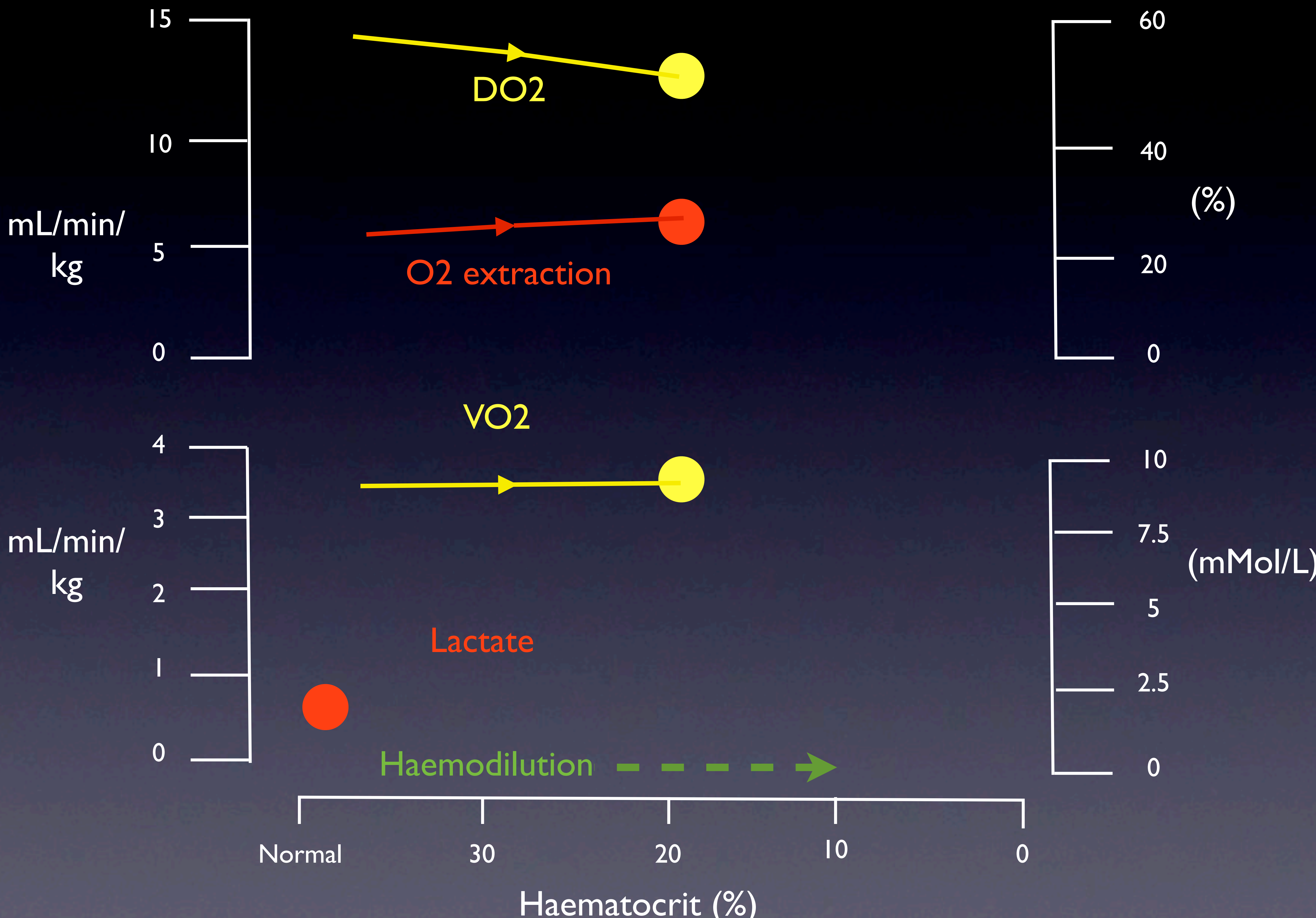

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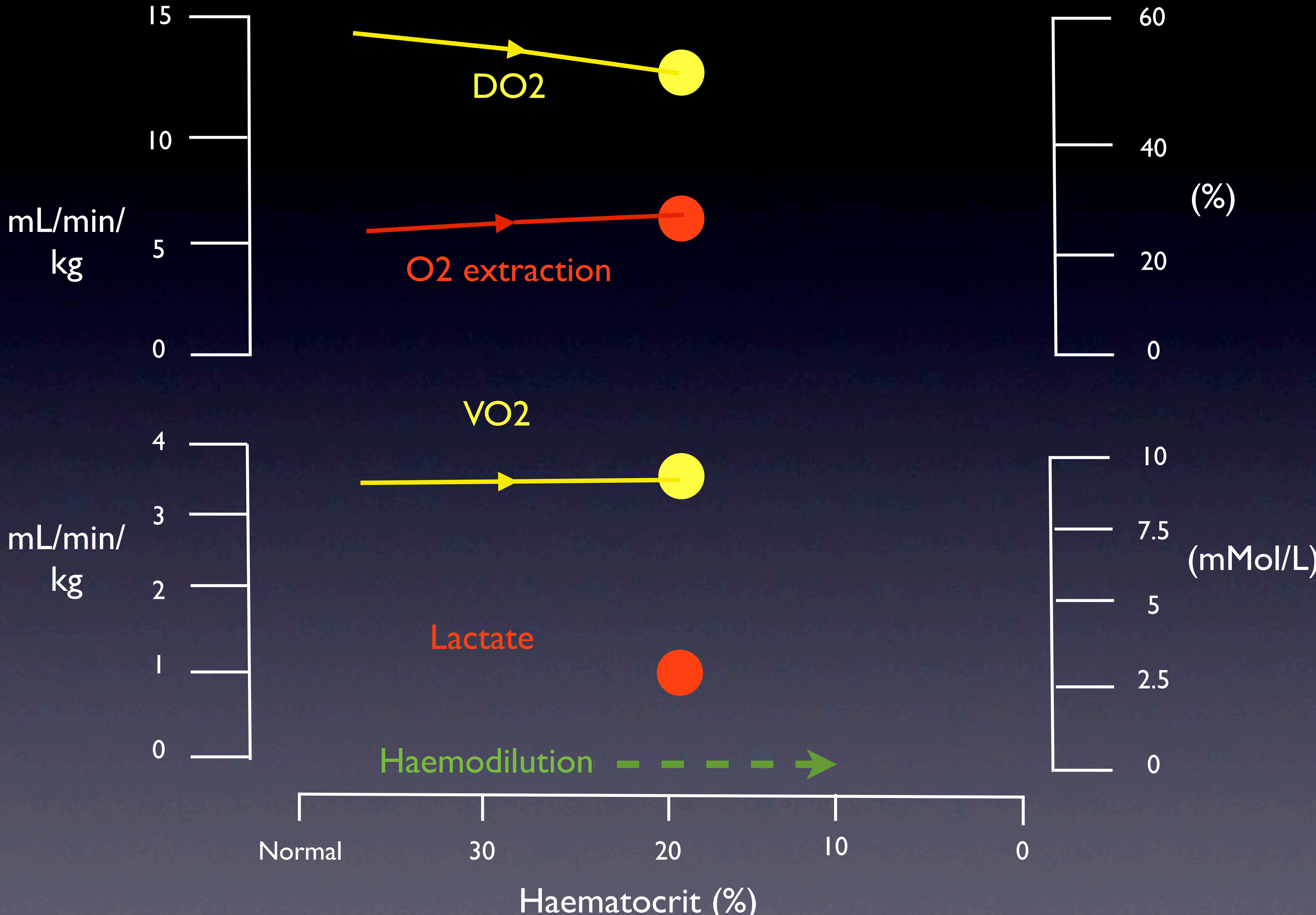

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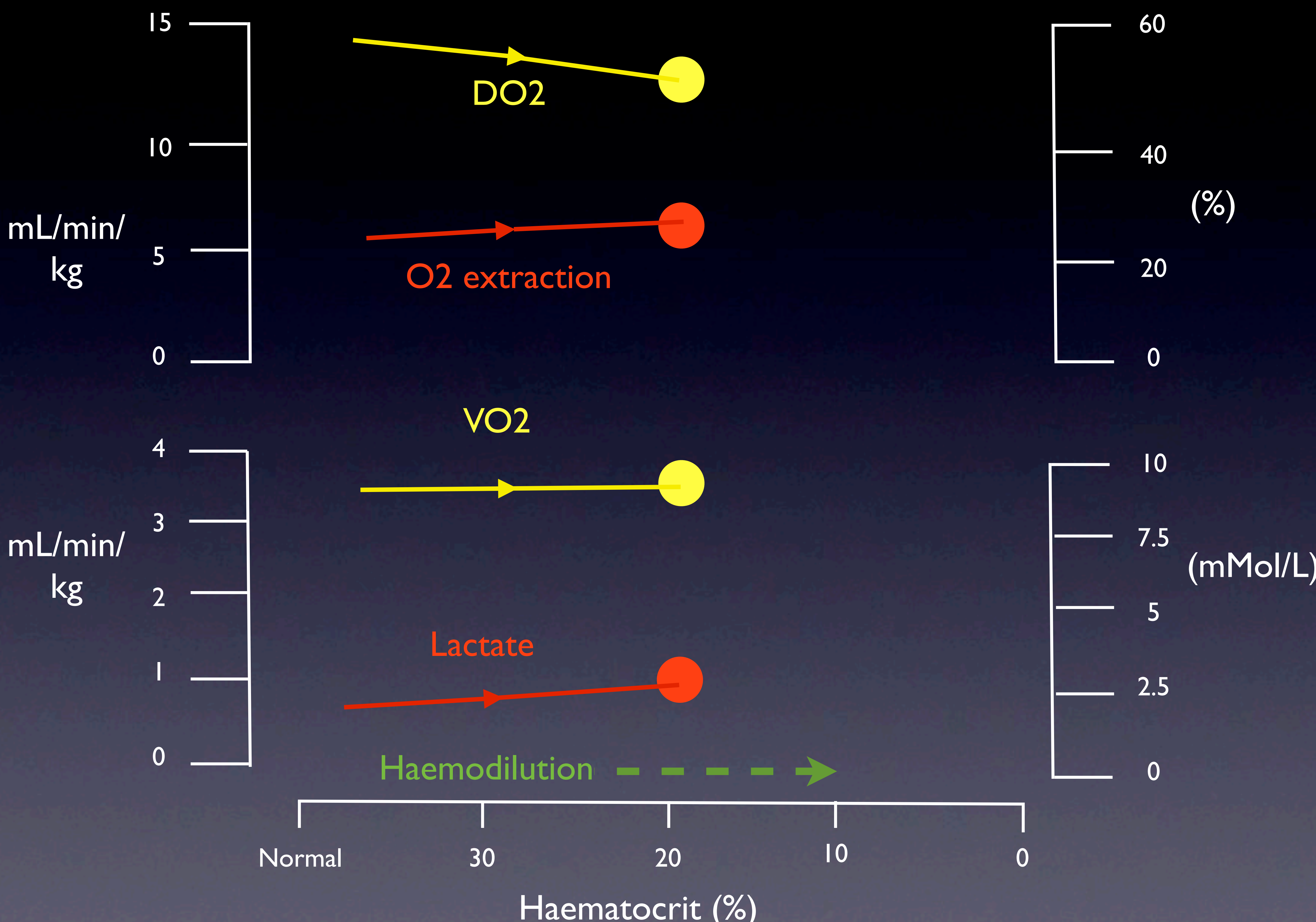

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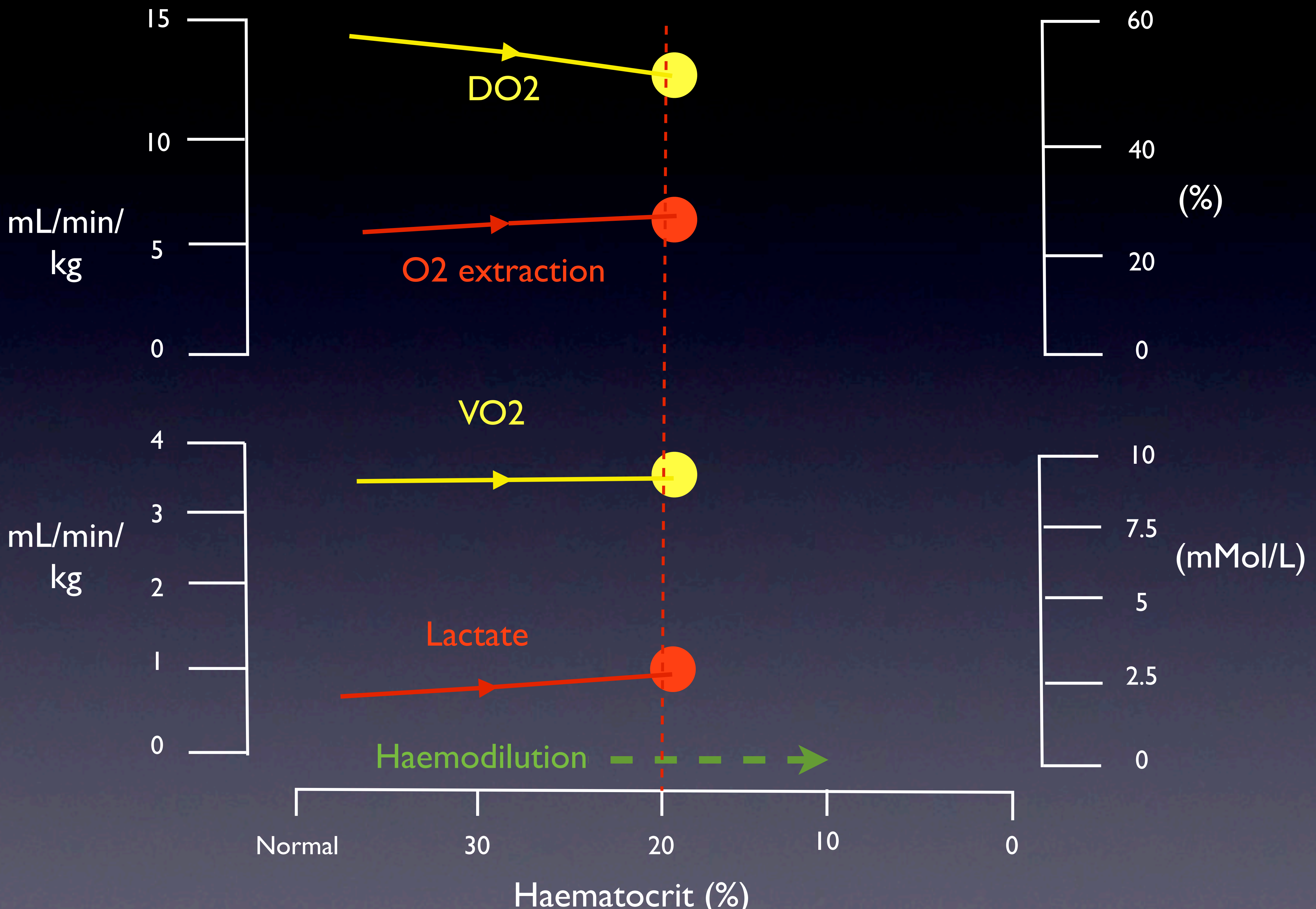

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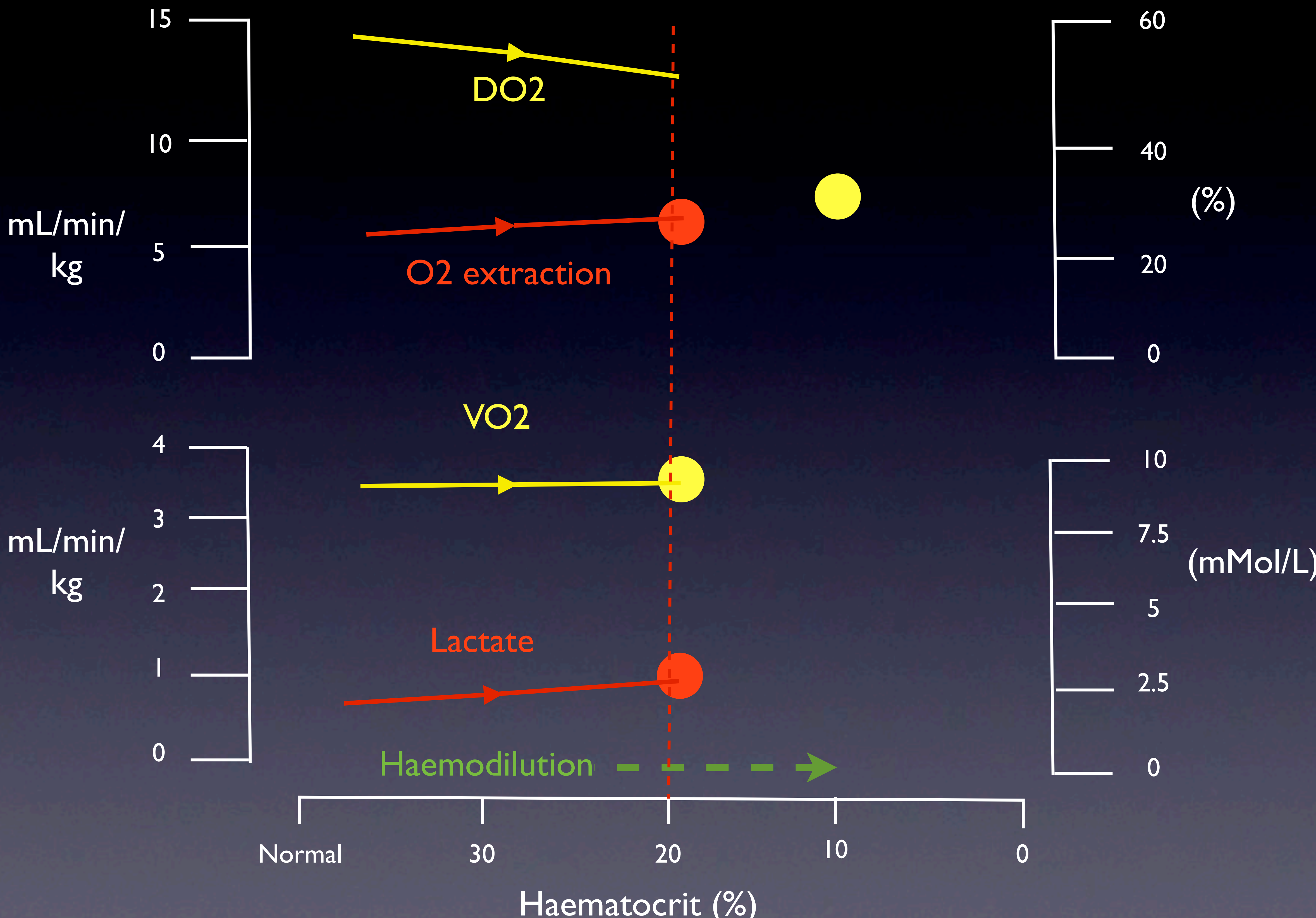

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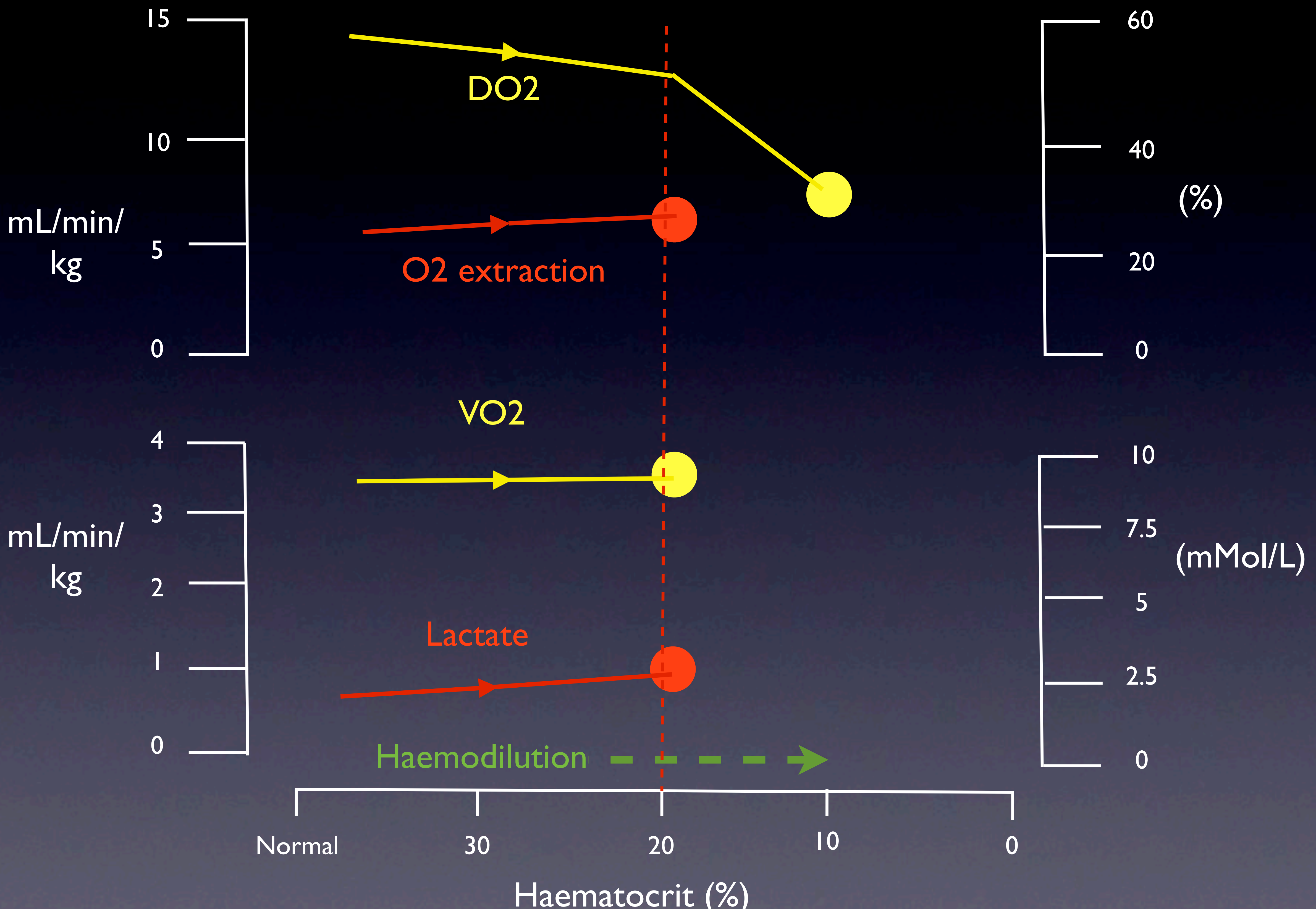

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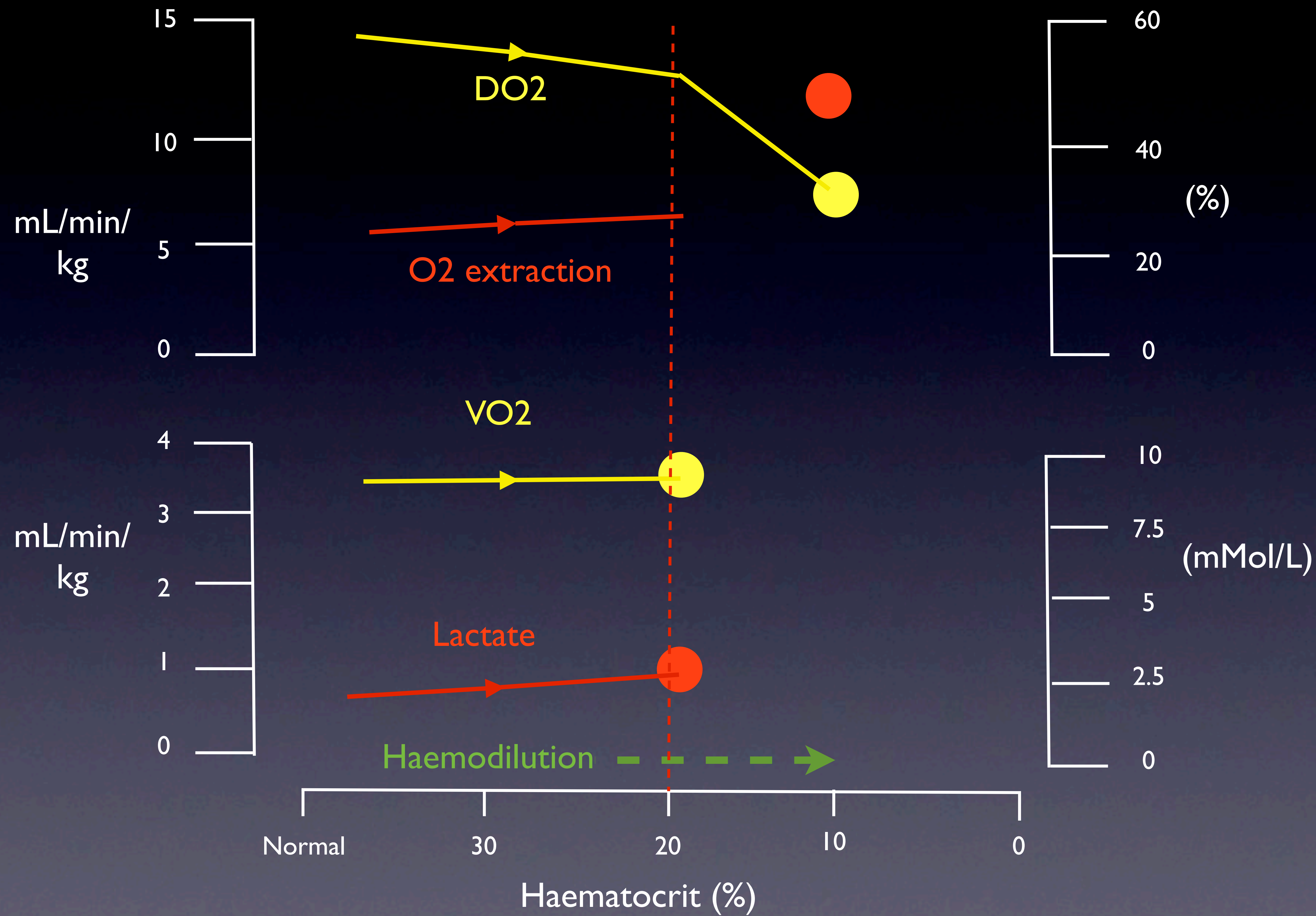

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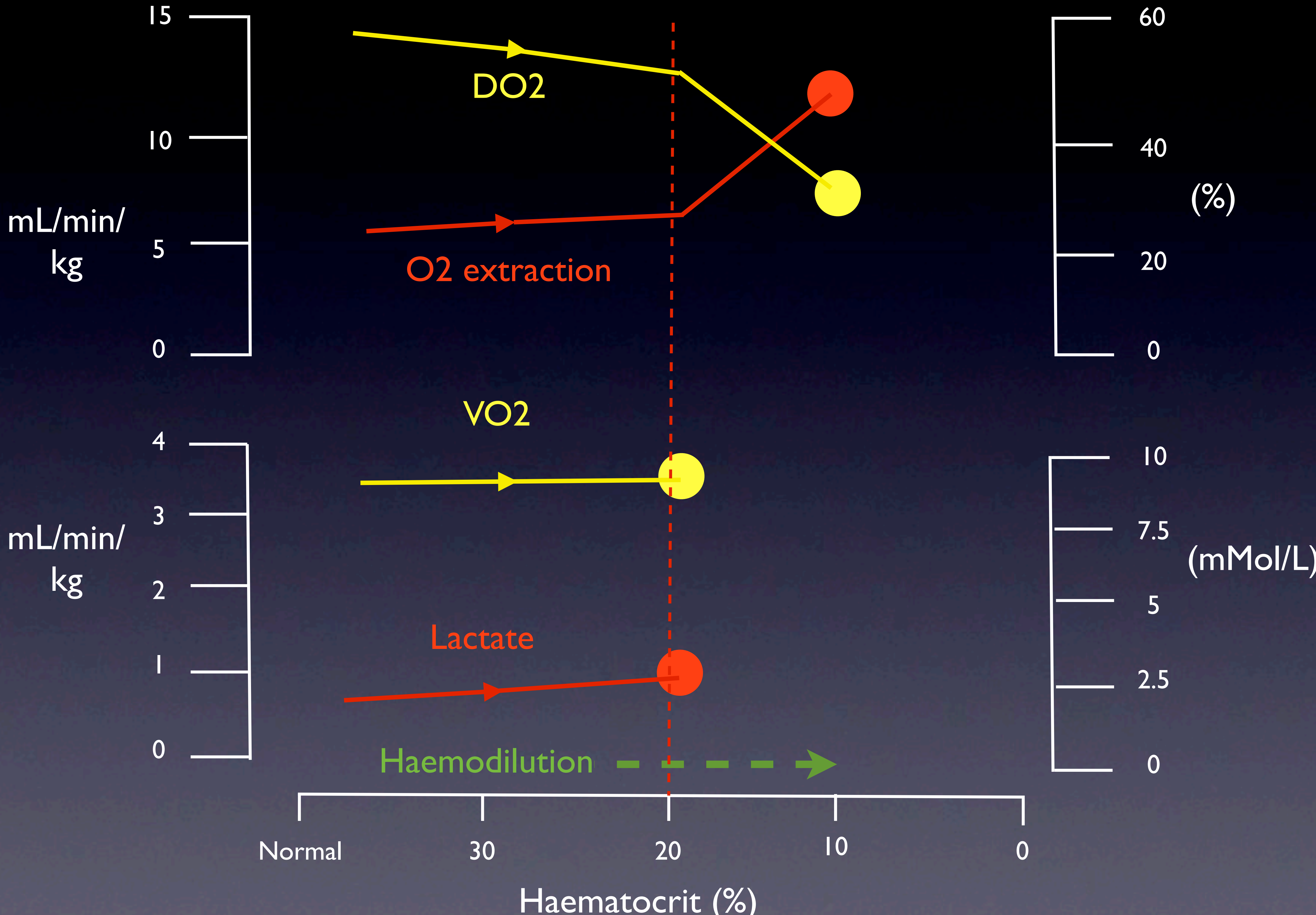

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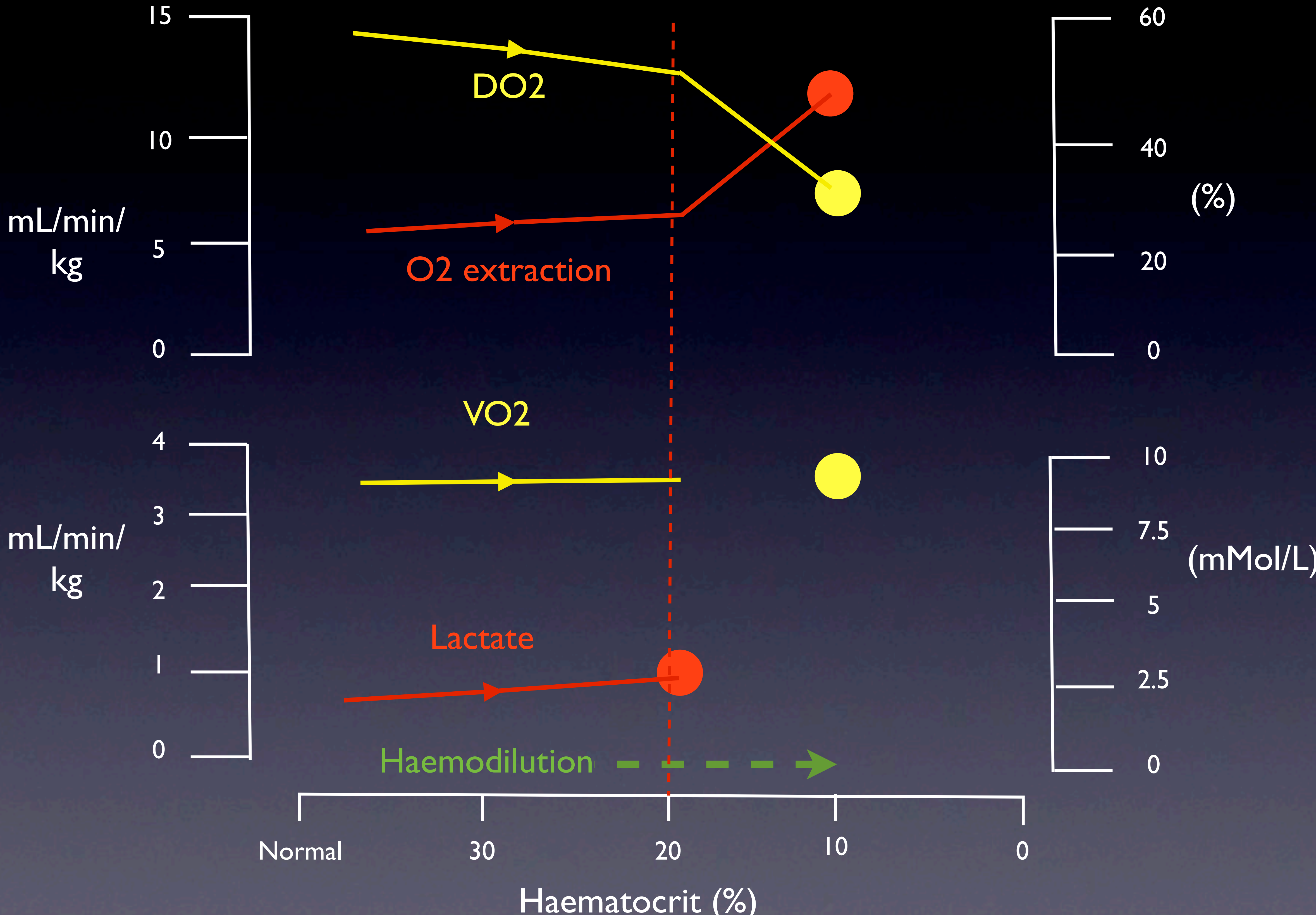

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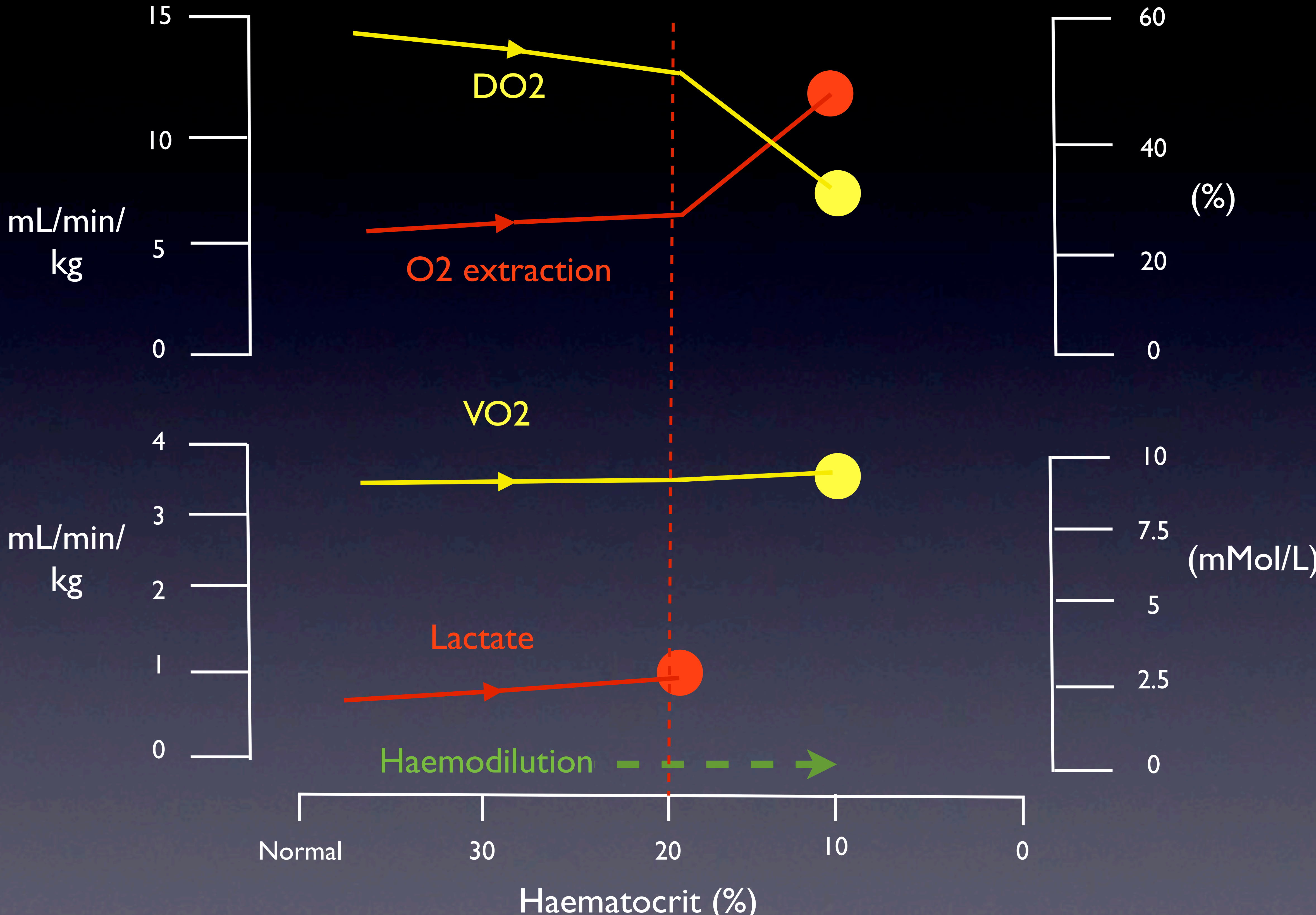

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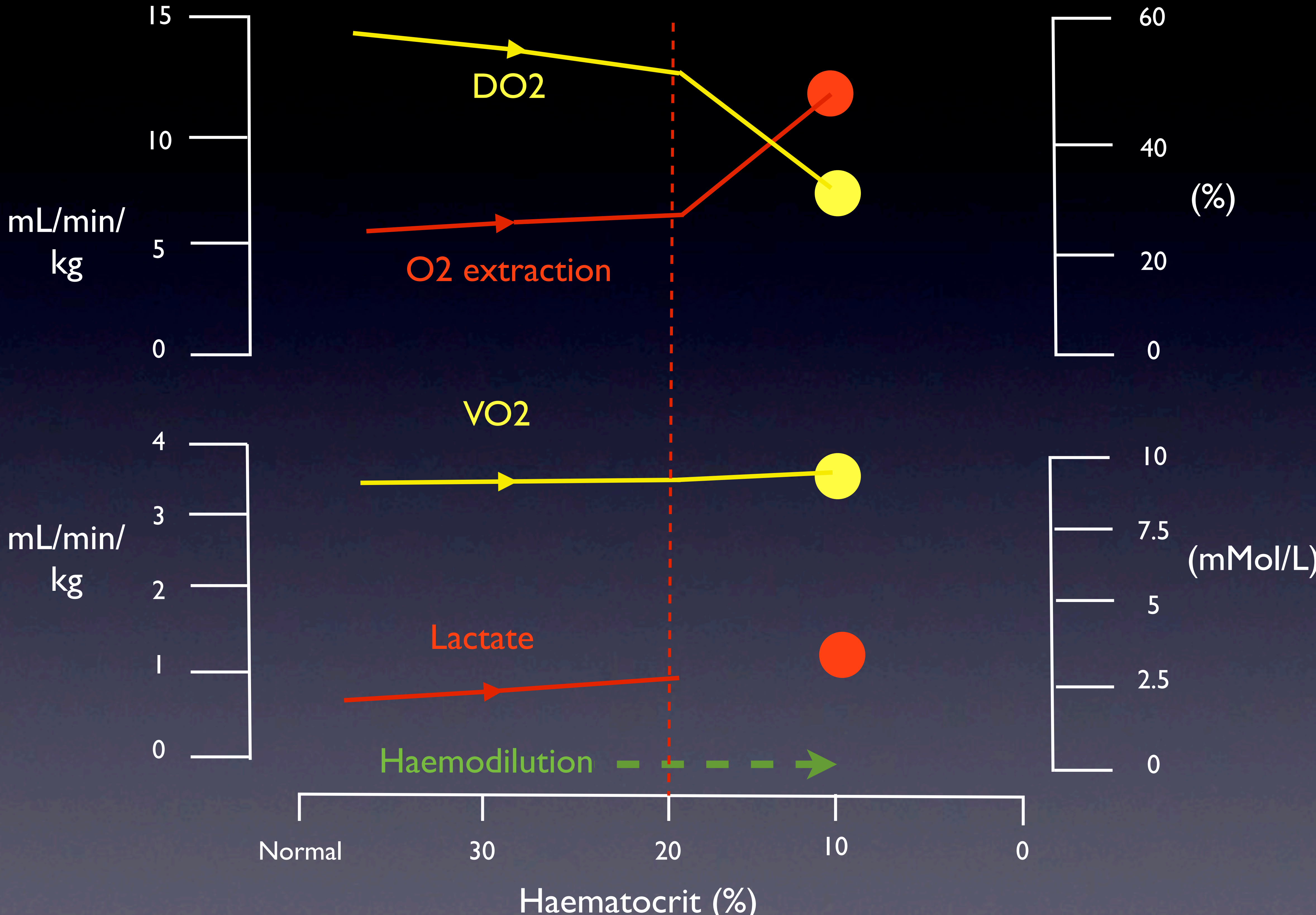

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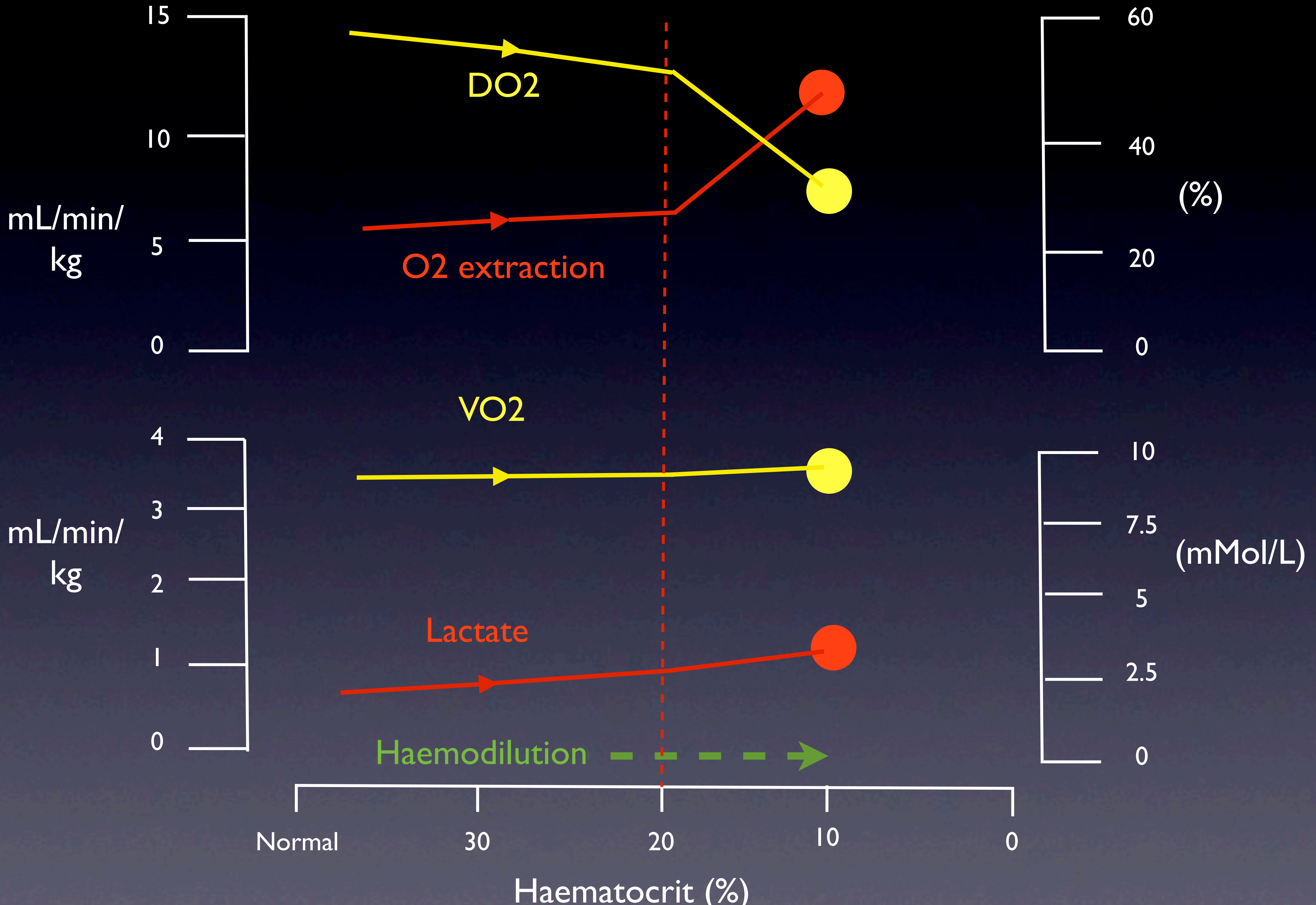

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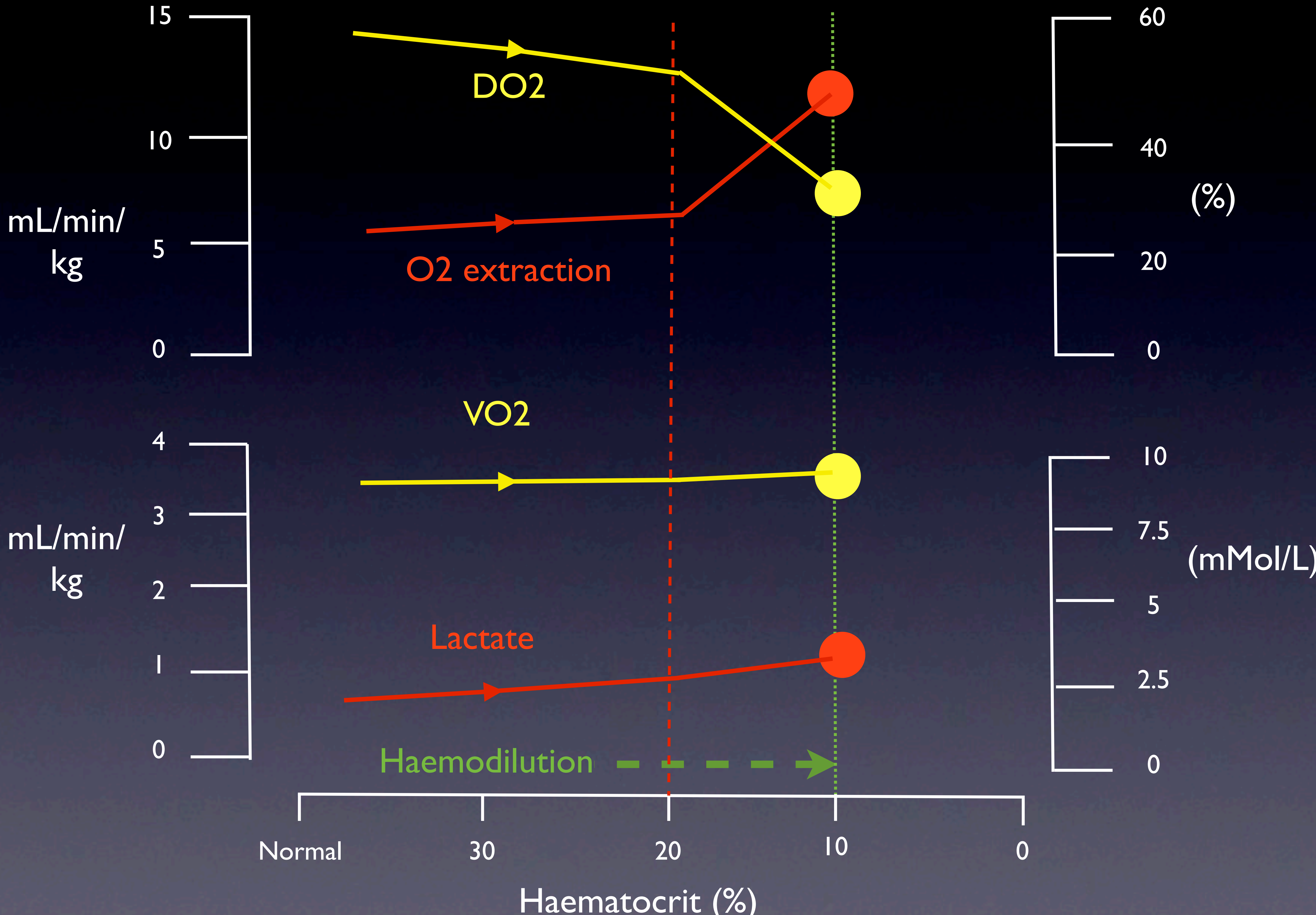

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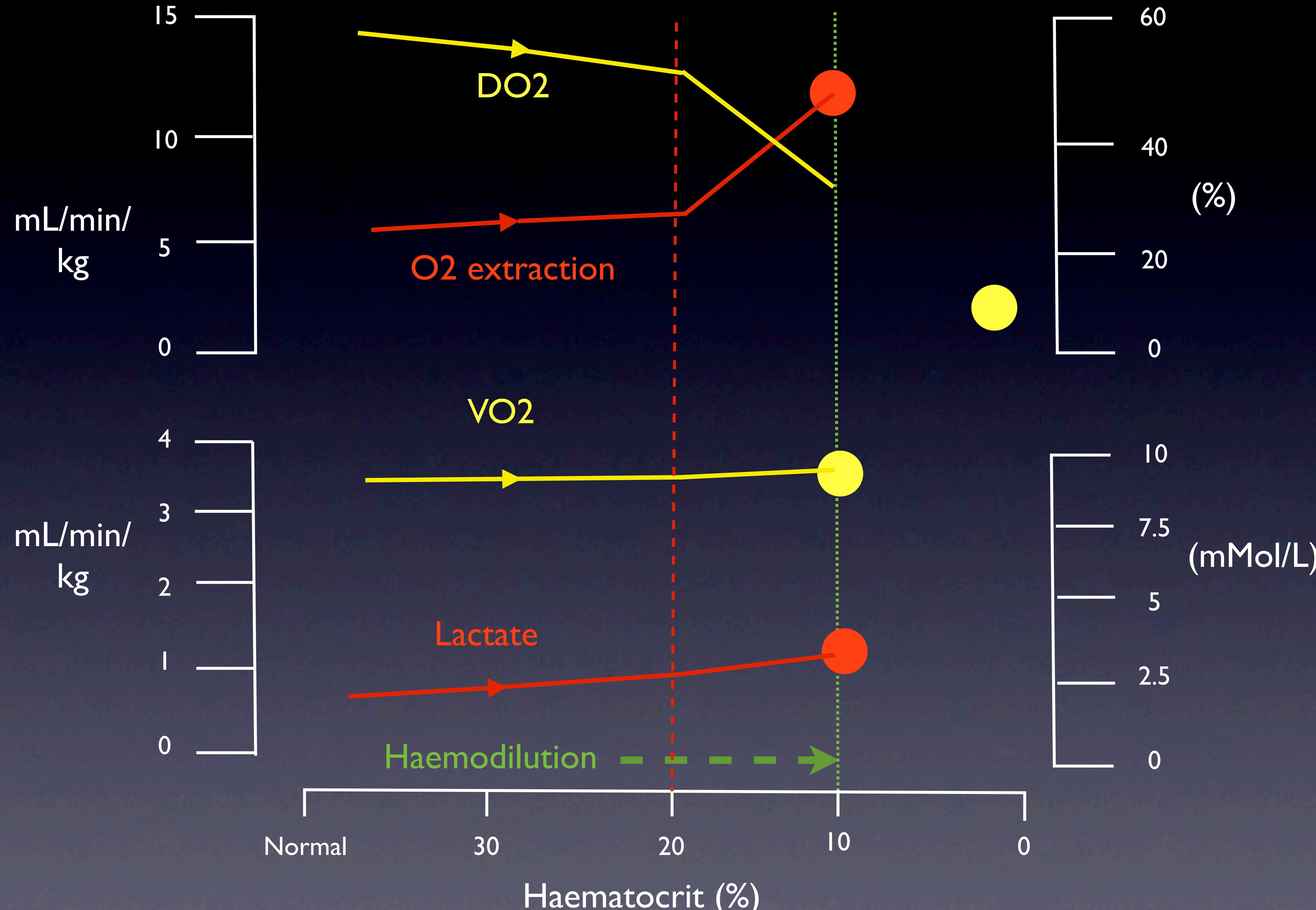

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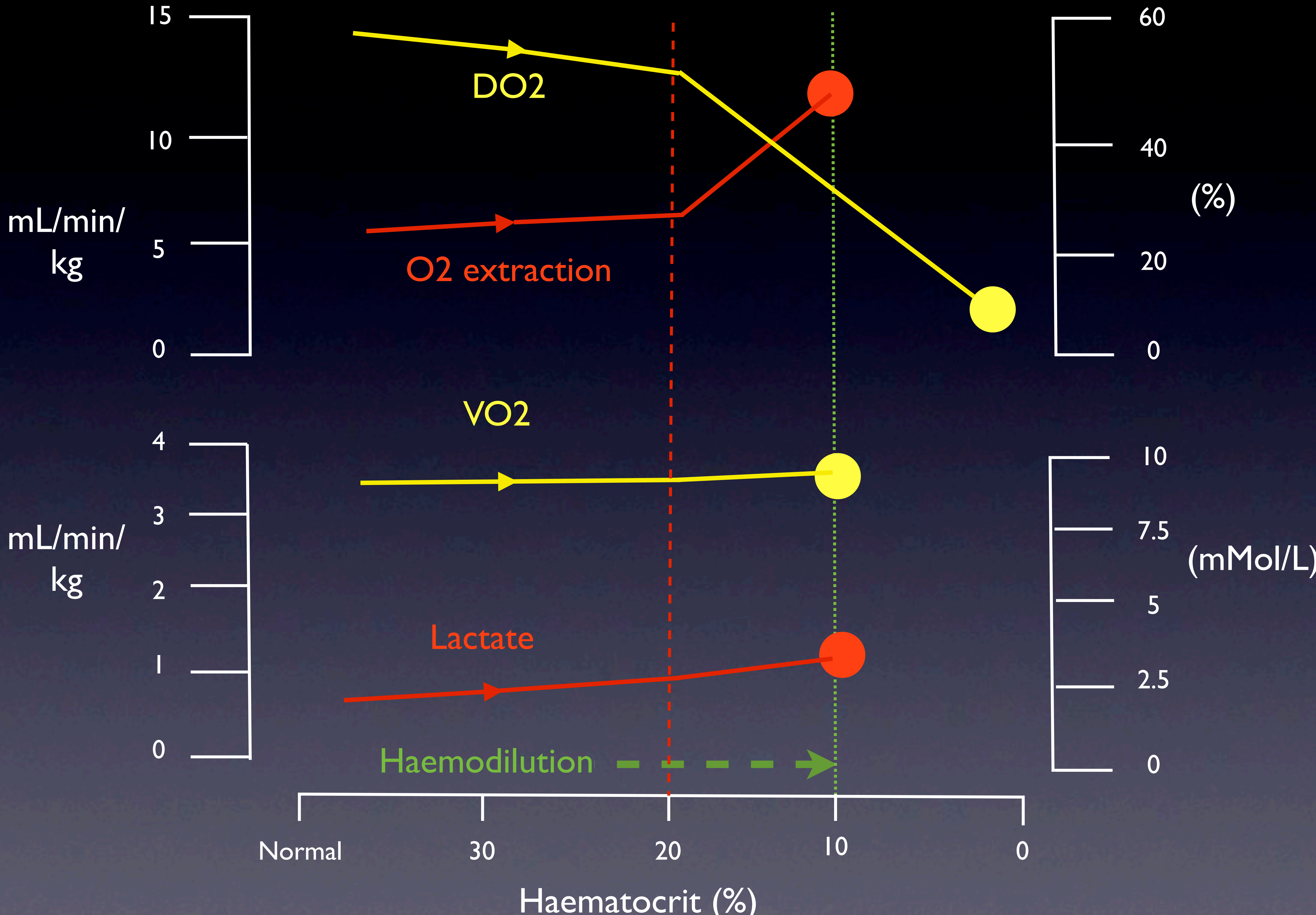

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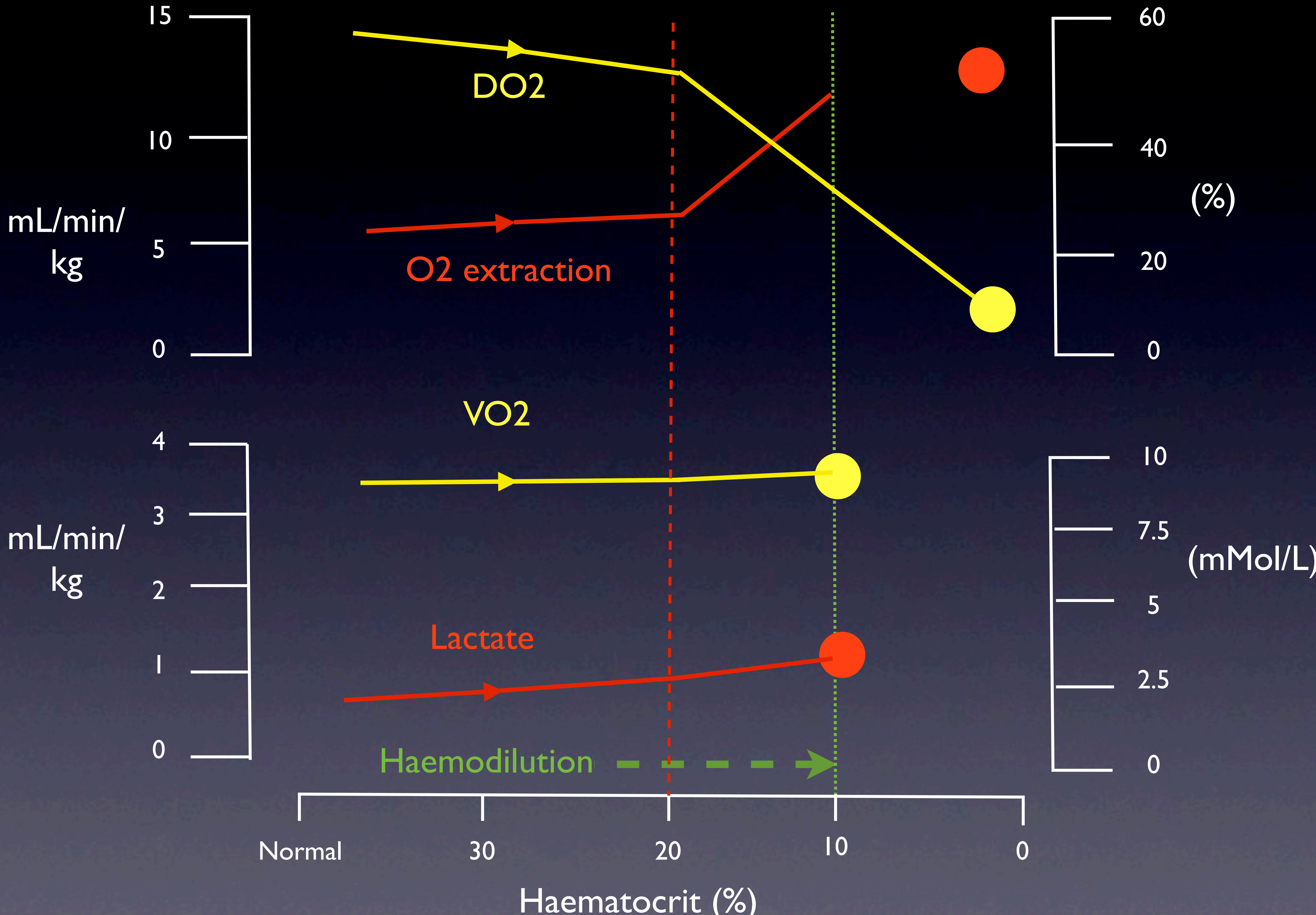

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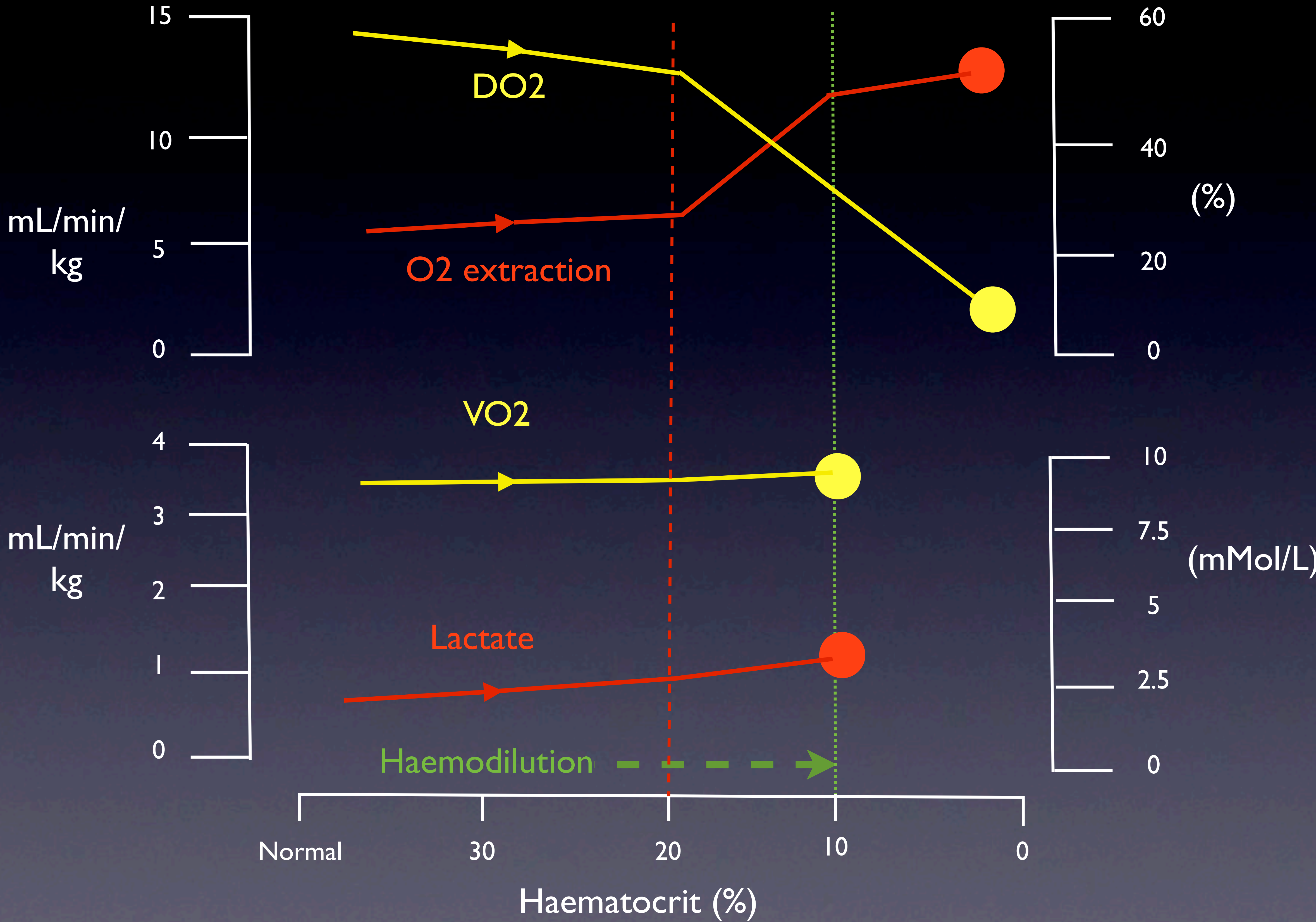

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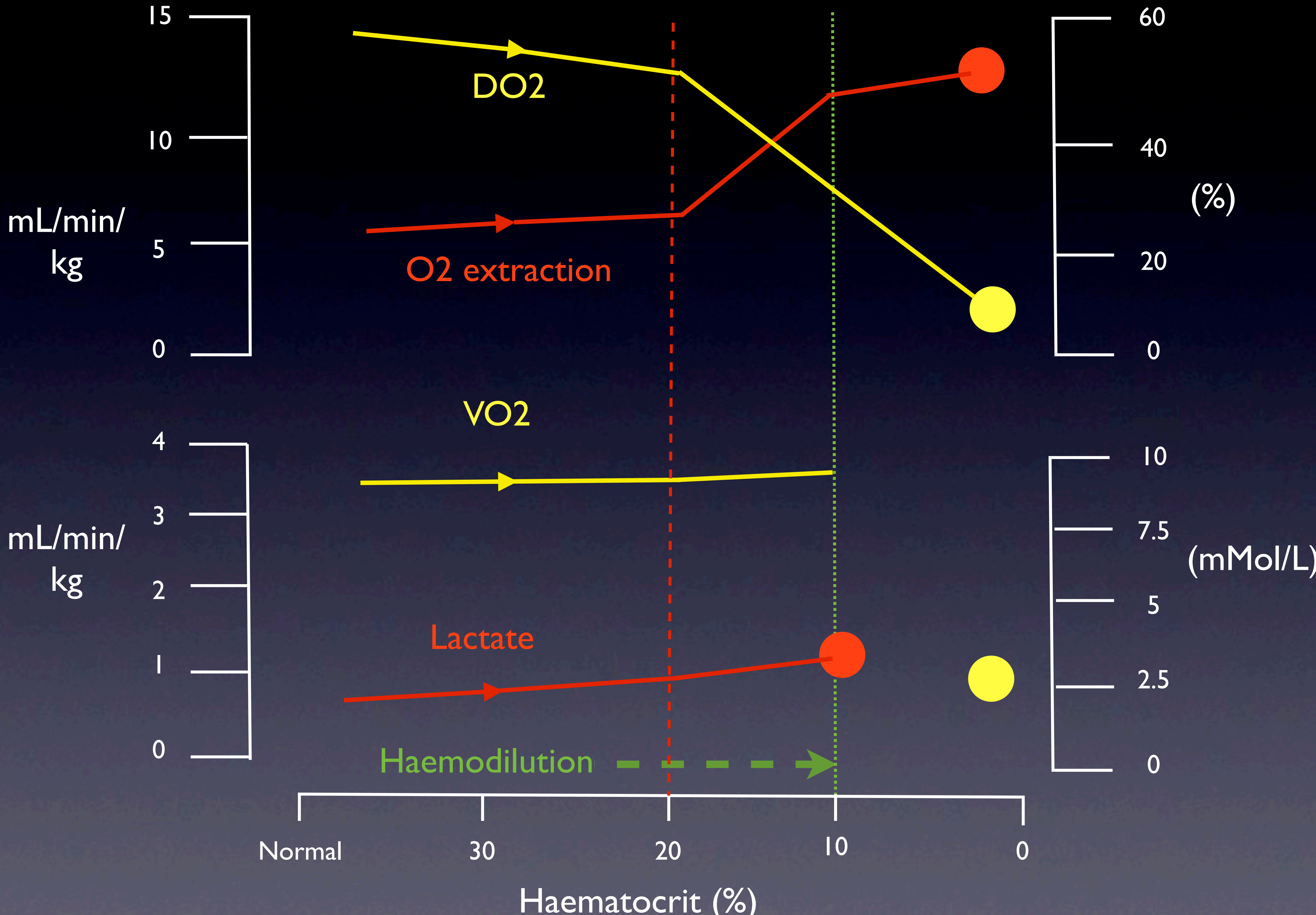

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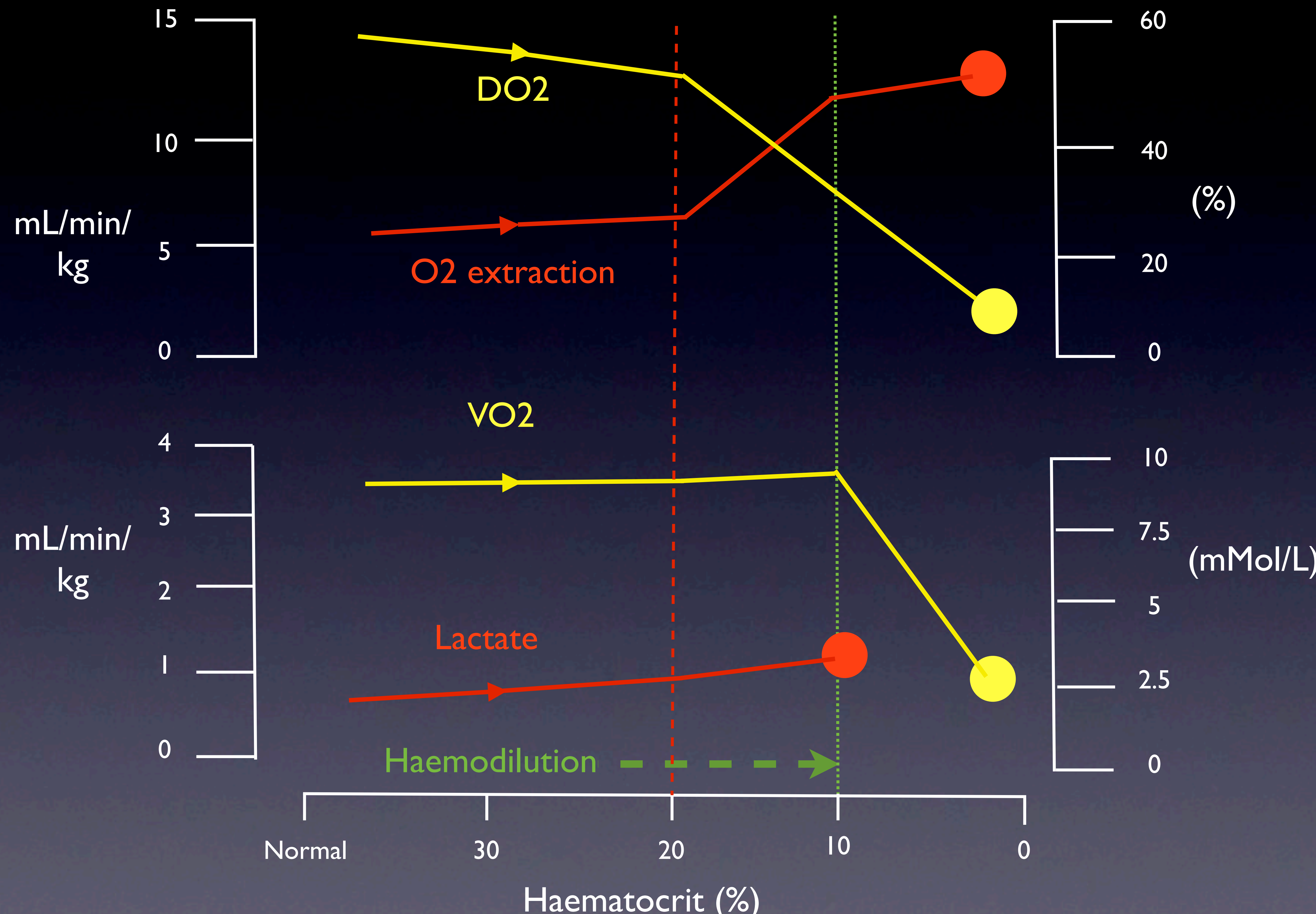

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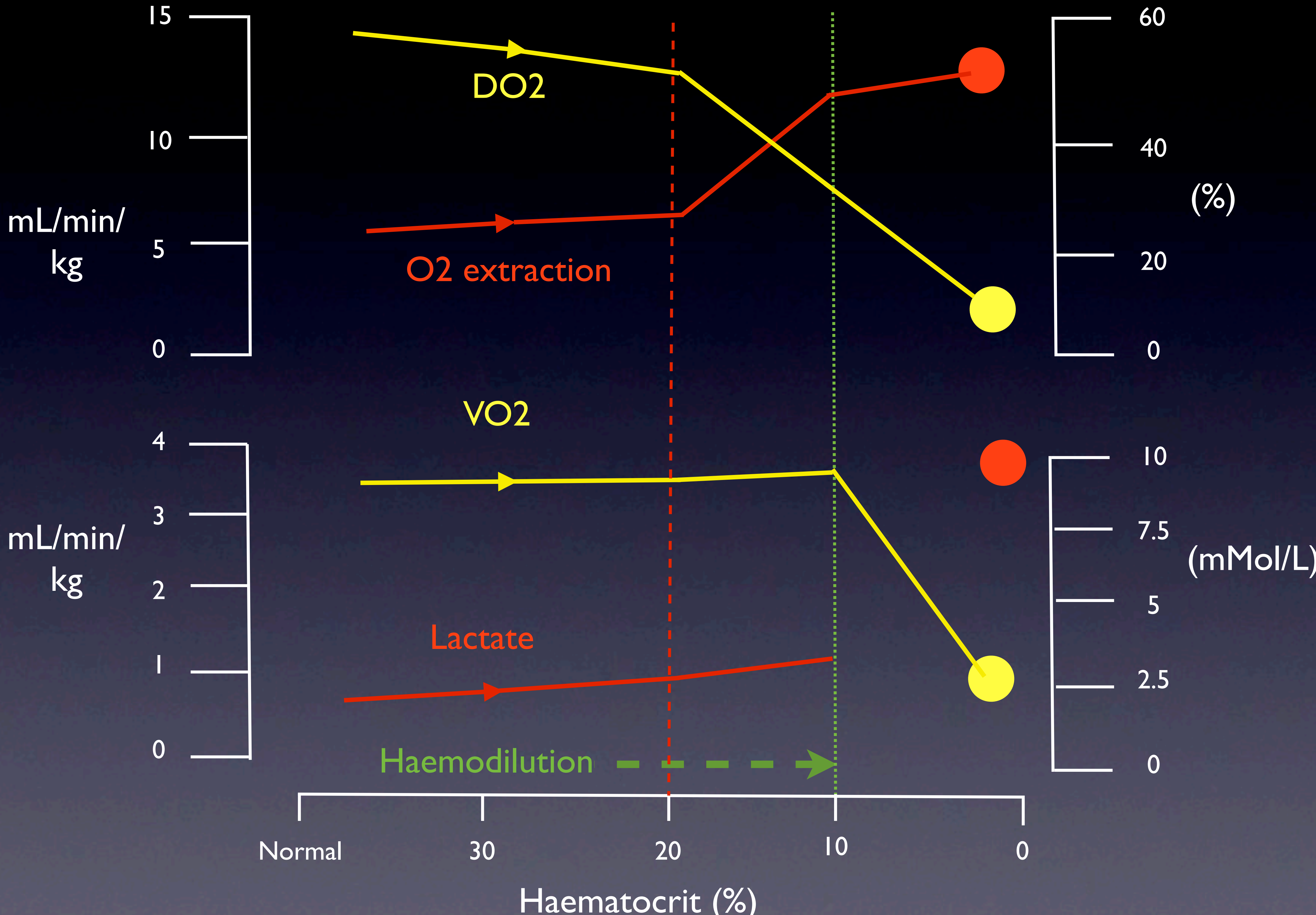

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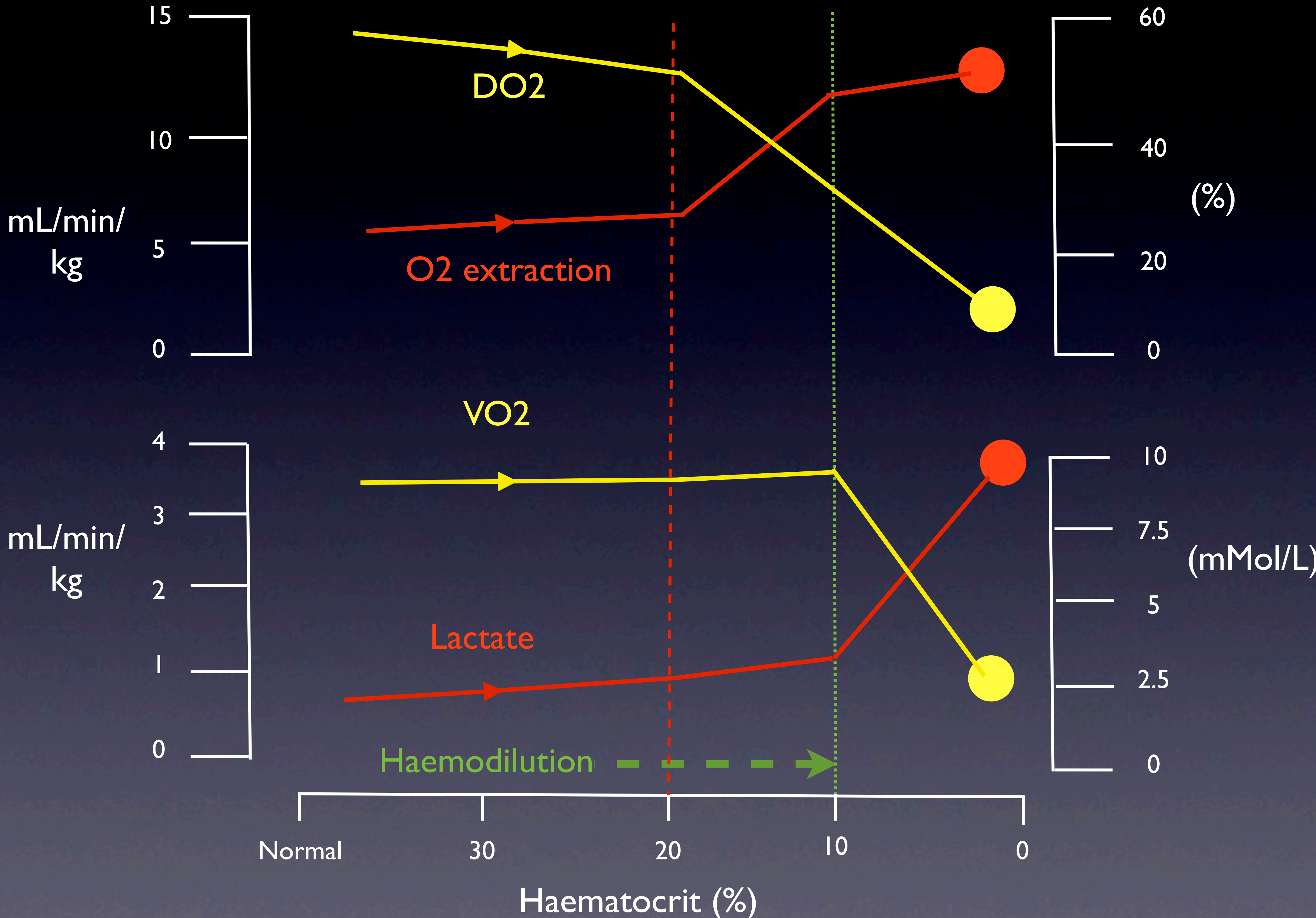

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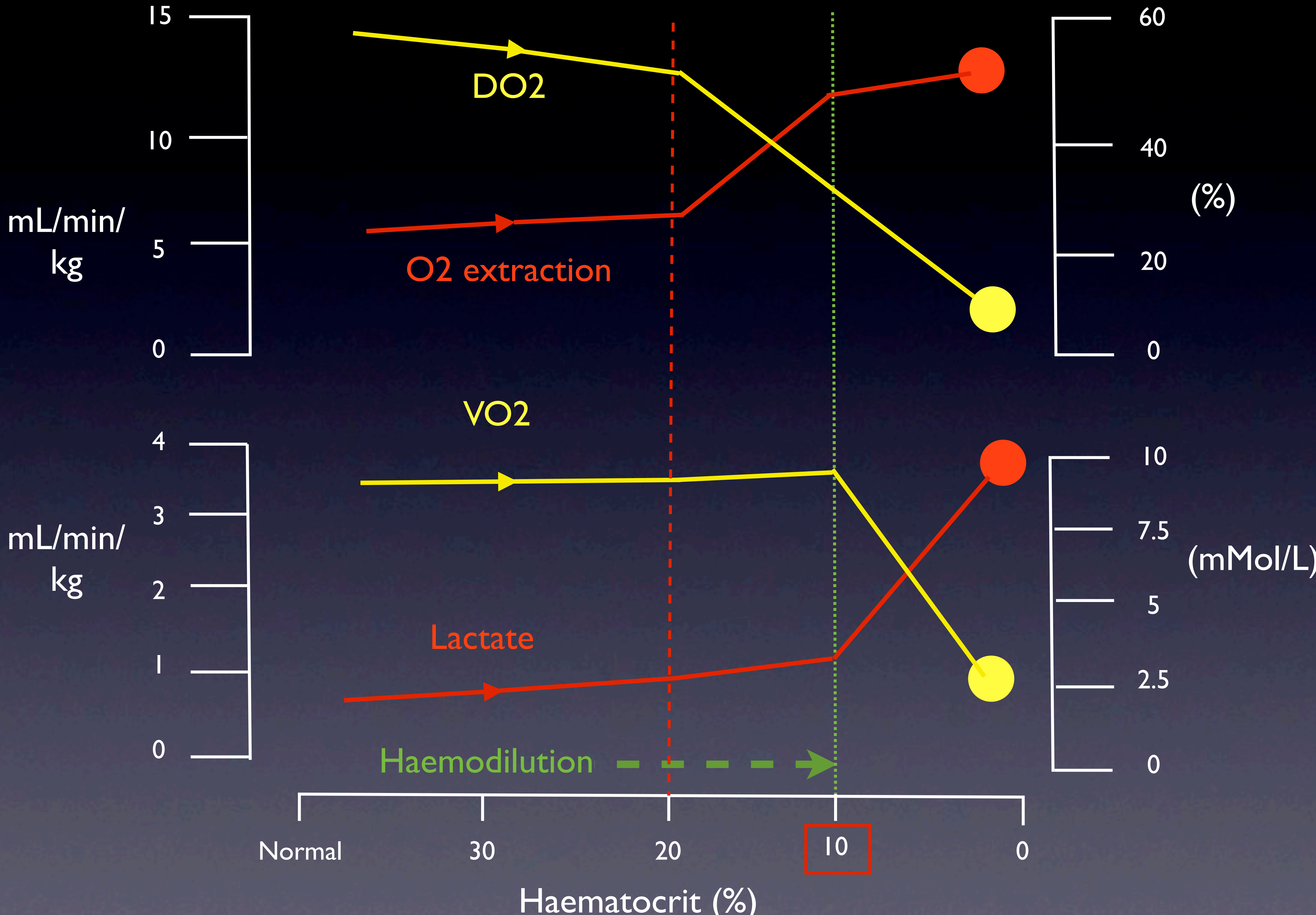

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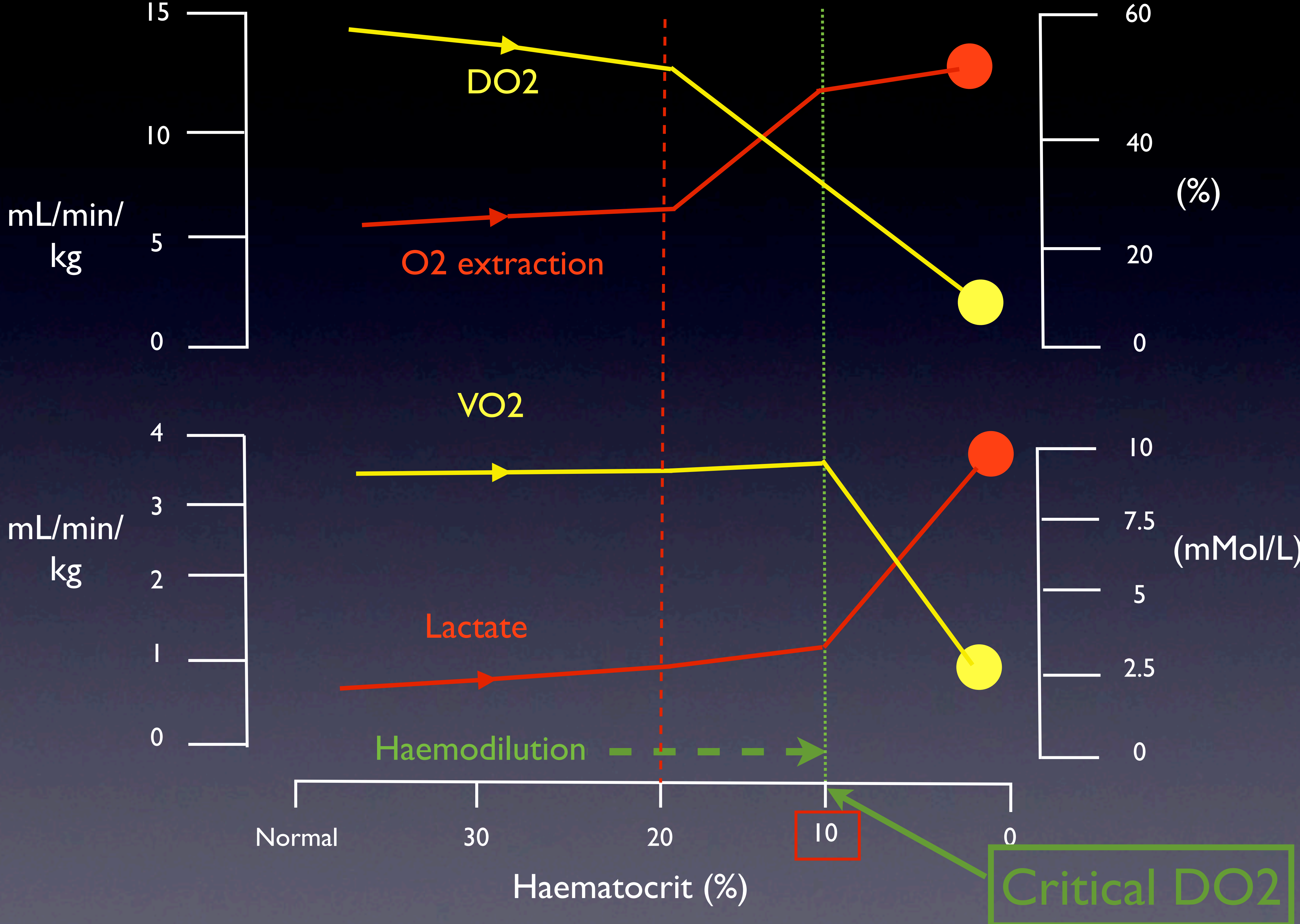

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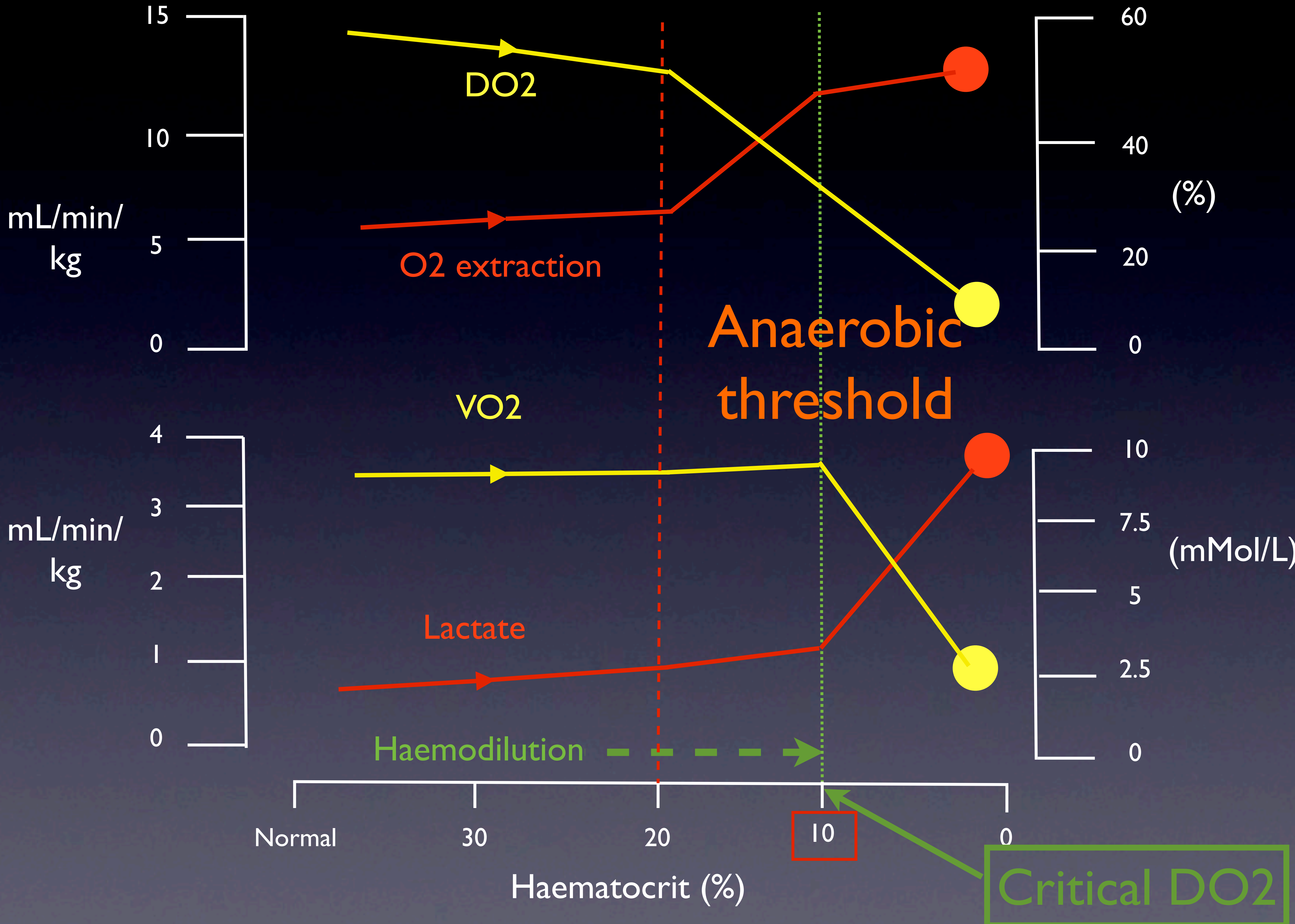

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Clinical Case

Clinical Case

79 year old woman 3rd day post total hip replacement

Clinical Case

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Hb 7.5 gm/dL but well, therefore not for transfusion

Clinical Case

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Hb 7.5 gm/dL but well, therefore not for transfusion

Later found to be confused, breathless and passes moderate quantity of melaena

Clinical Case

79 year old woman 3rd day post total hip replacement

Hb 7.5 gm/dL but well, therefore not for transfusion

Later found to be confused, breathless and passes

moderate quantity of melaena

What are your main concerns?

Cardiac output x Hb x % Sat O2

↓ ↓ ↓

5l 7.5 gm 100 %

Cardiac output x Hb x % Sat O2

5l 7.5 gm 100 %

500 O2 ml/min delivered

Cardiac output x Hb x % Sat O2

51 | 7.5 gm | 100 %

Cardiac output x Hb x % Sat O2

5l 7.5 gm 100 %

2.5 l 7.5 gm 100 %

Cardiac output x Hb x % Sat O2

5l 7.5 gm 100 %

2.5 l 7.5 gm 100 %

250 O2 ml/min delivered

Clinical Case

77 yr old lady

C. Difficile toxic mega colon

Peripherally very oedematous

Received 5.5 l fluid

BP = 95/55 ; HR 99

RR = 35

U.O = 15 ml/hr

Central line in place in femoral vein

What is our approach?

Consider 02 delivery

Consider 02 delivery

Cardiac output is the most important of the "Big 3"

Adequate cardiac output

Aim for:

Adequate cardiac output

Aim for:

- Clinical
  - Warm toes
  - Normal BP
  - Good urine output

Adequate cardiac output

Aim for:

- Clinical
  - Warm toes
  - Normal BP
  - Good urine output
- Biochemical
  - SvO2 (normal ~ 75%)
  - Lactate (can be venous - Delta lactate = Sv02)

Adequate cardiac output

Aim for:

- Clinical
  - Warm toes
  - Normal BP
  - Good urine output
- Biochemical
  - SvO2 (normal ~ 75%)
  - Lactate (can be venous - Delta lactate = Sv02)
- Direct measurement

Cardiac output adequate ?

$\boxed{\text{Cardiac output adequate ?}}$

No

Cardiac output adequate ?

↓ No

Get to the top of the Starling curve -> optimize fluids

Cardiac output adequate ?

↓ No

Get to the top of the Starling curve -> optimize fluids

↓

Predict if fluid responsive?

Cardiac output adequate ?

No

Get to the top of the Starling curve -> optimize fluids

Predict if fluid responsive?

IPPV

Spontaneous respirations

Cardiac output adequate ?

No

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Predict if fluid responsive?

IPPV

SVV/PPV/SPV

Spontaneous respirations

Cardiac output adequate ?

No

Get to the top of the Starling curve -> optimize fluids

Predict if fluid responsive?

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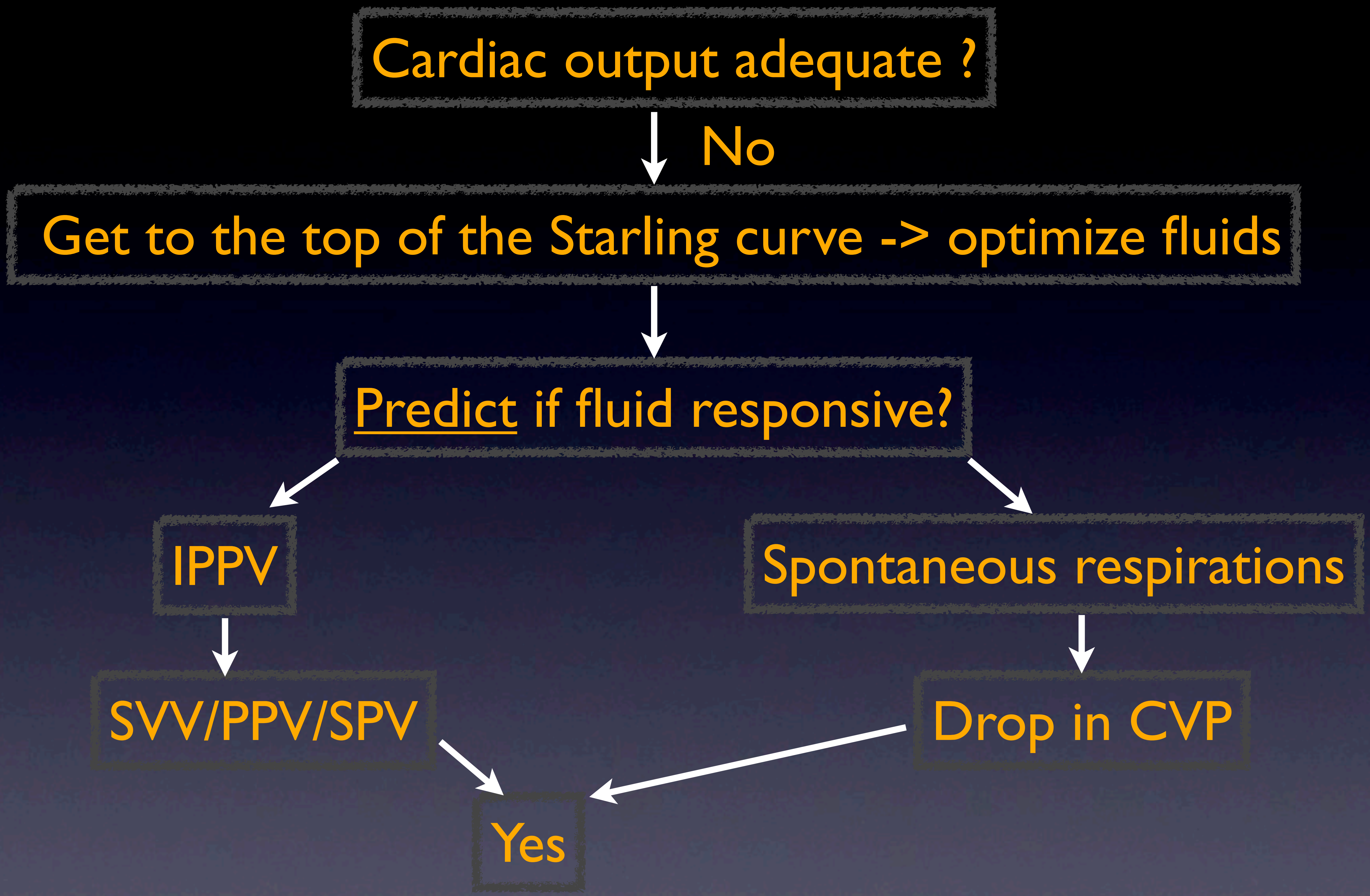
SVV/PPV/SPV

Spontaneous respirations

Drop in CVP



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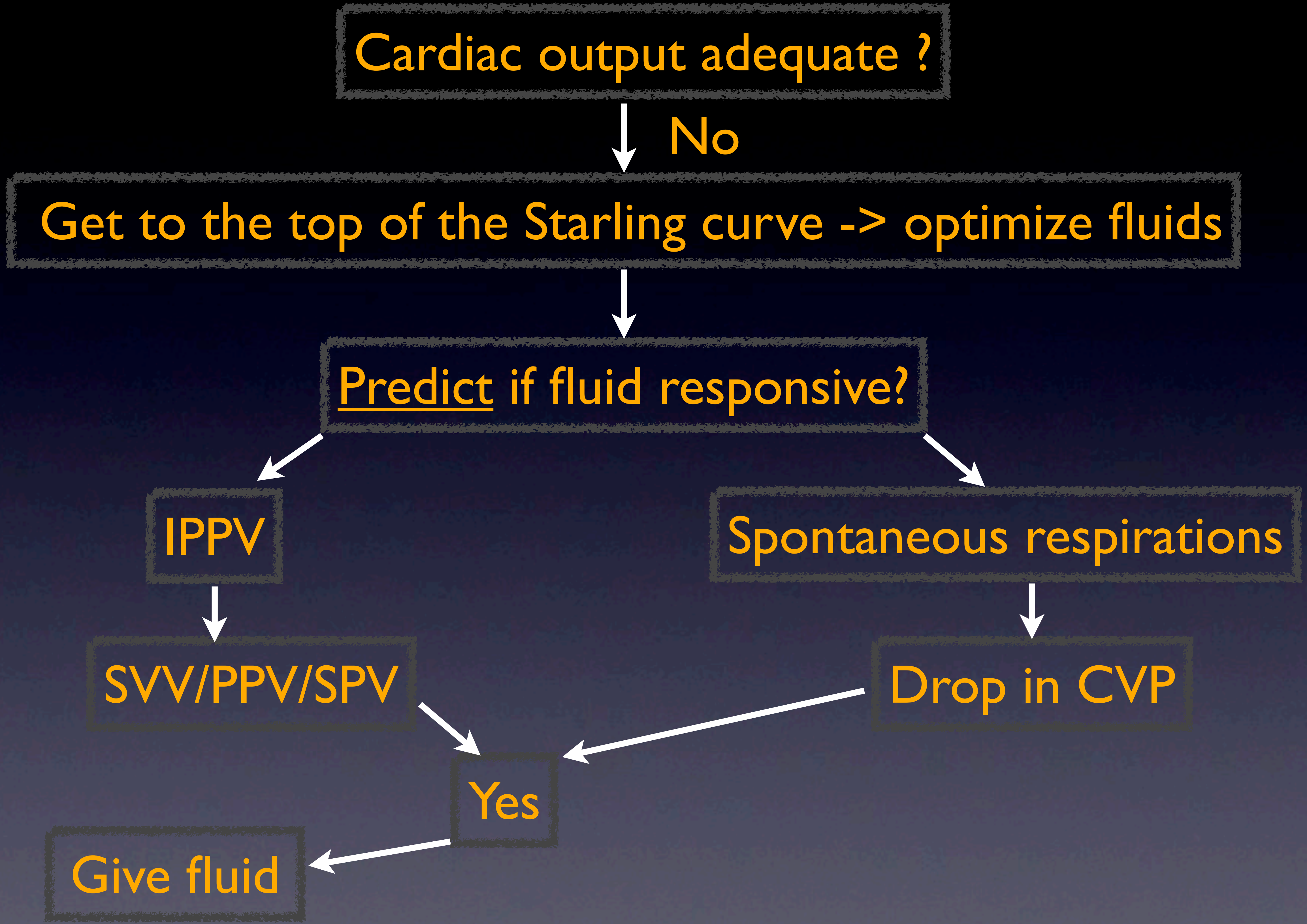
Drop in CVP
Yes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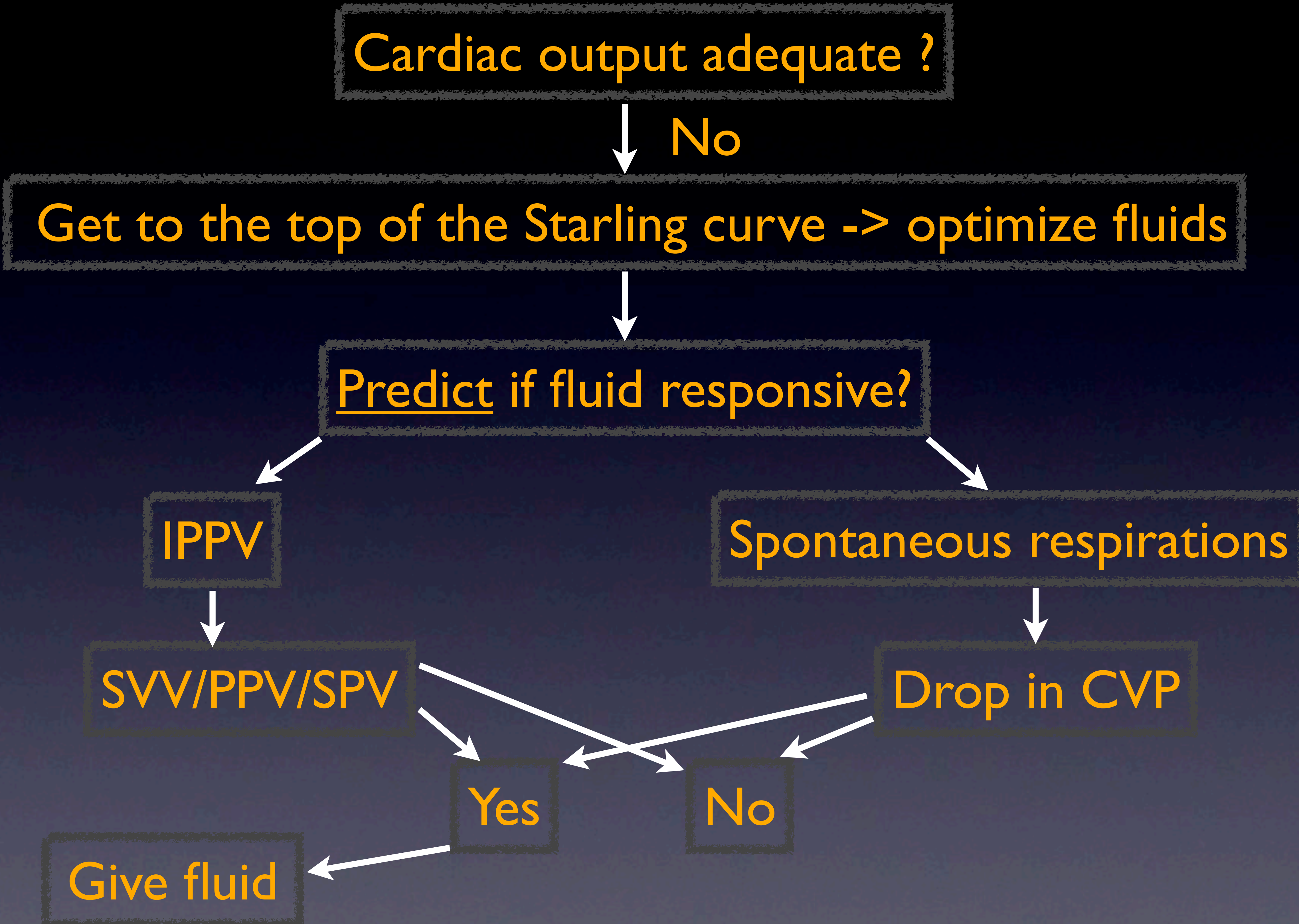
Drop in CVP
Yes
Give fluid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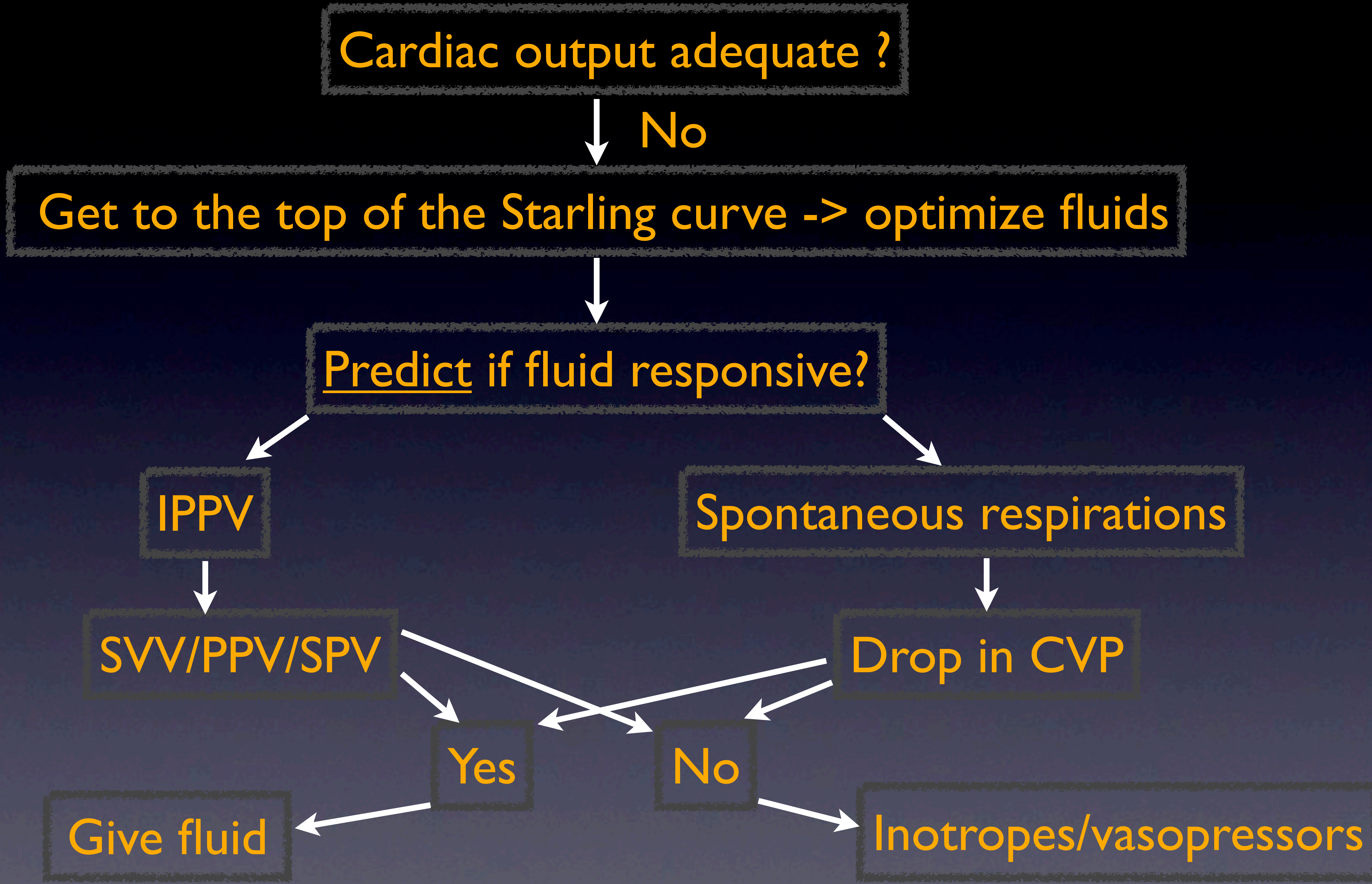
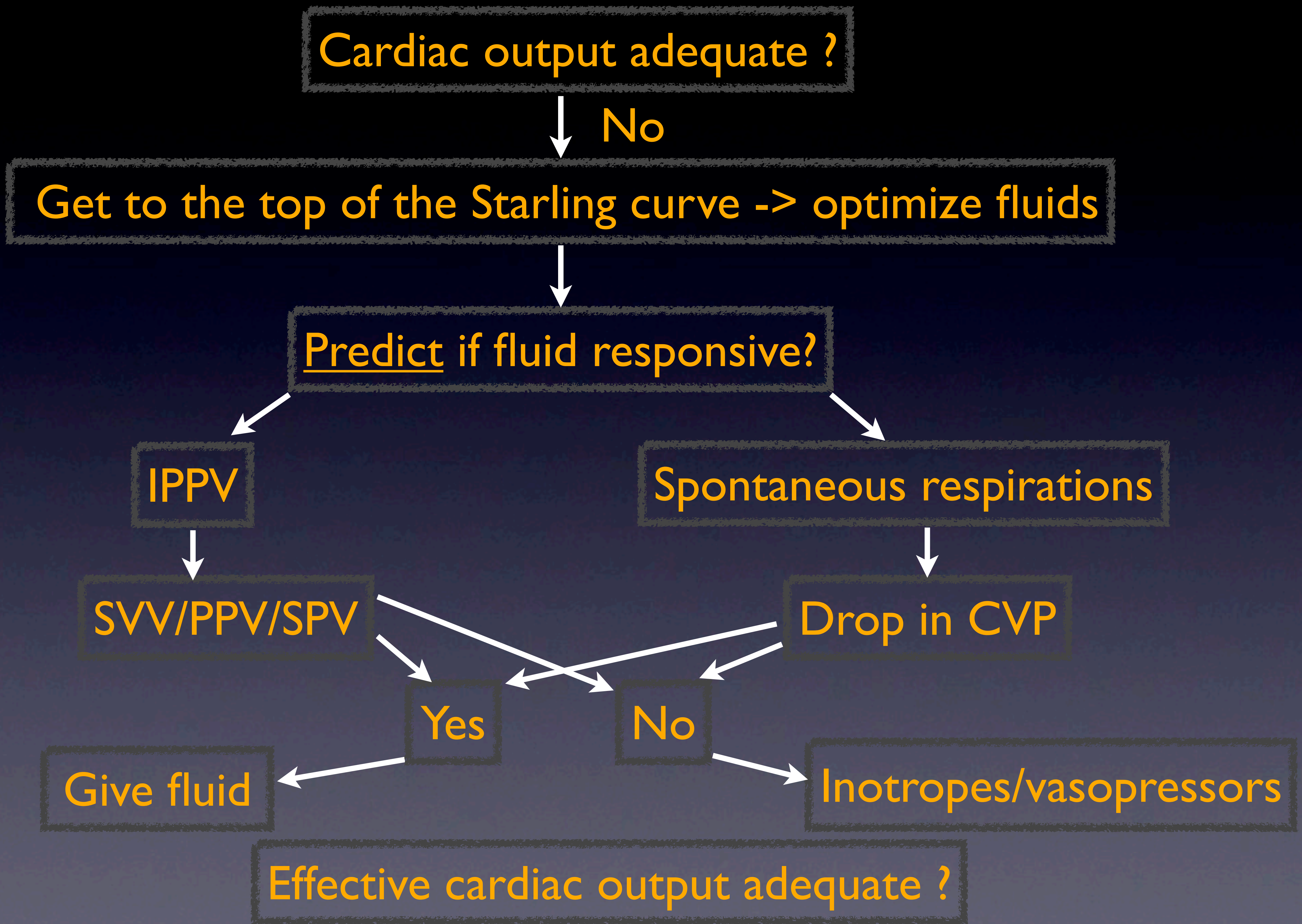
Drop in CVP
Yes
No
Give fluid


Cardiac output adequate ?
No
Get to the top of the Starling curve -> optimize fluids
Predict if fluid responsive?
IPPV
Spontaneous respirations
SVV/PPV/SPV
Drop in CVP
Yes
No
Give fluid
Inotropes/vasopressors



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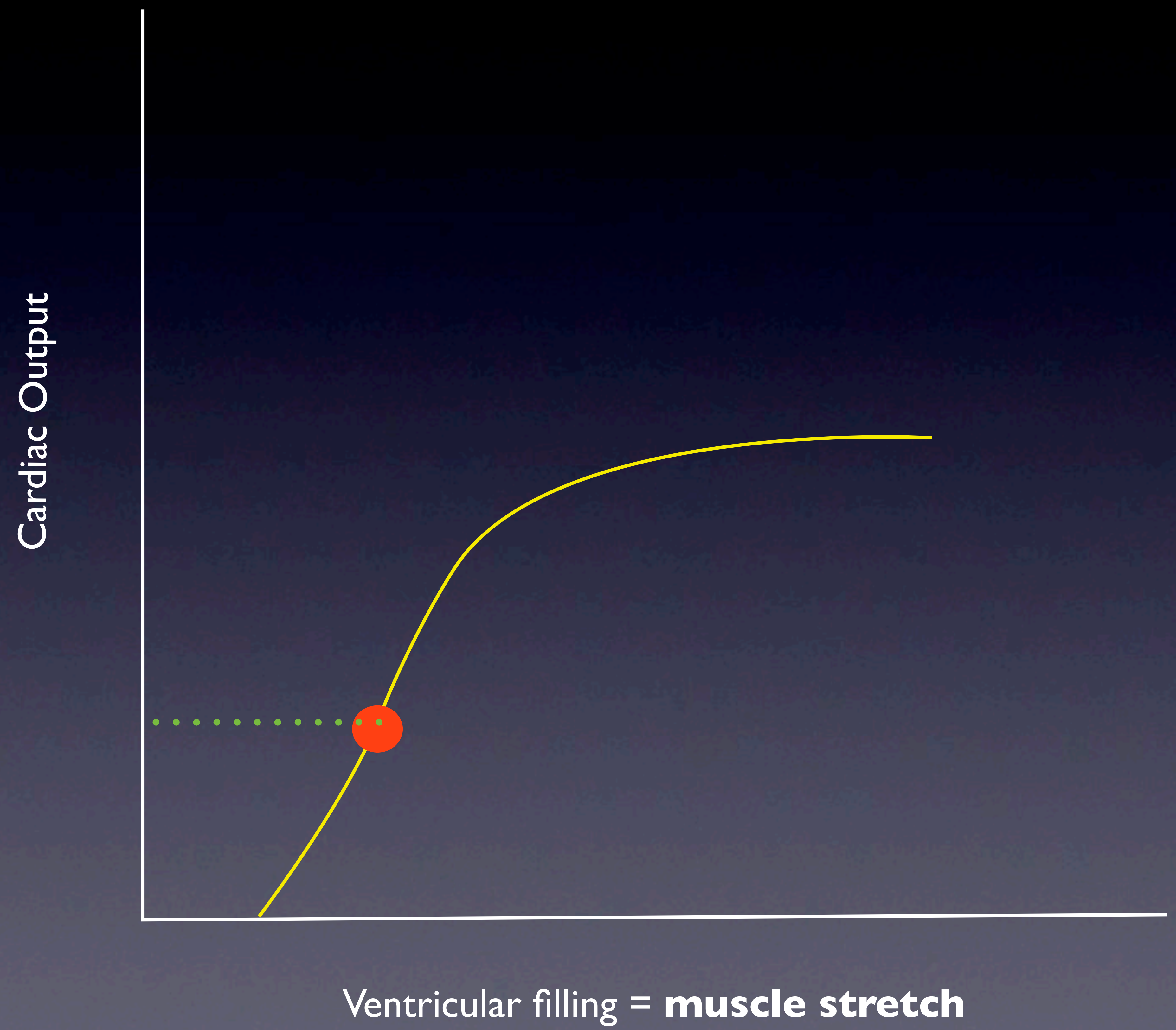
Drop in CVP
Yes
No
Give fluid
Inotropes/vasopressors
Effective cardiac output adequate ?

Achieving effective cardiac output



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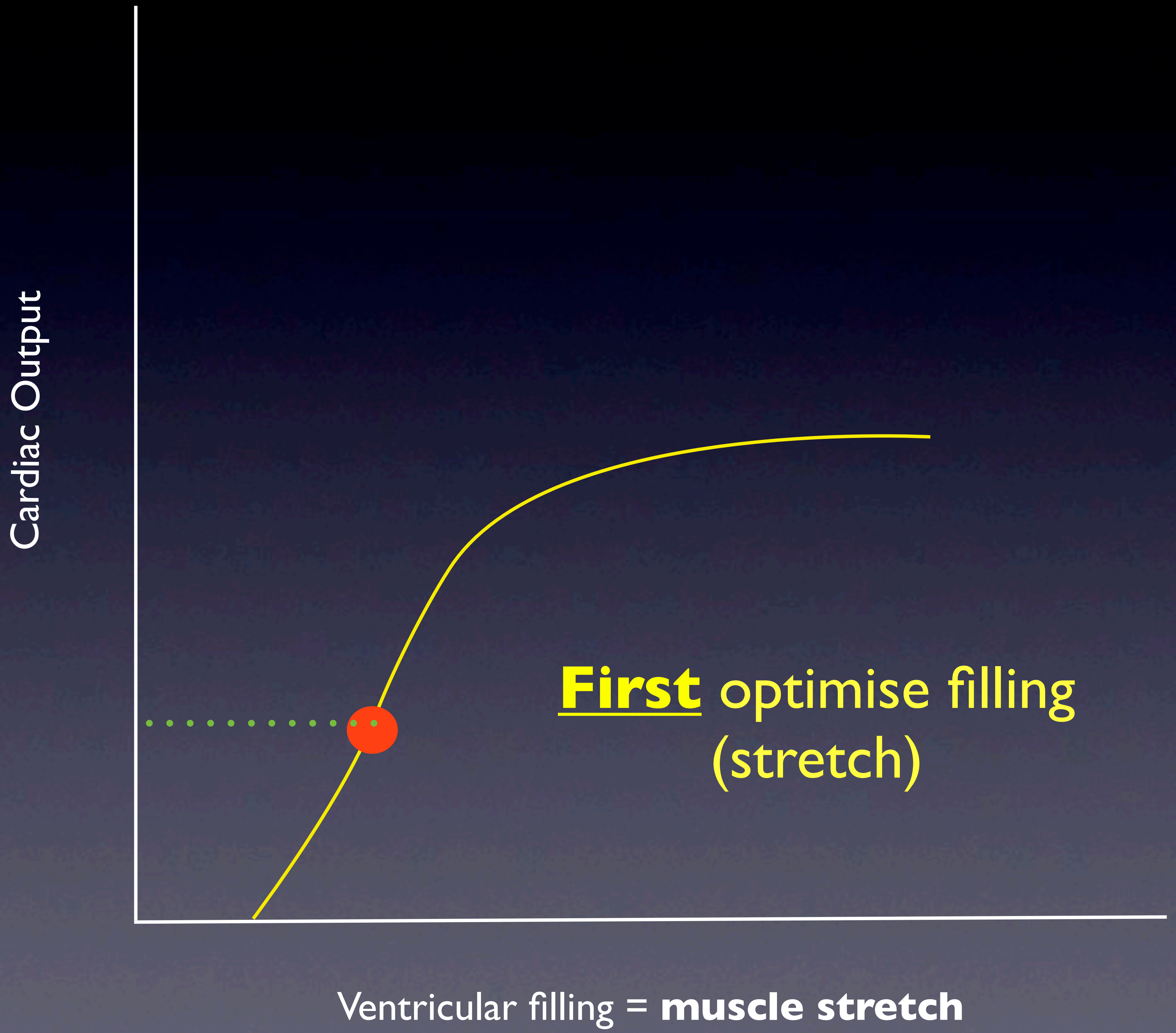

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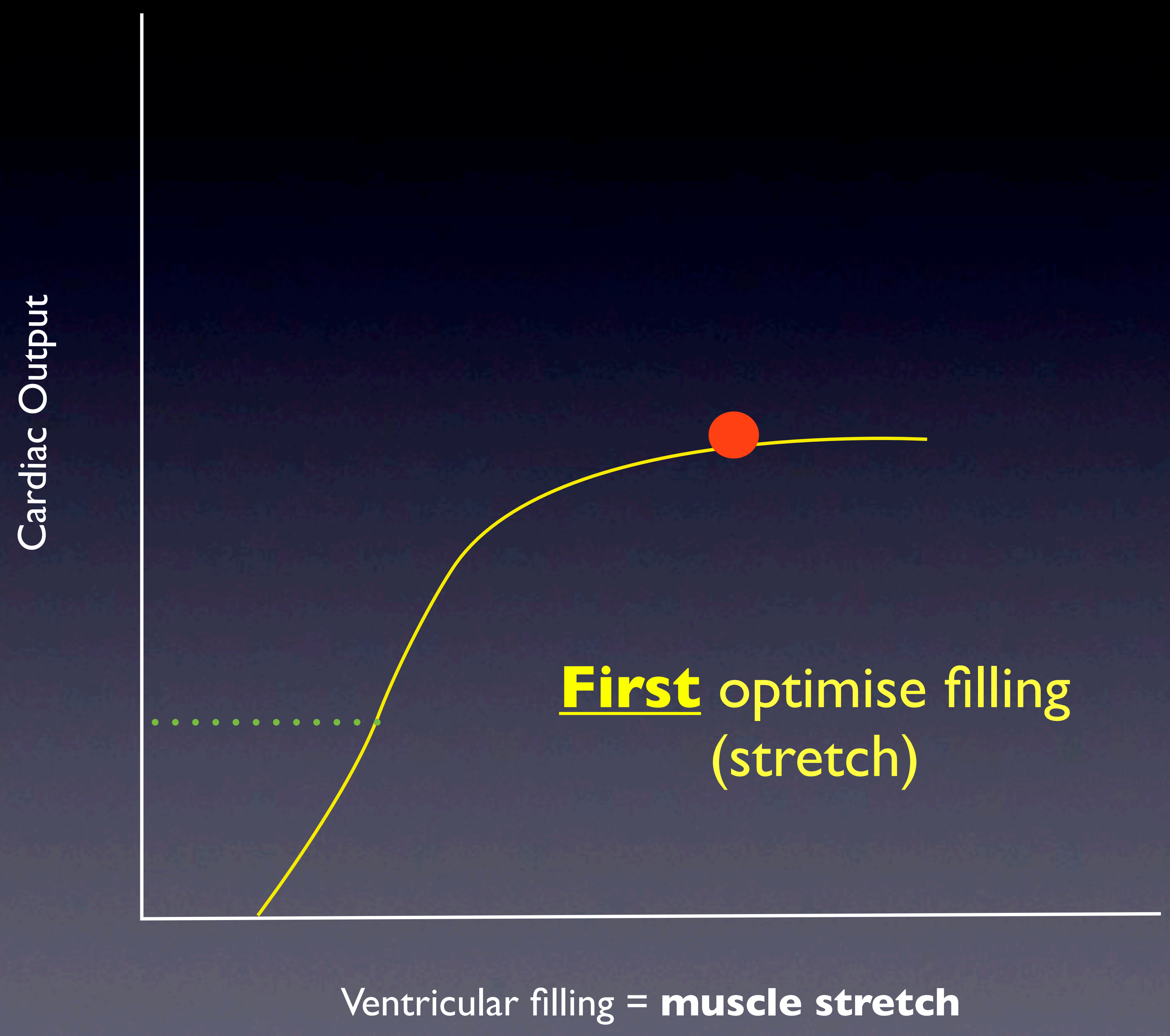

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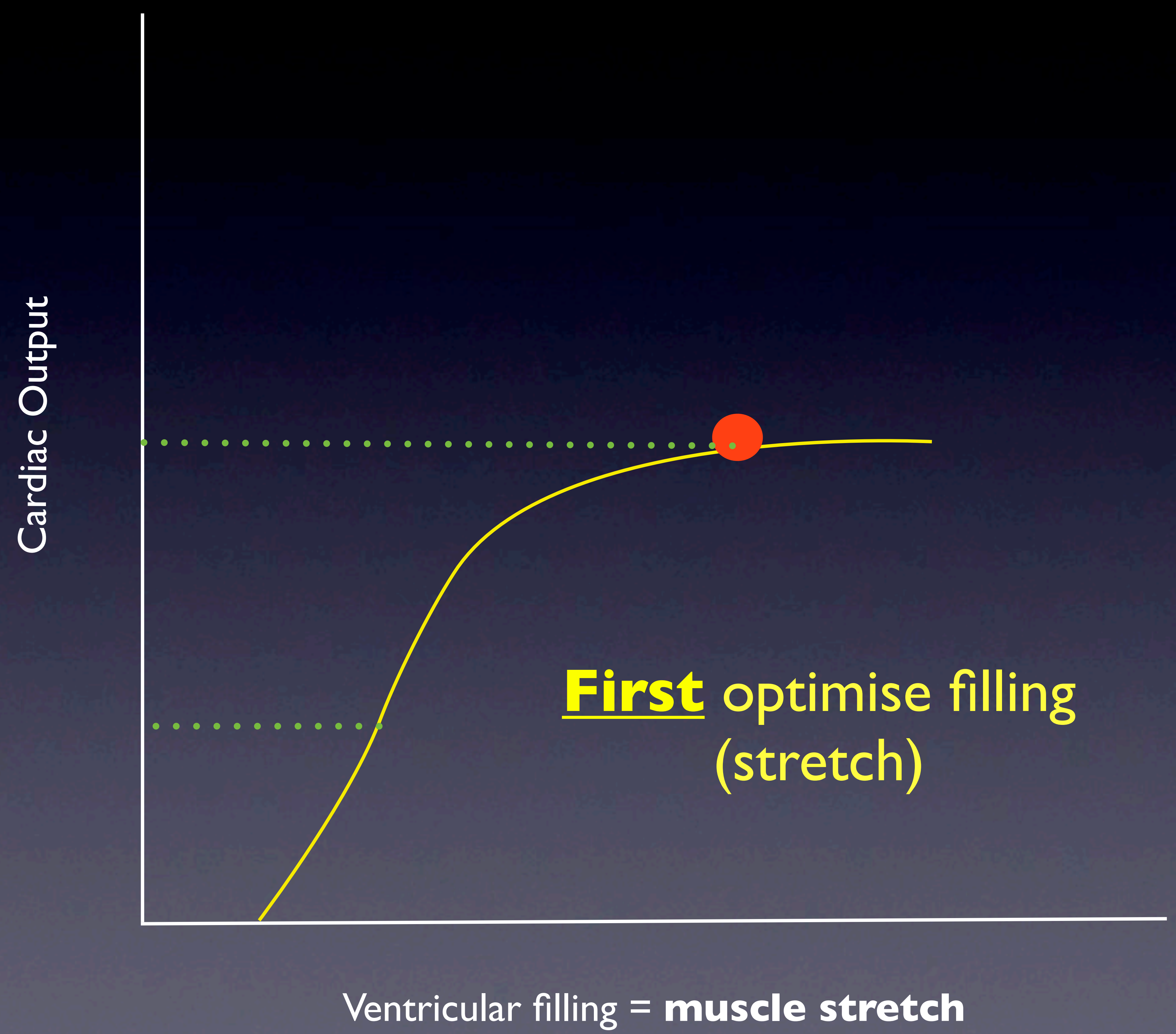

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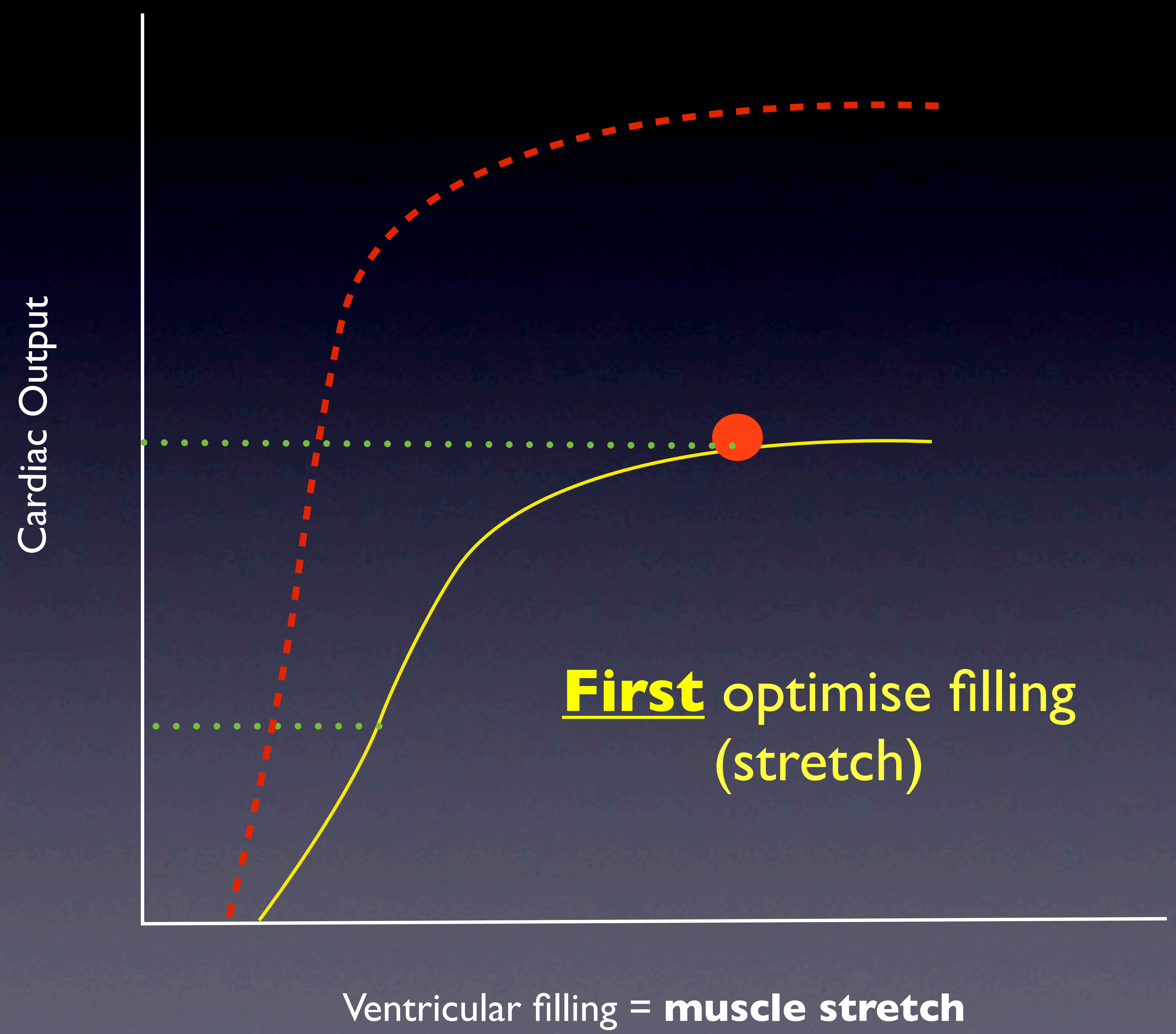

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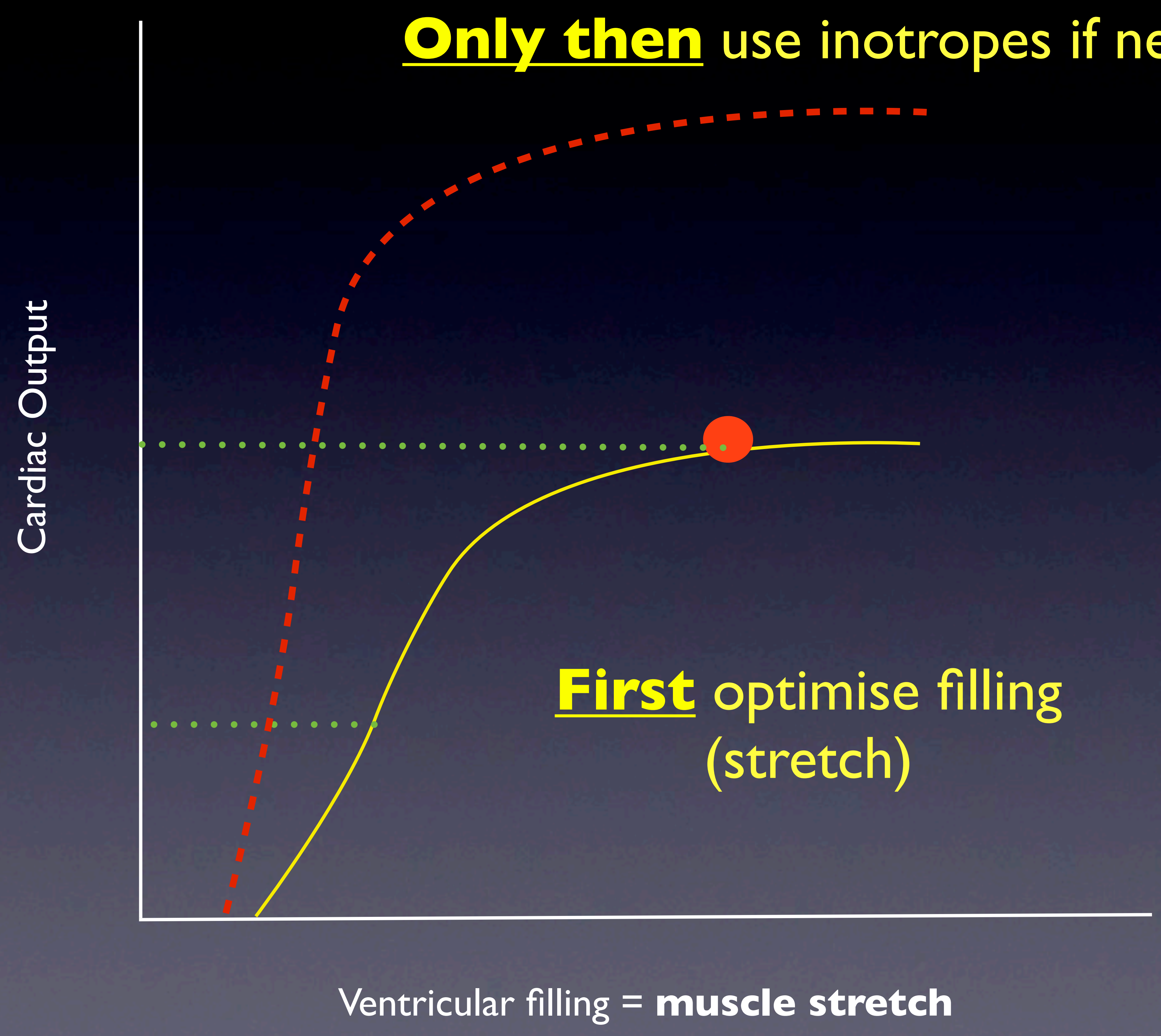

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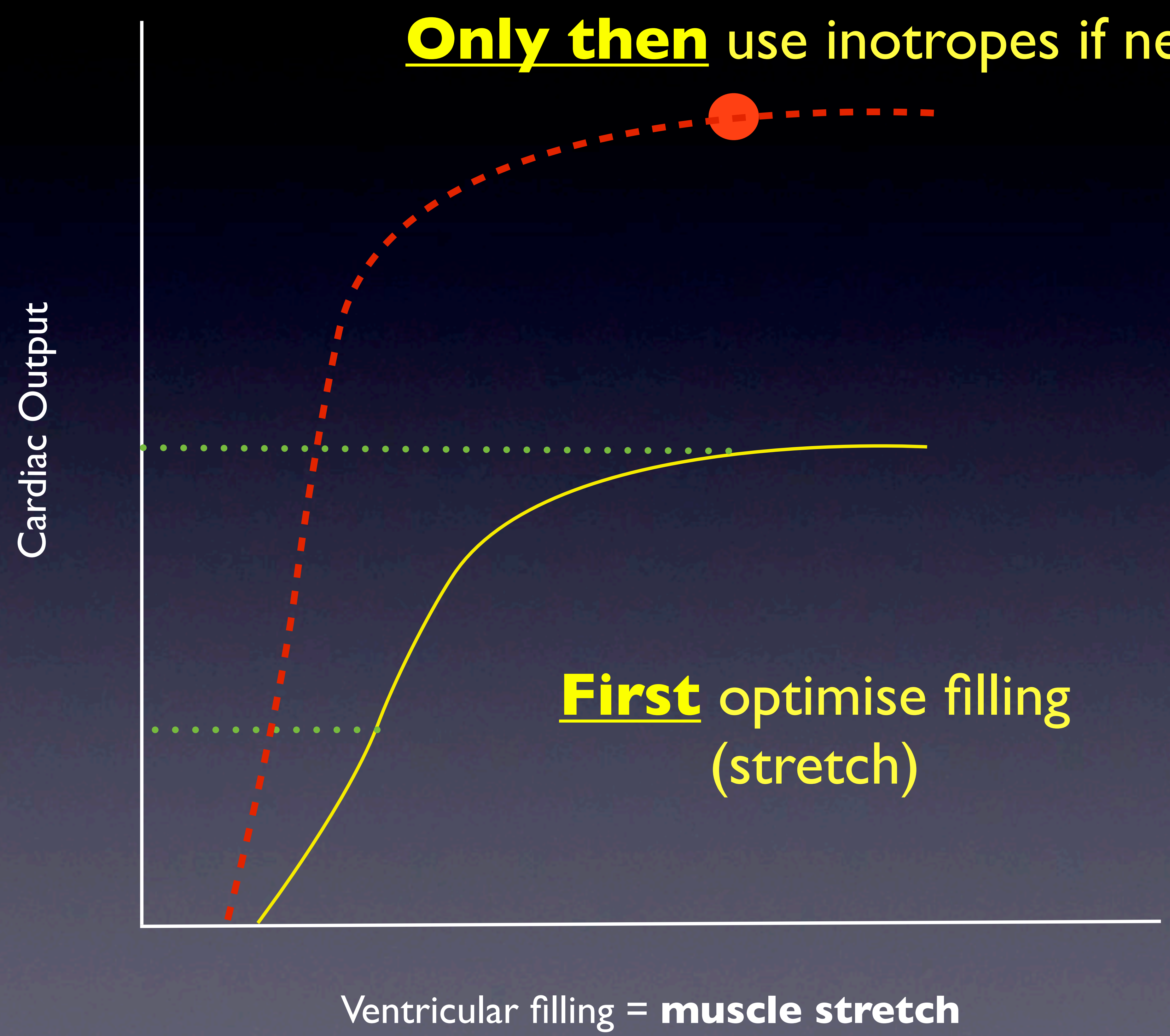

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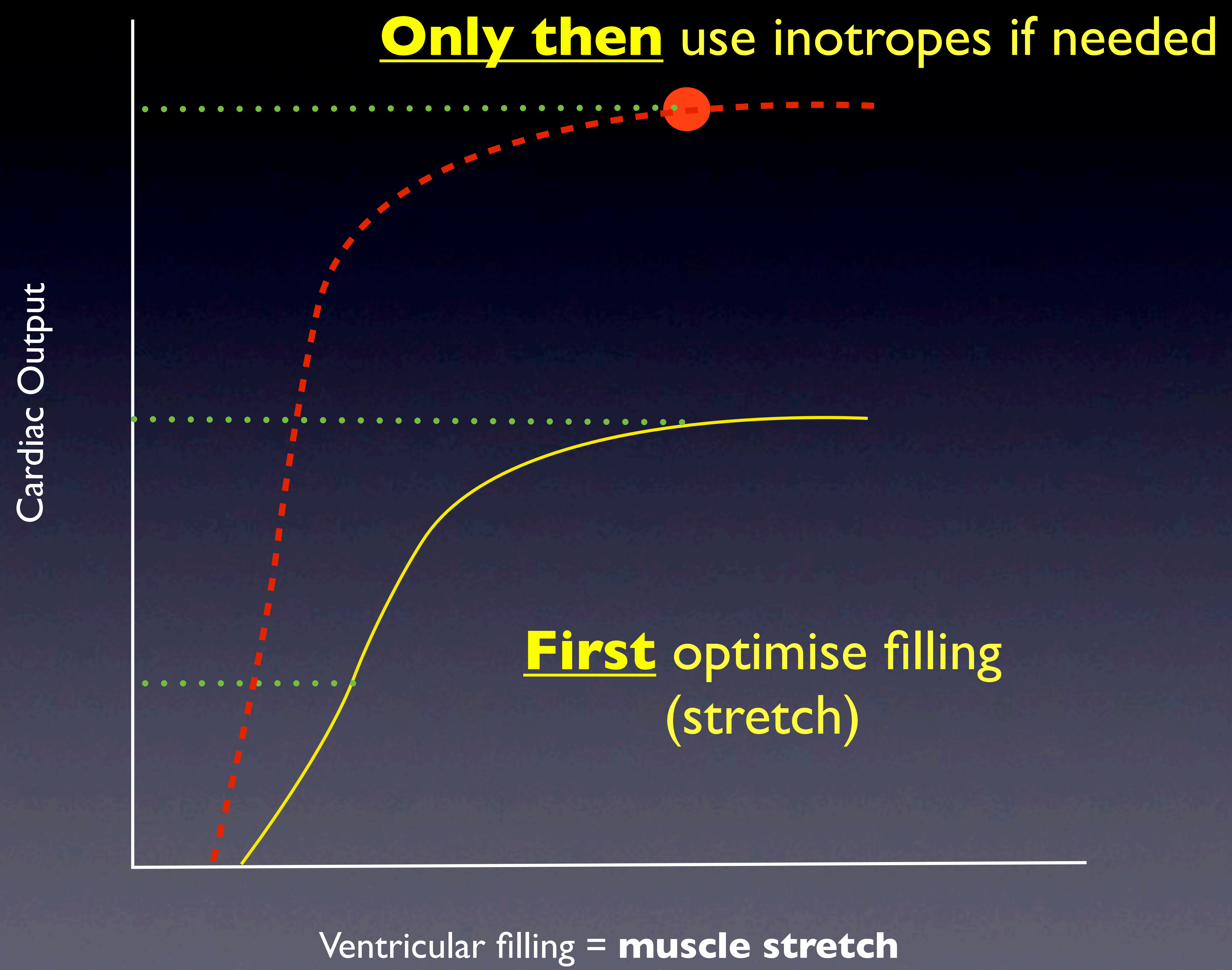

How would we assess this patients volume status?

How about the CVP ?

CHEST

Special Feature

Does Central Venous Pressure Predict Fluid Responsiveness?*

A Systematic Review of the Literature and the Tale of Seven Mares

Paul E. Marik, MD, FCCP; Michael Baram, MD, FCCP; and Bobbak Vahid, MD

Chest 2008; 134:172-178

CHEST

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"CVP should <u>not</u> be used to make clinical decisions regarding fluid management."

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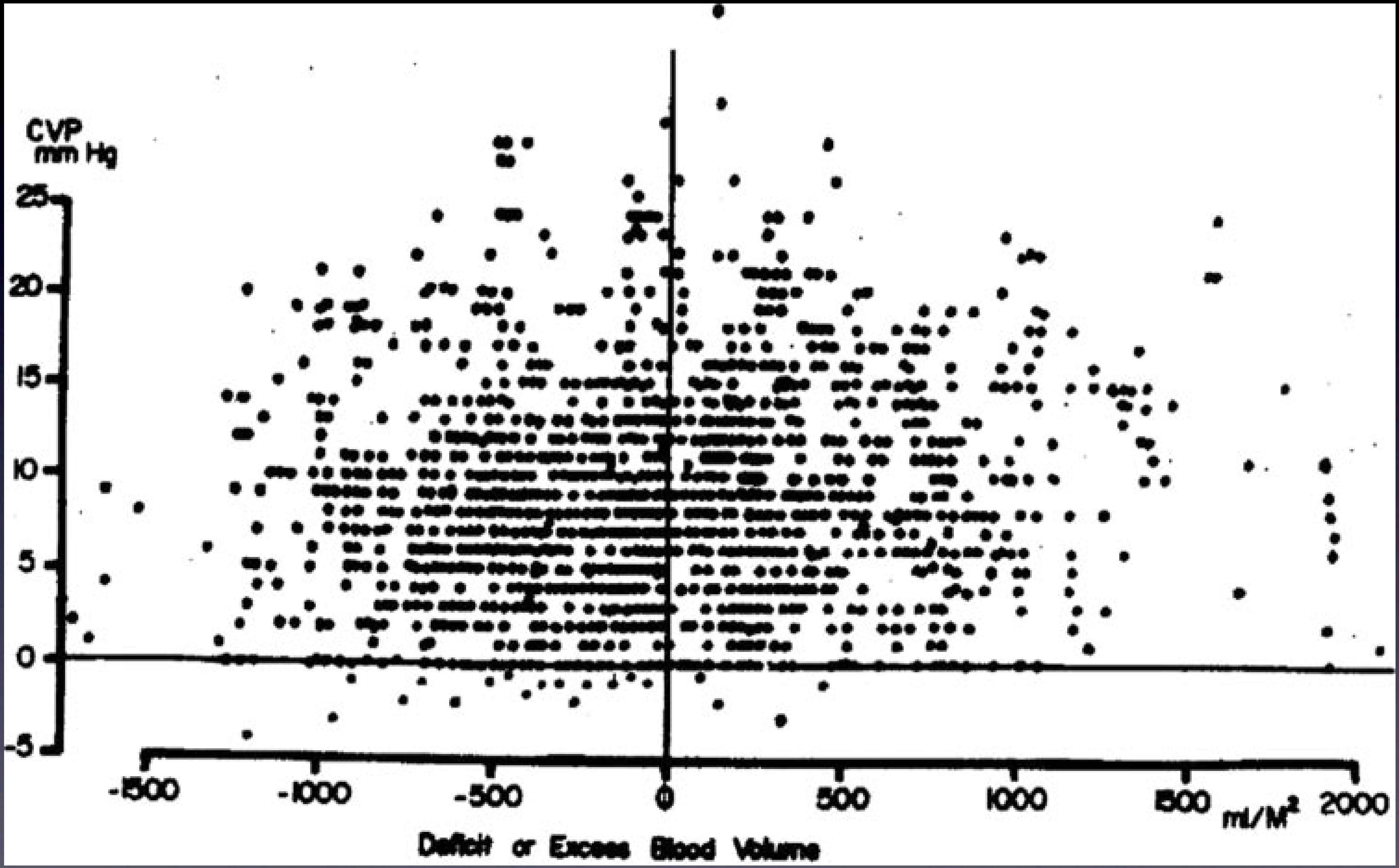
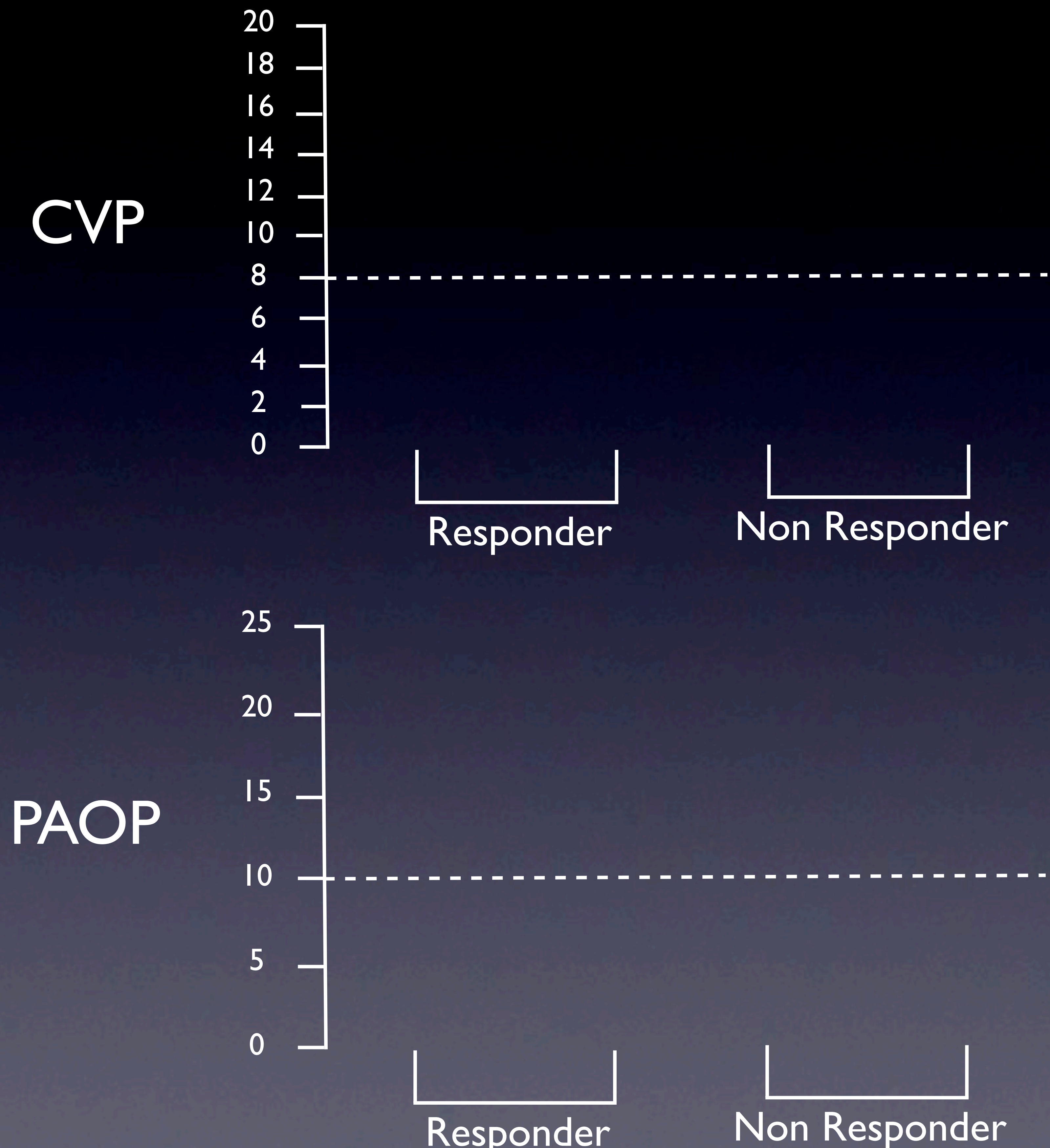
Chest 2008; 134:172-178

But......no correlation between CVP and hemodynamic response to fluid!

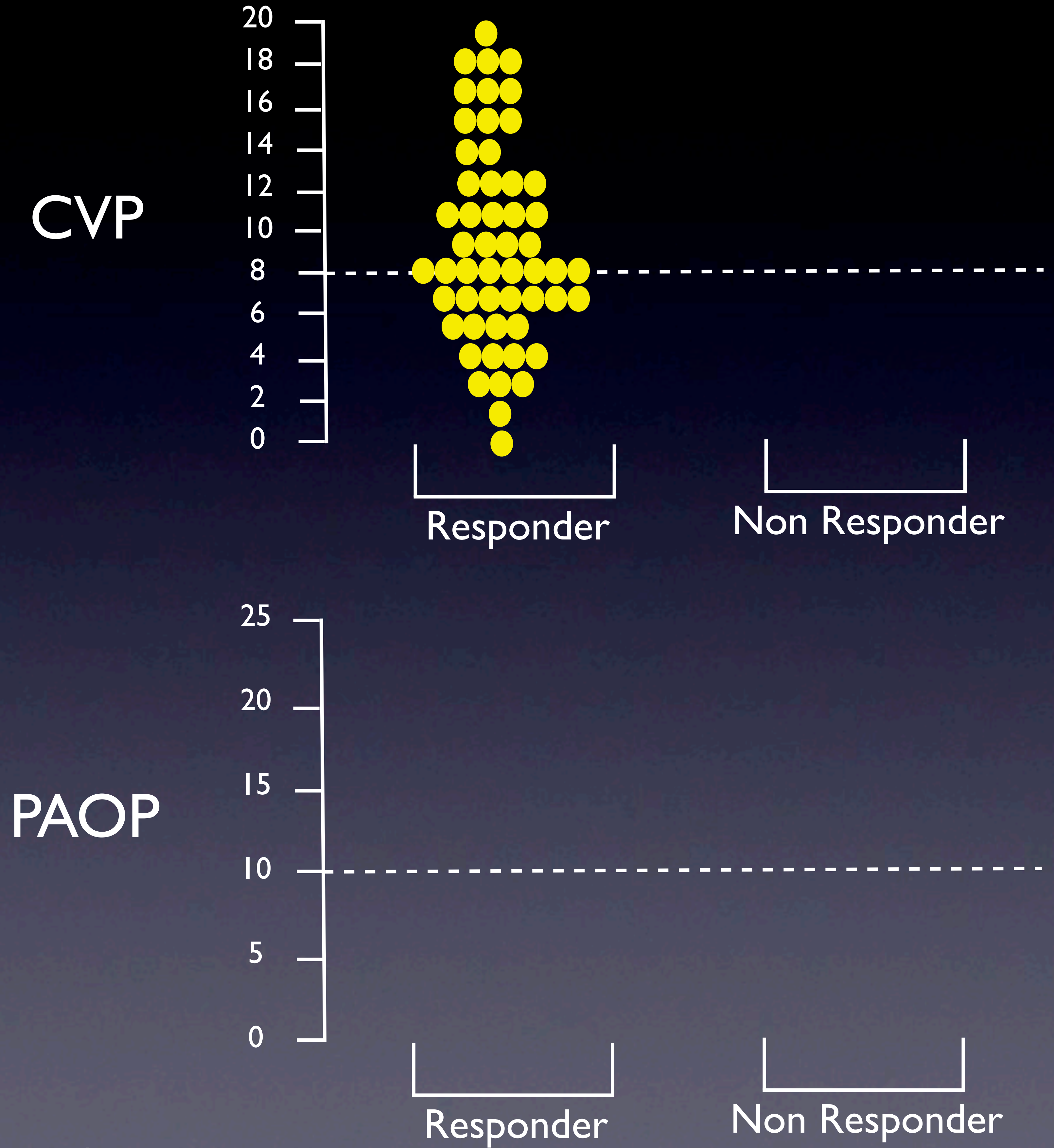


(r=0.27)

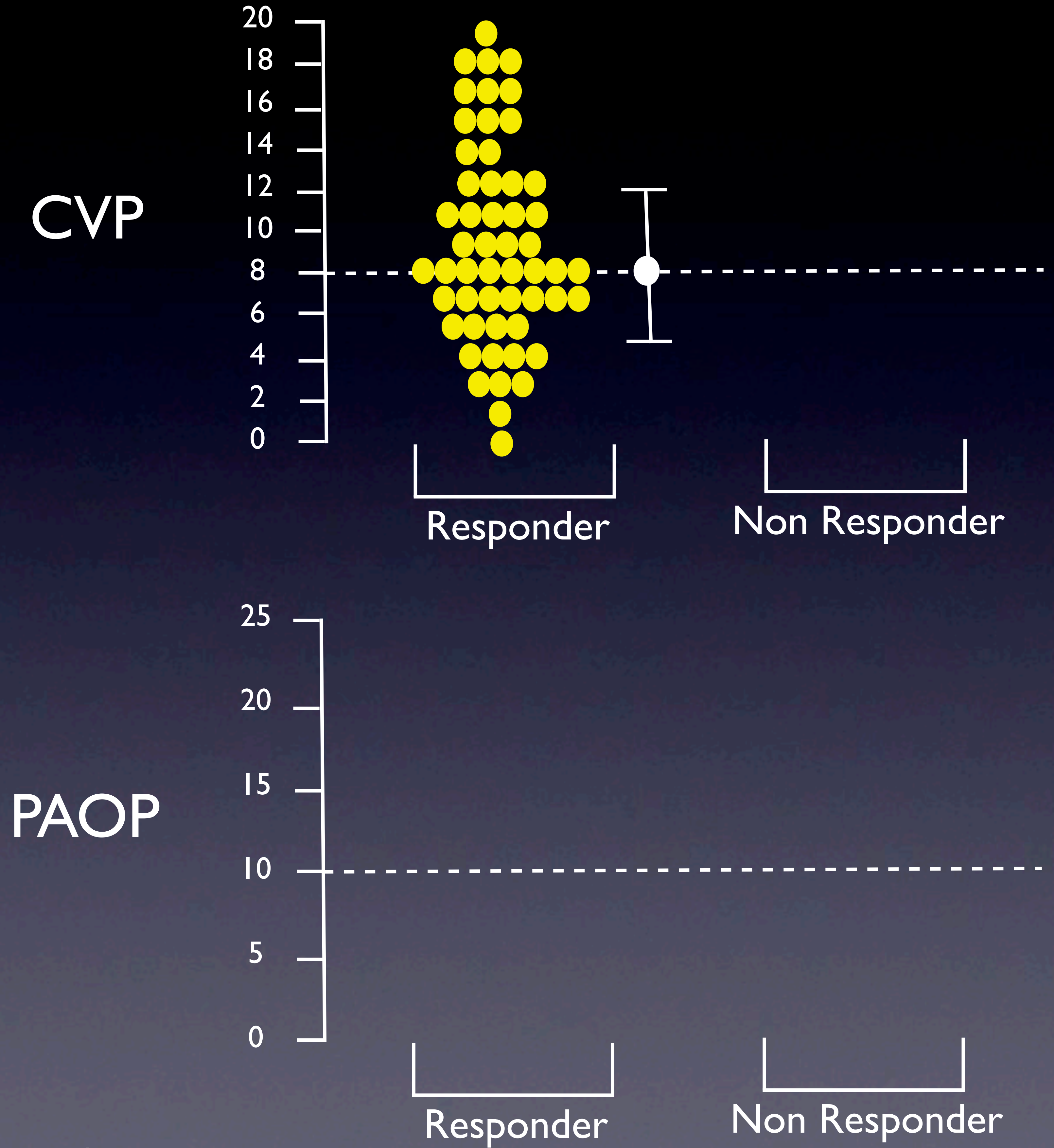
Crit Care Med 1984; 12:107–112



Crit Care Med 2007 Vol. 35, No.

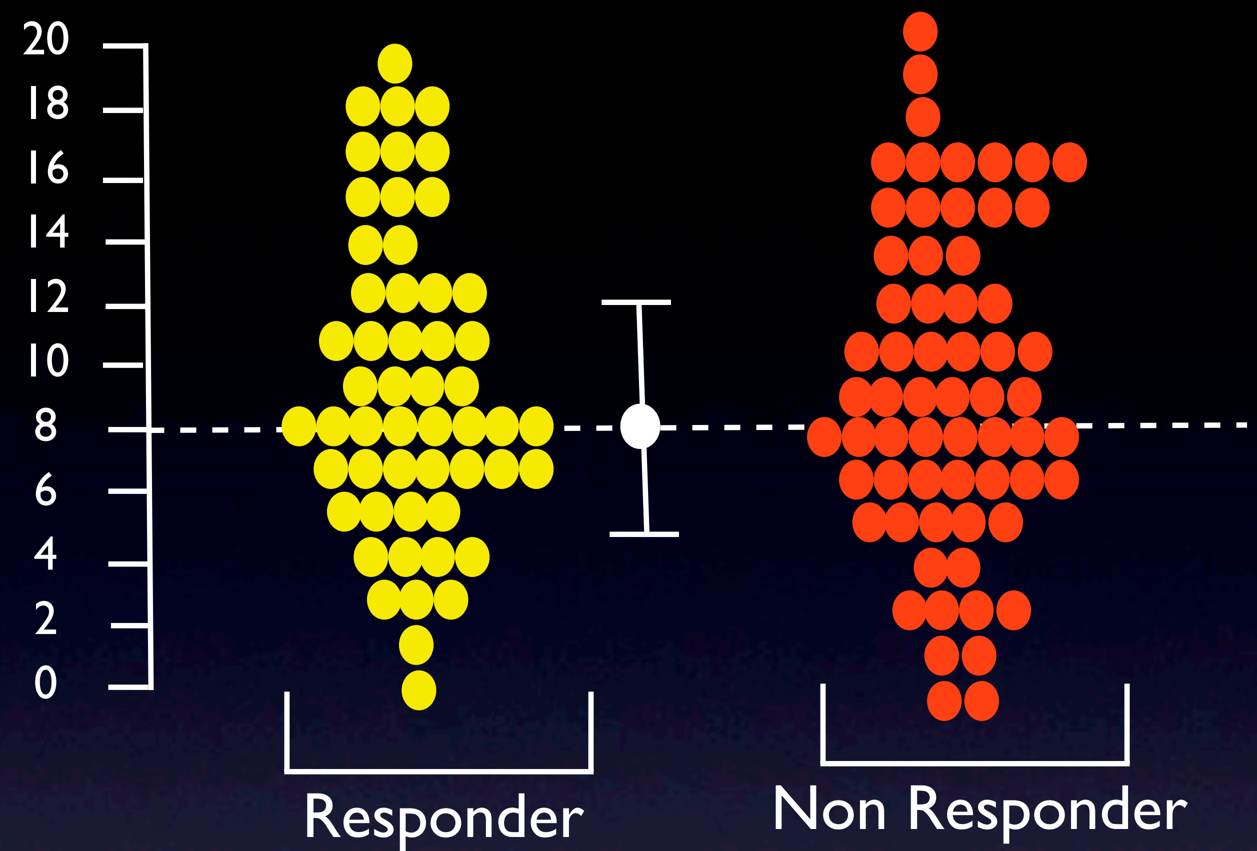


Crit Care Med 2007 Vol. 35, No.

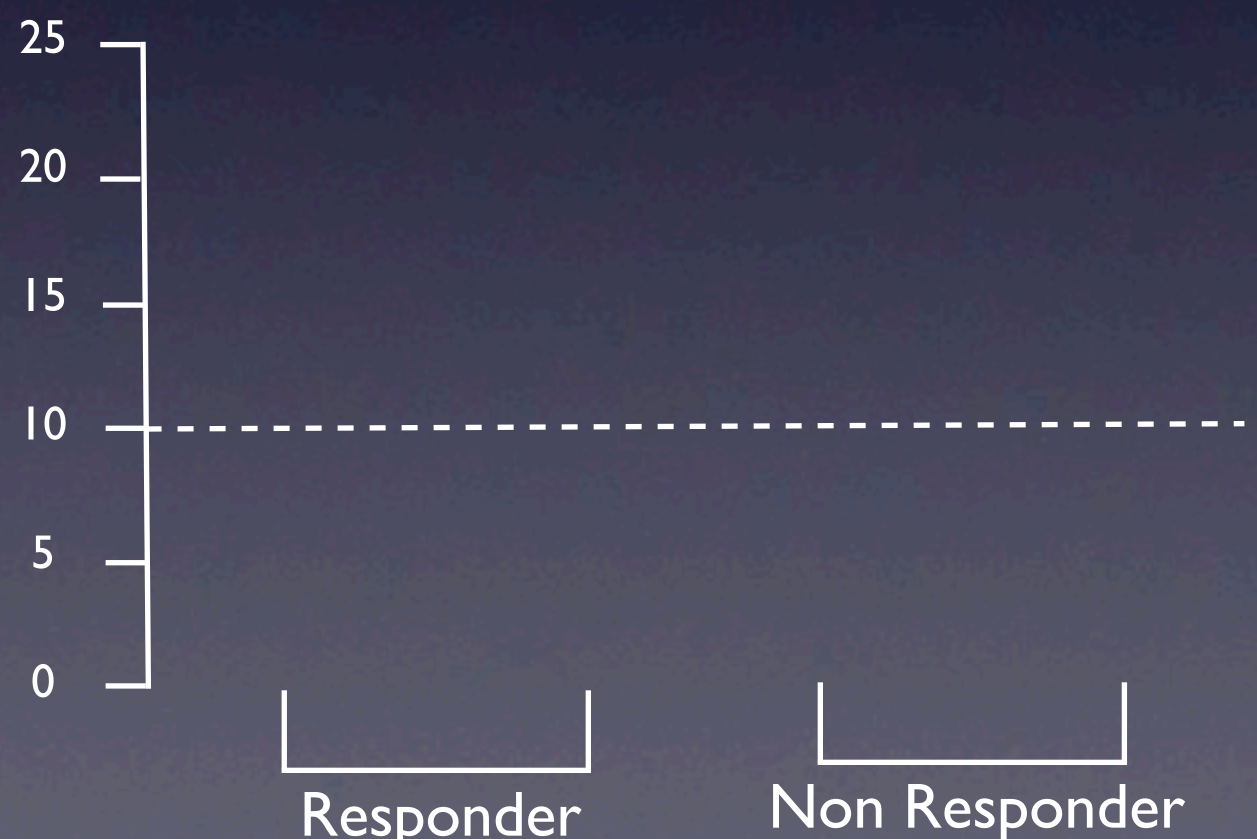


Crit Care Med 2007 Vol. 35, No.

CVP



PAOP



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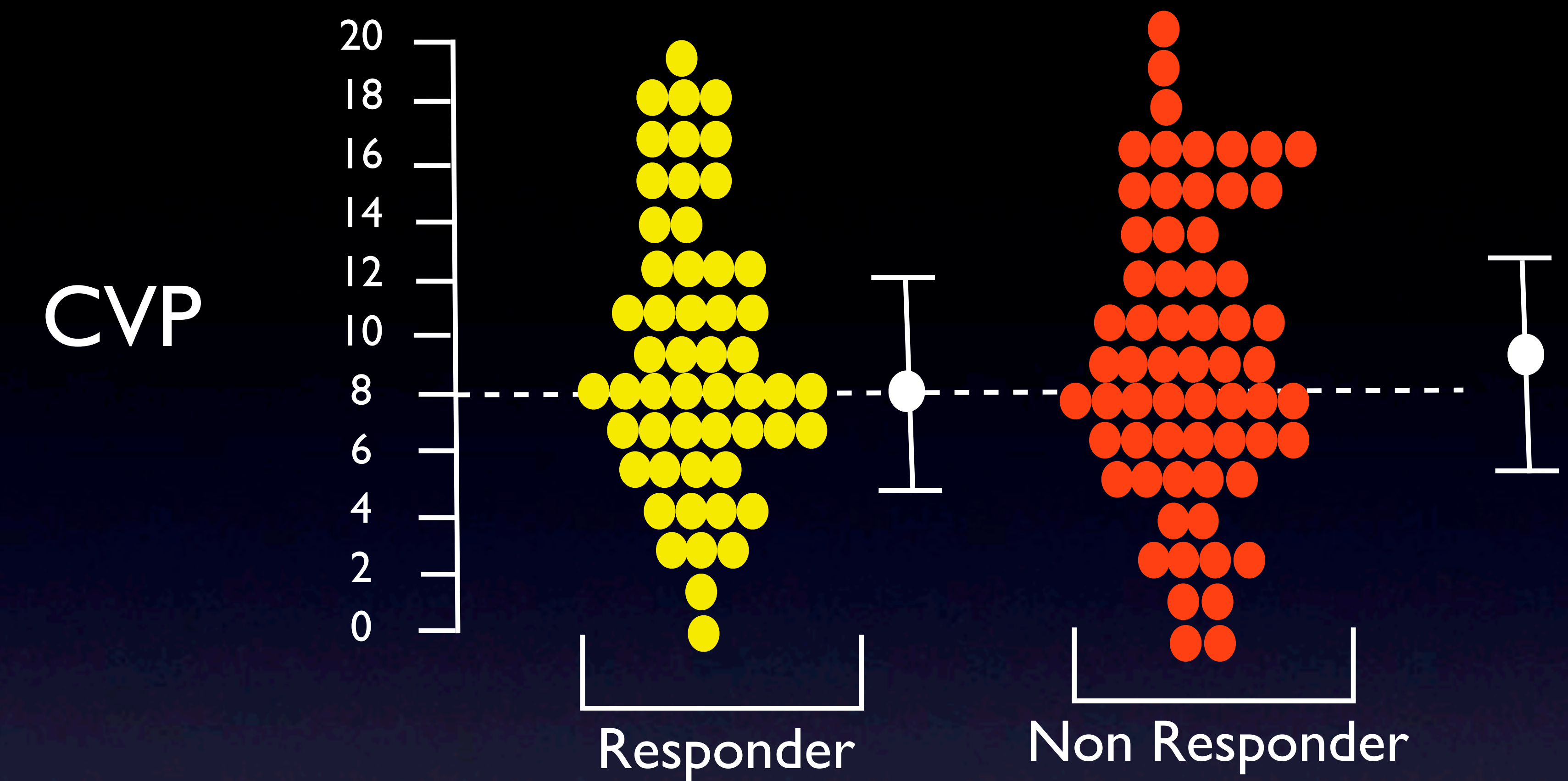

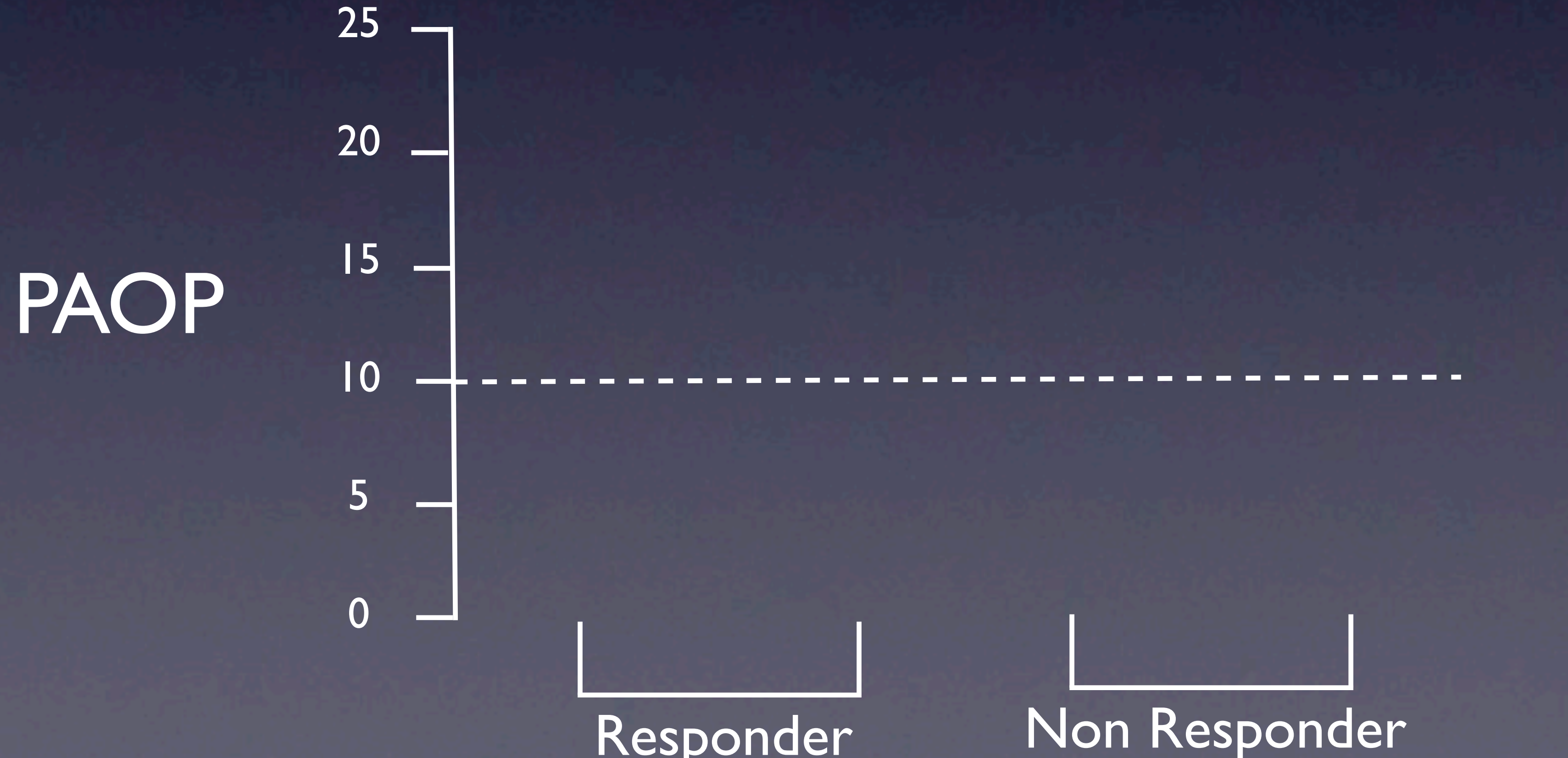

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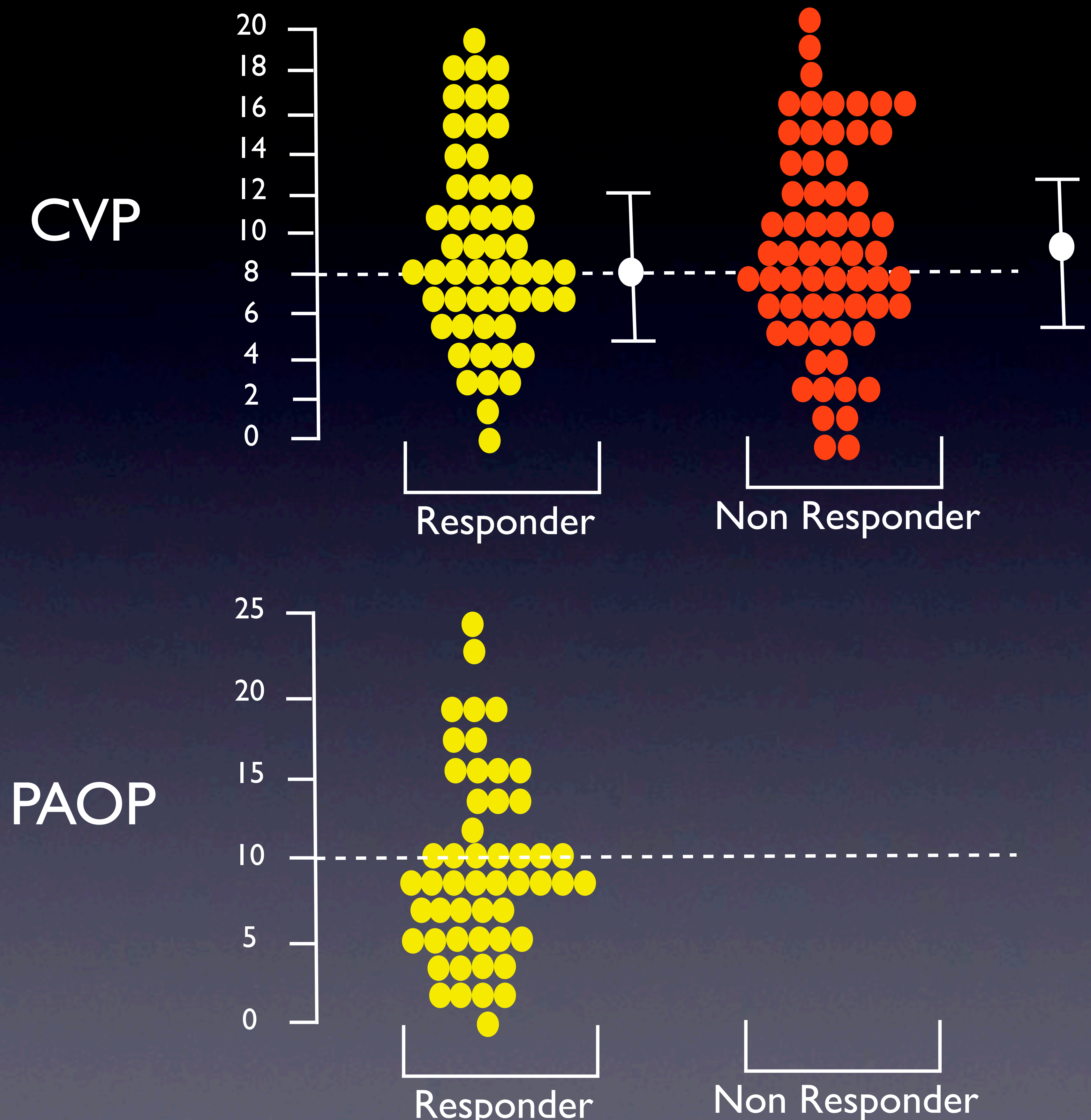

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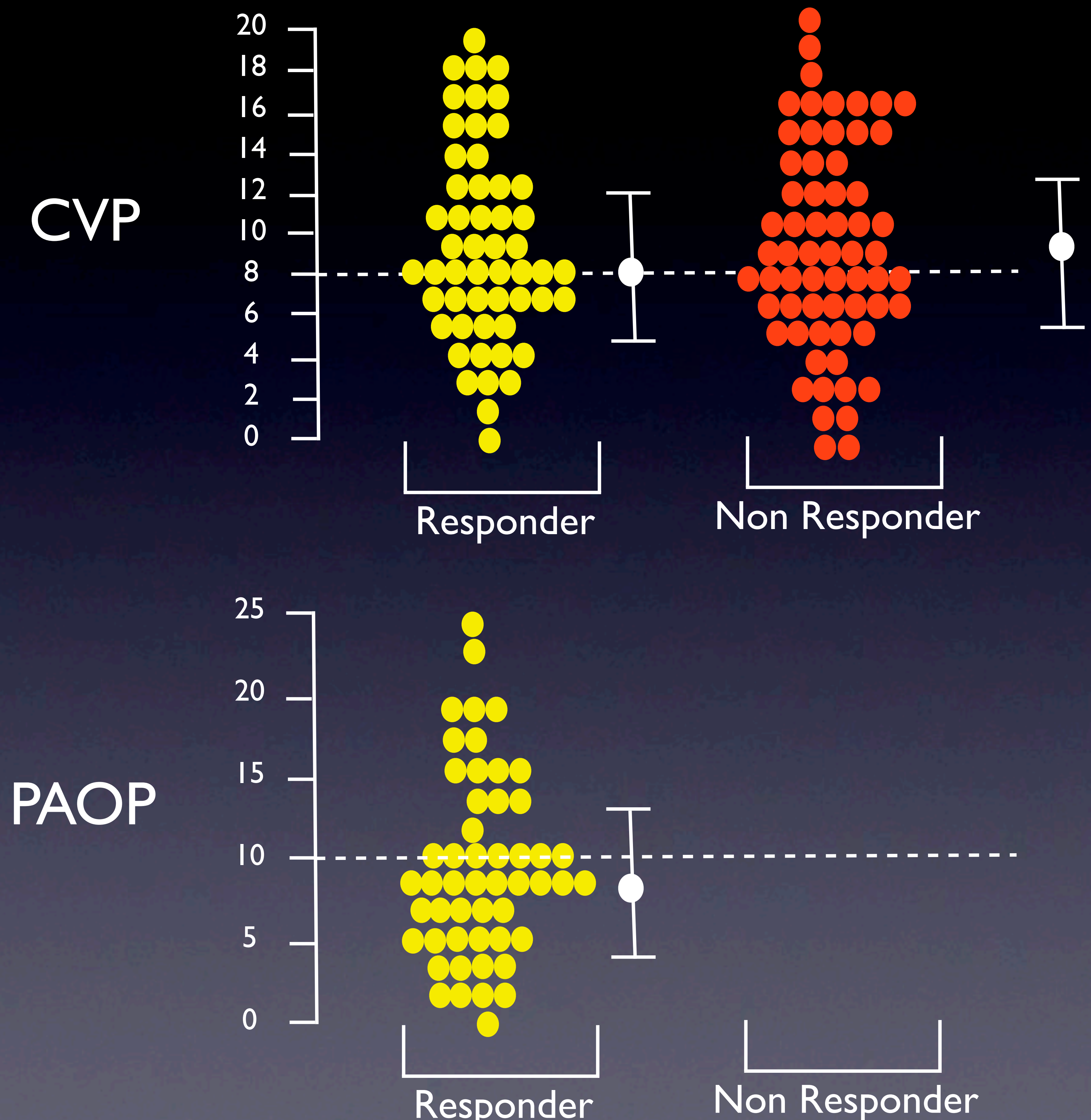

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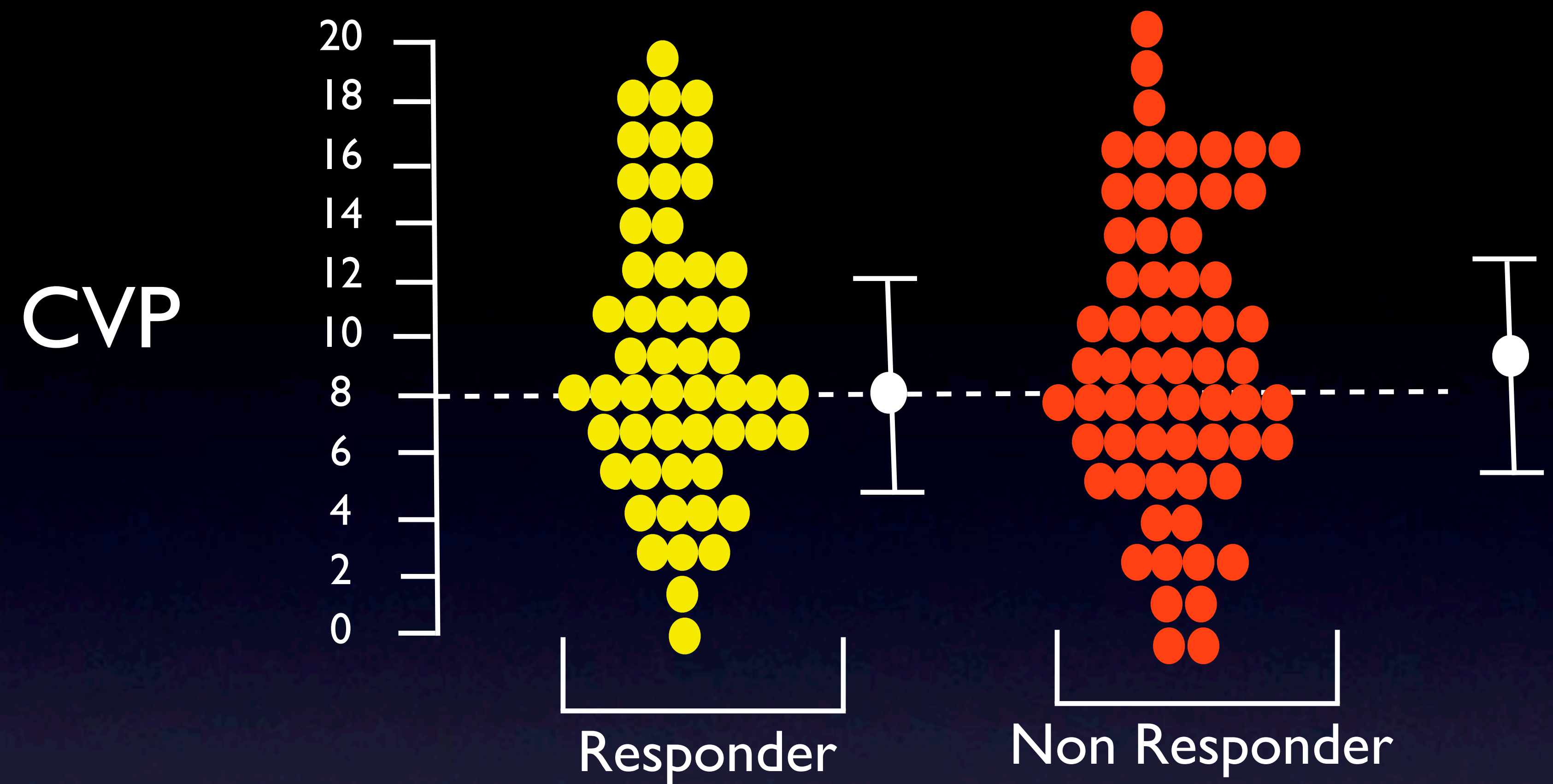

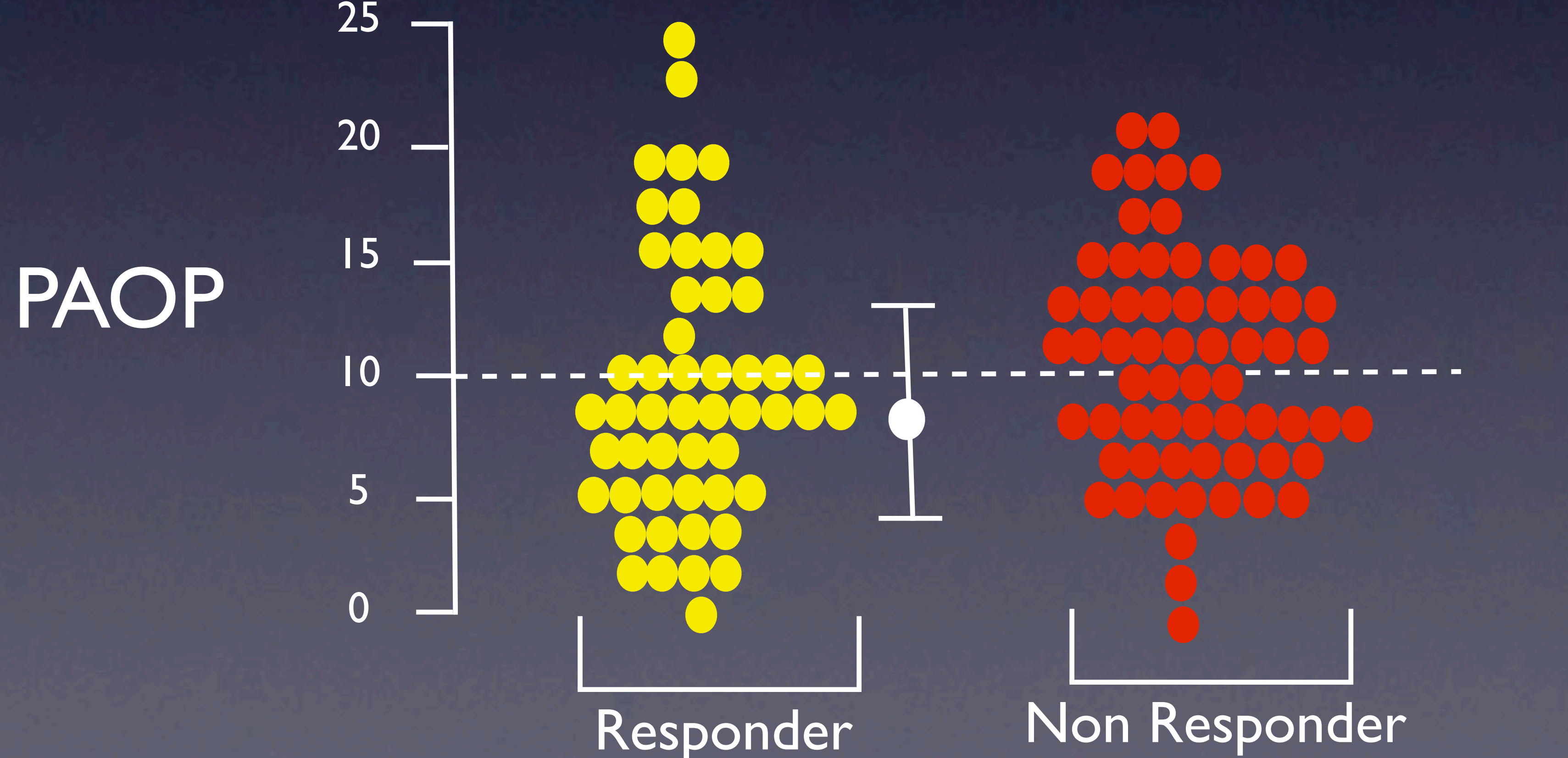

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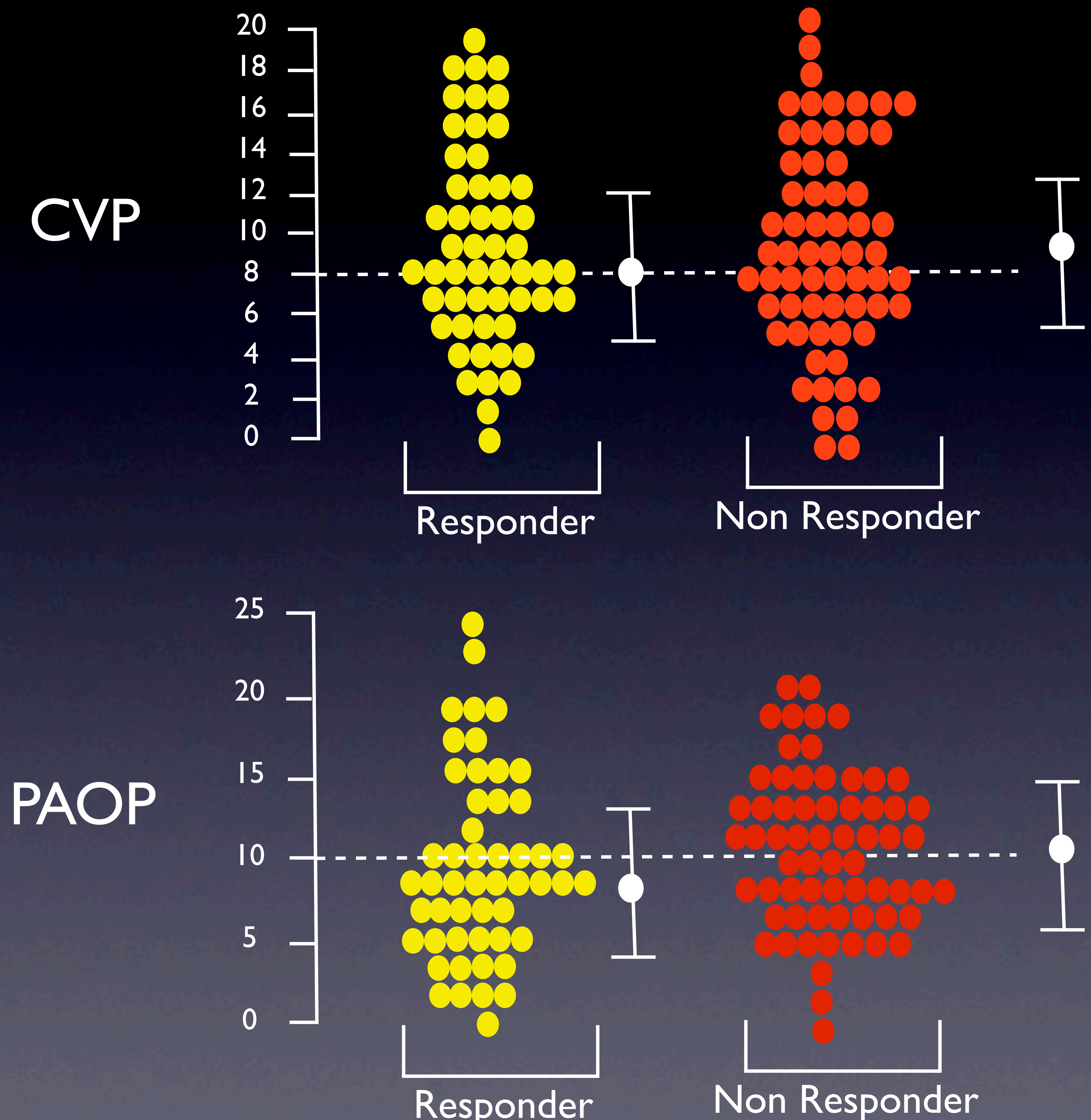

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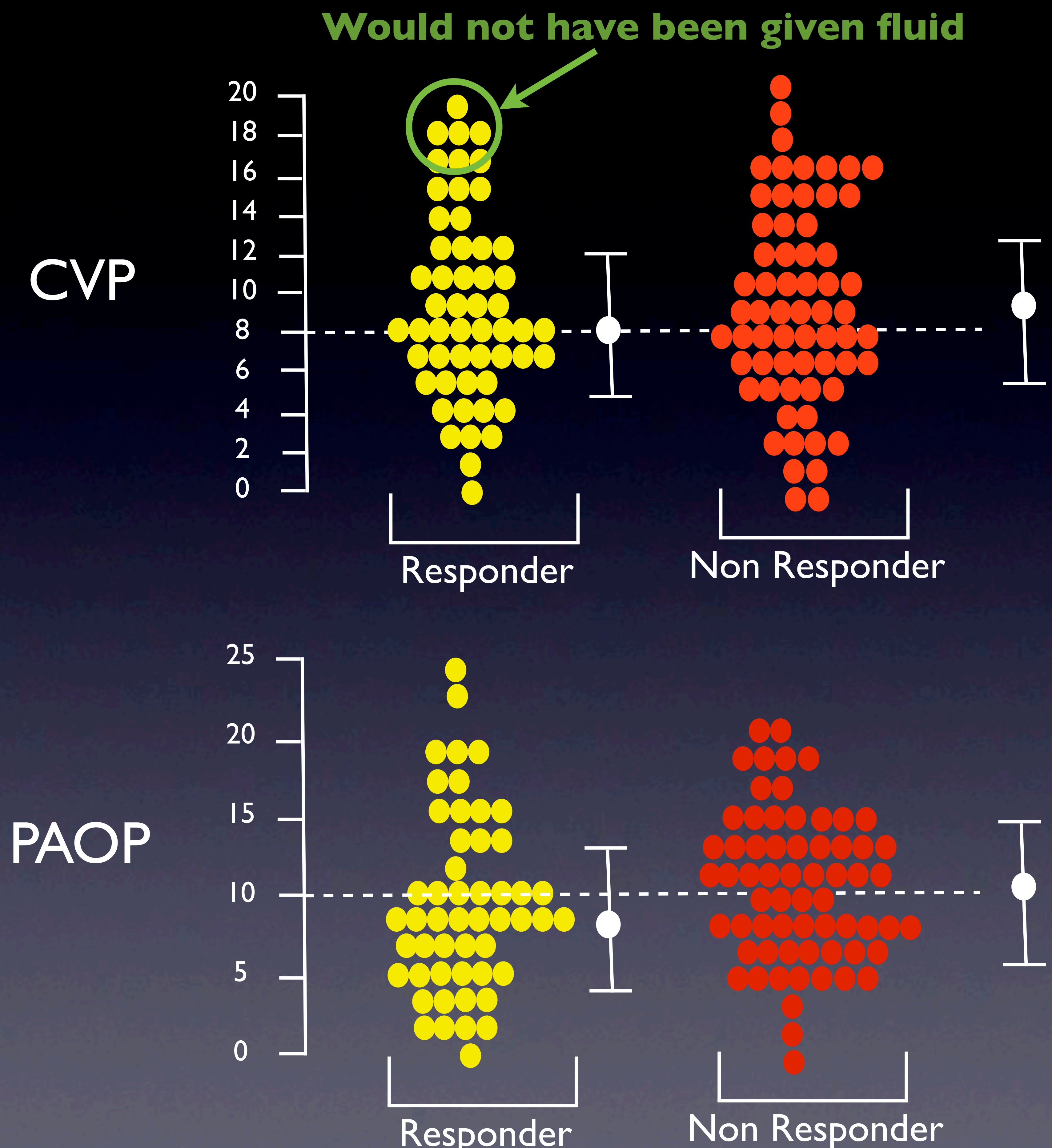

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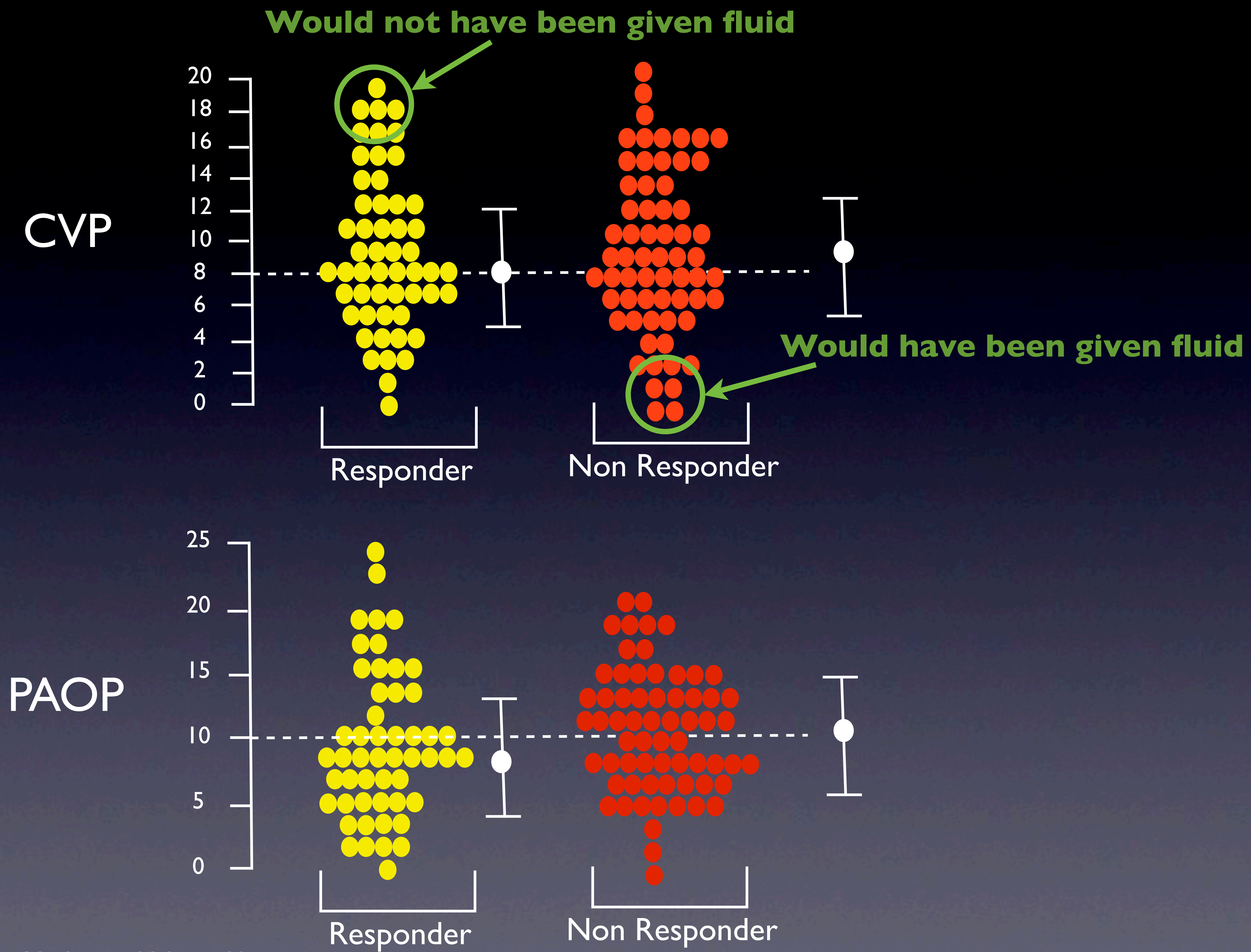
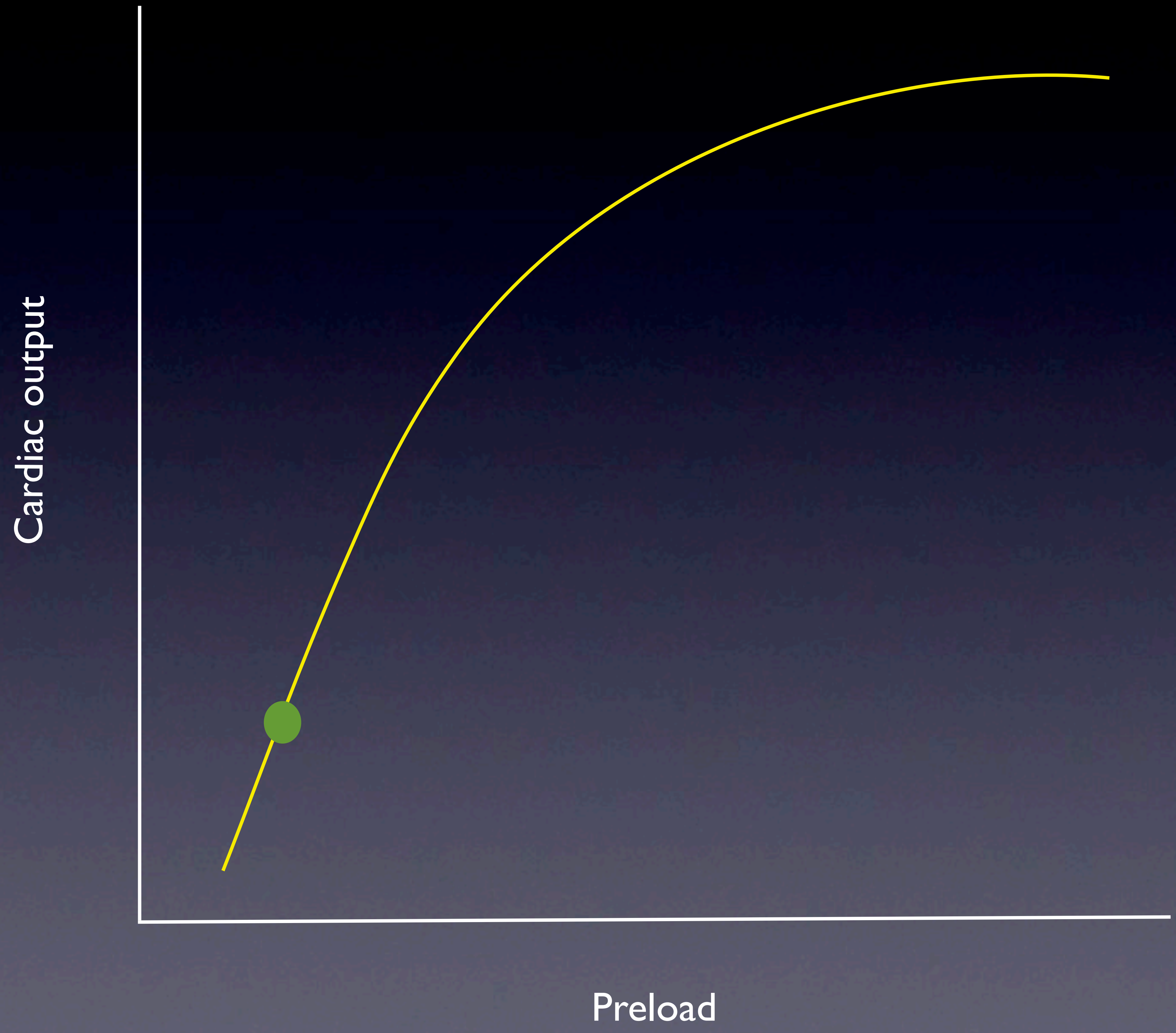


Crit Care Med 2007 Vol. 35, No.

Fluid Responsive or Not Responsive that is the question !



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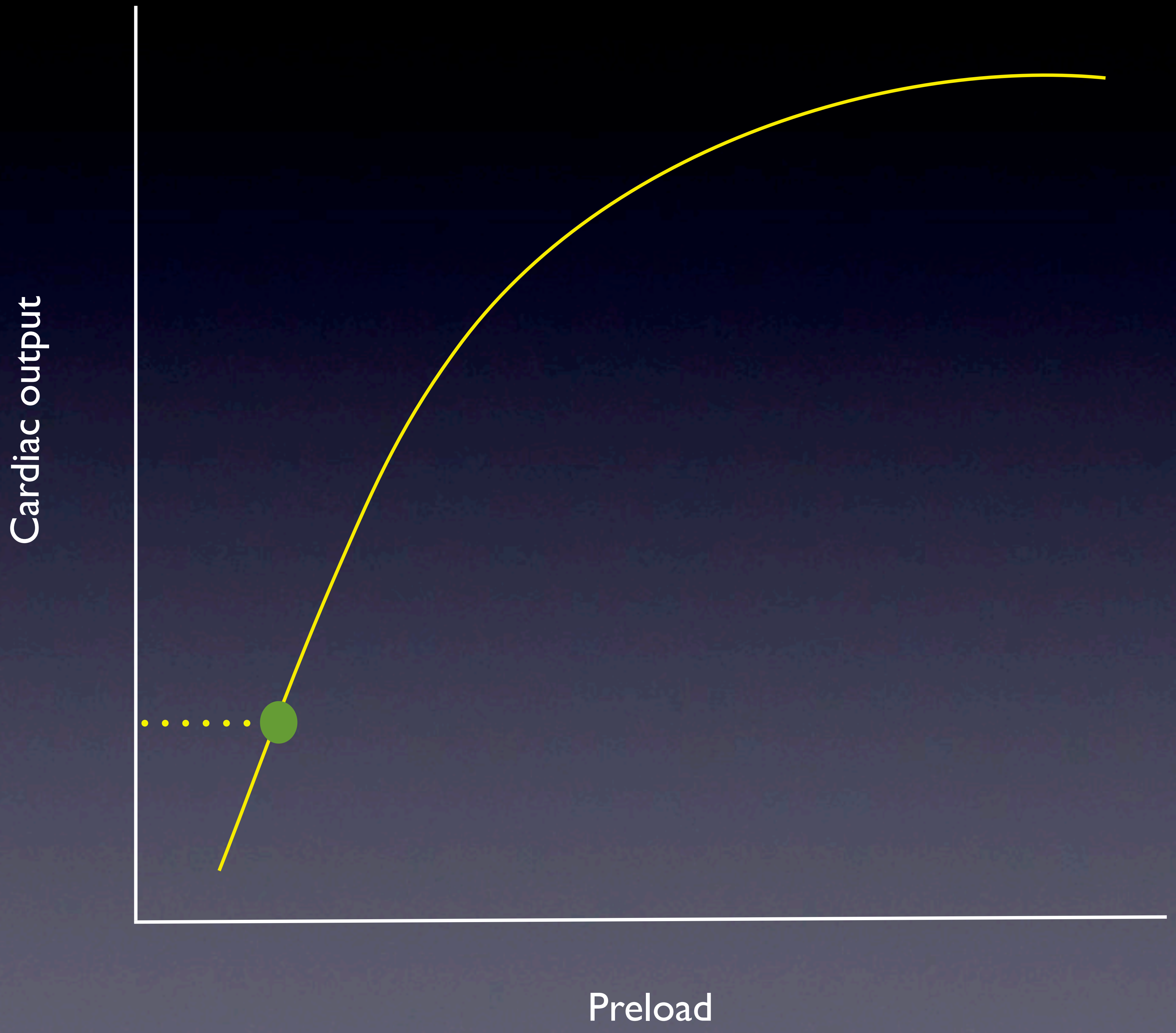

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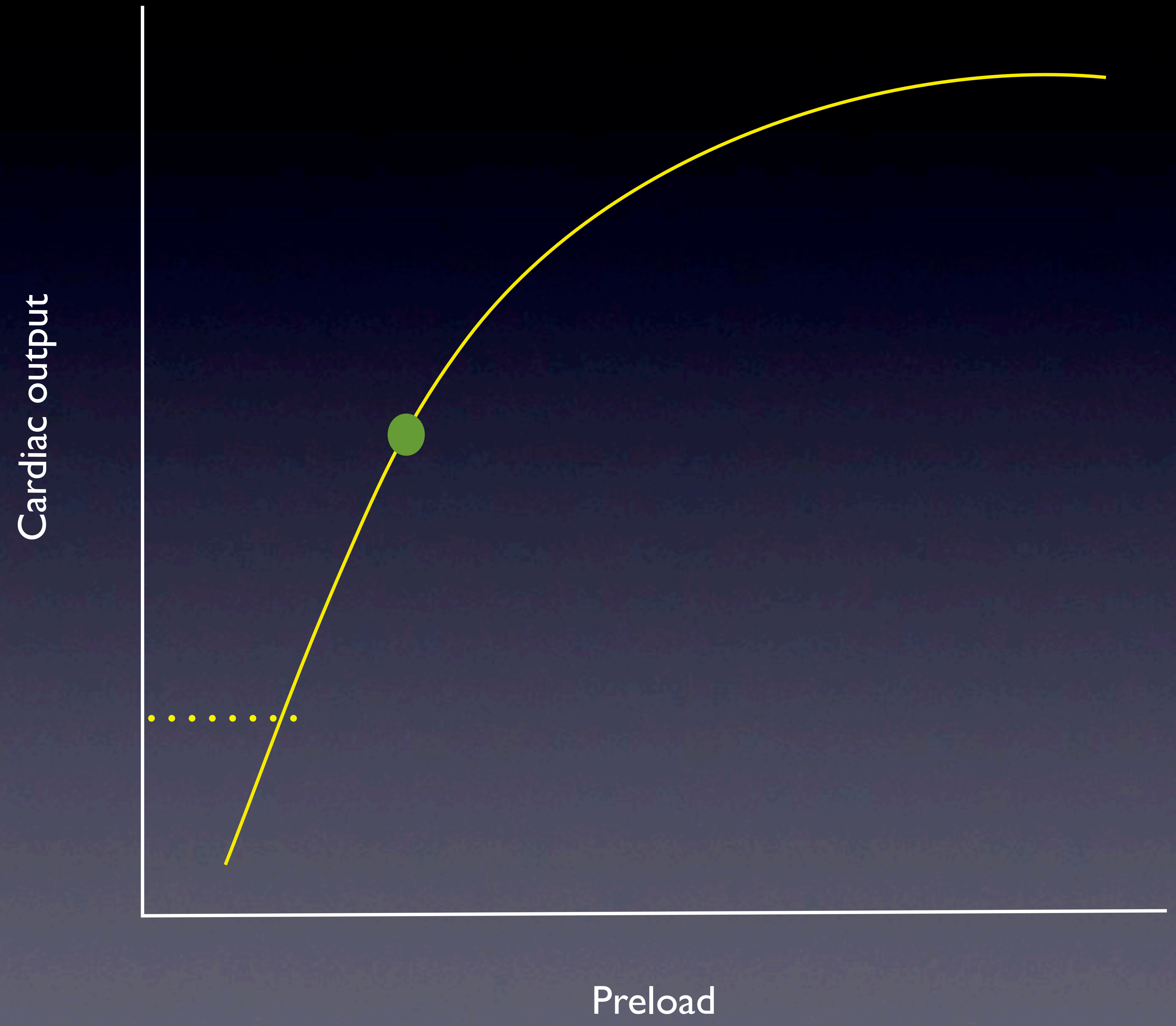

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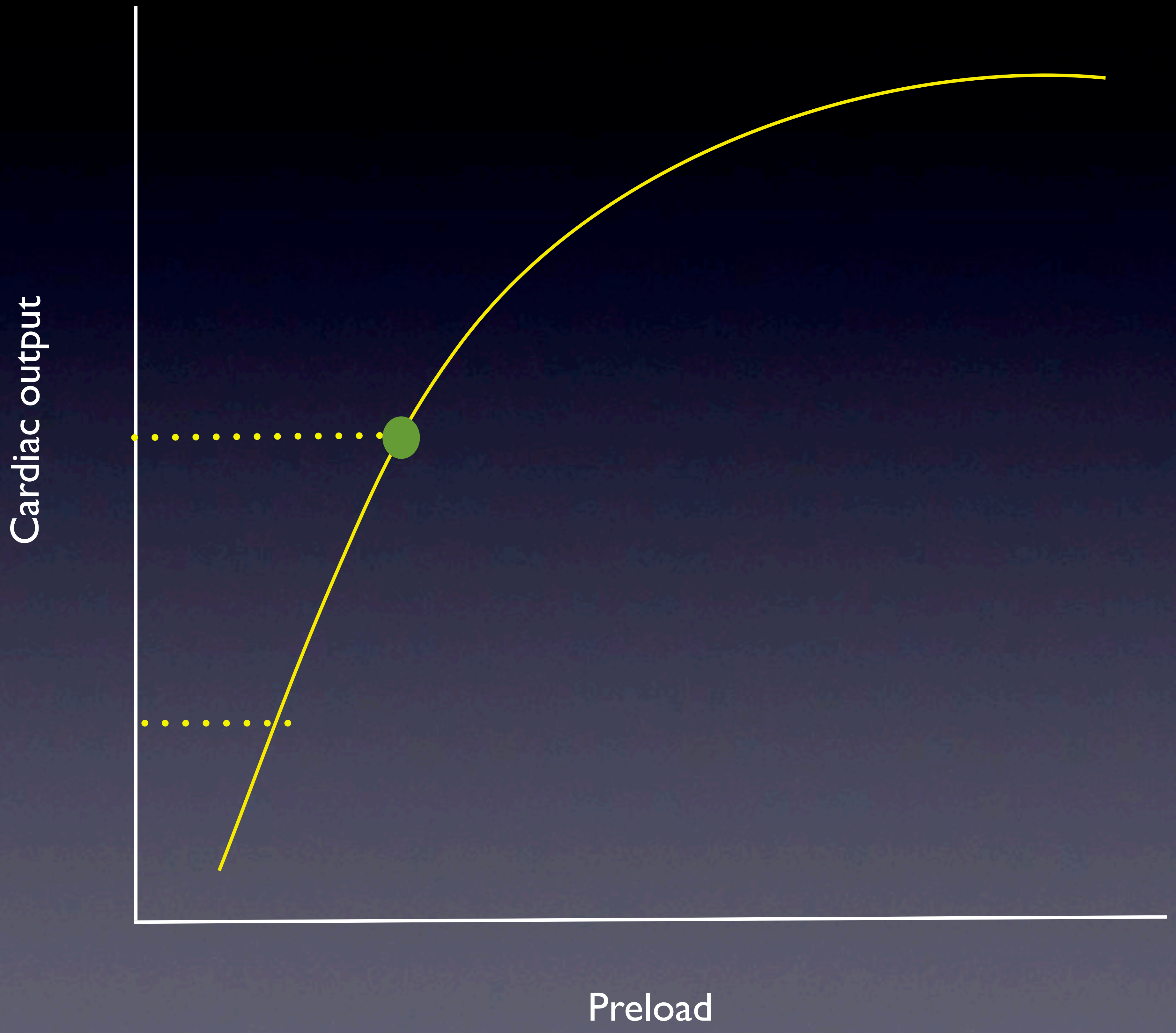

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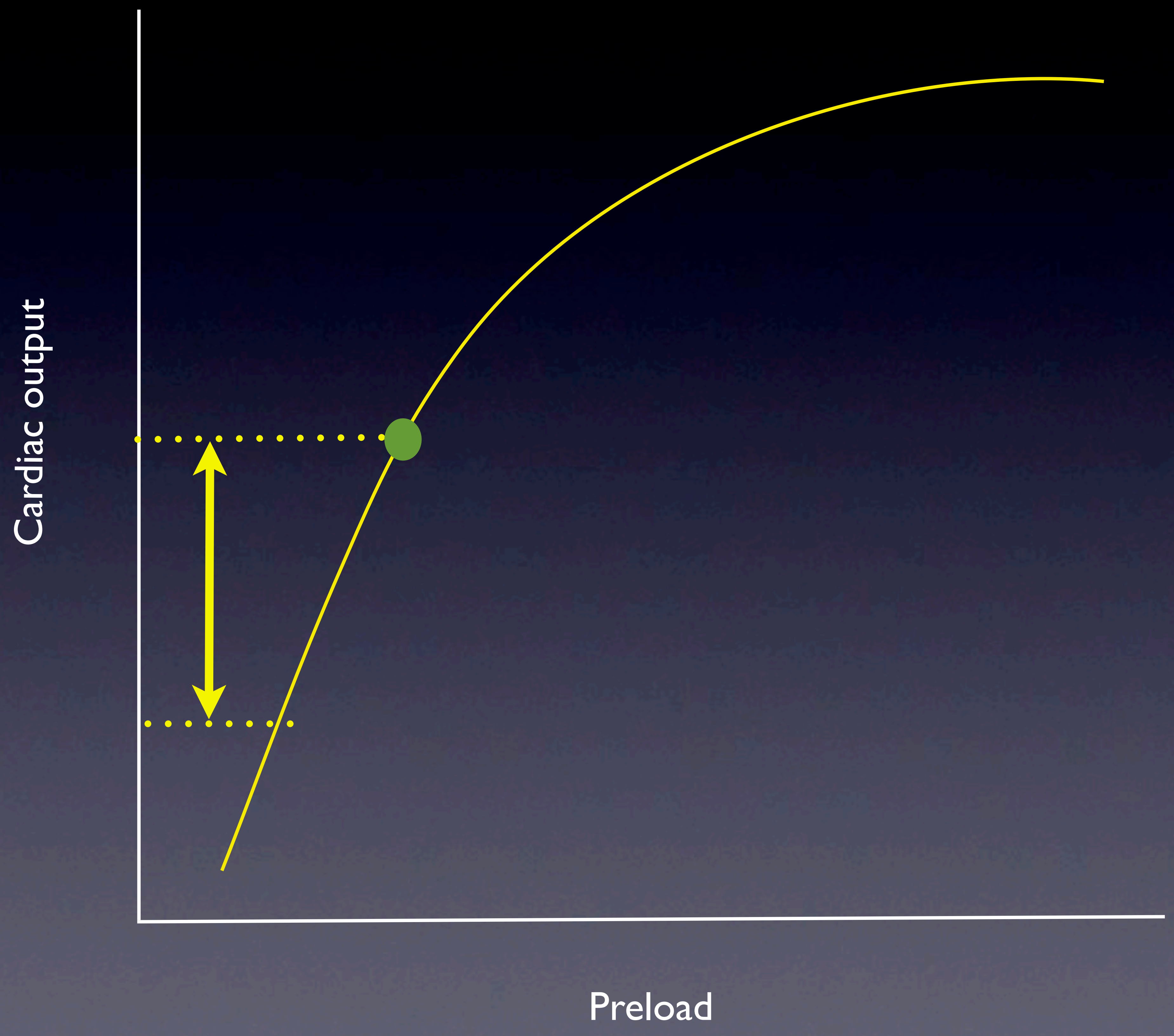

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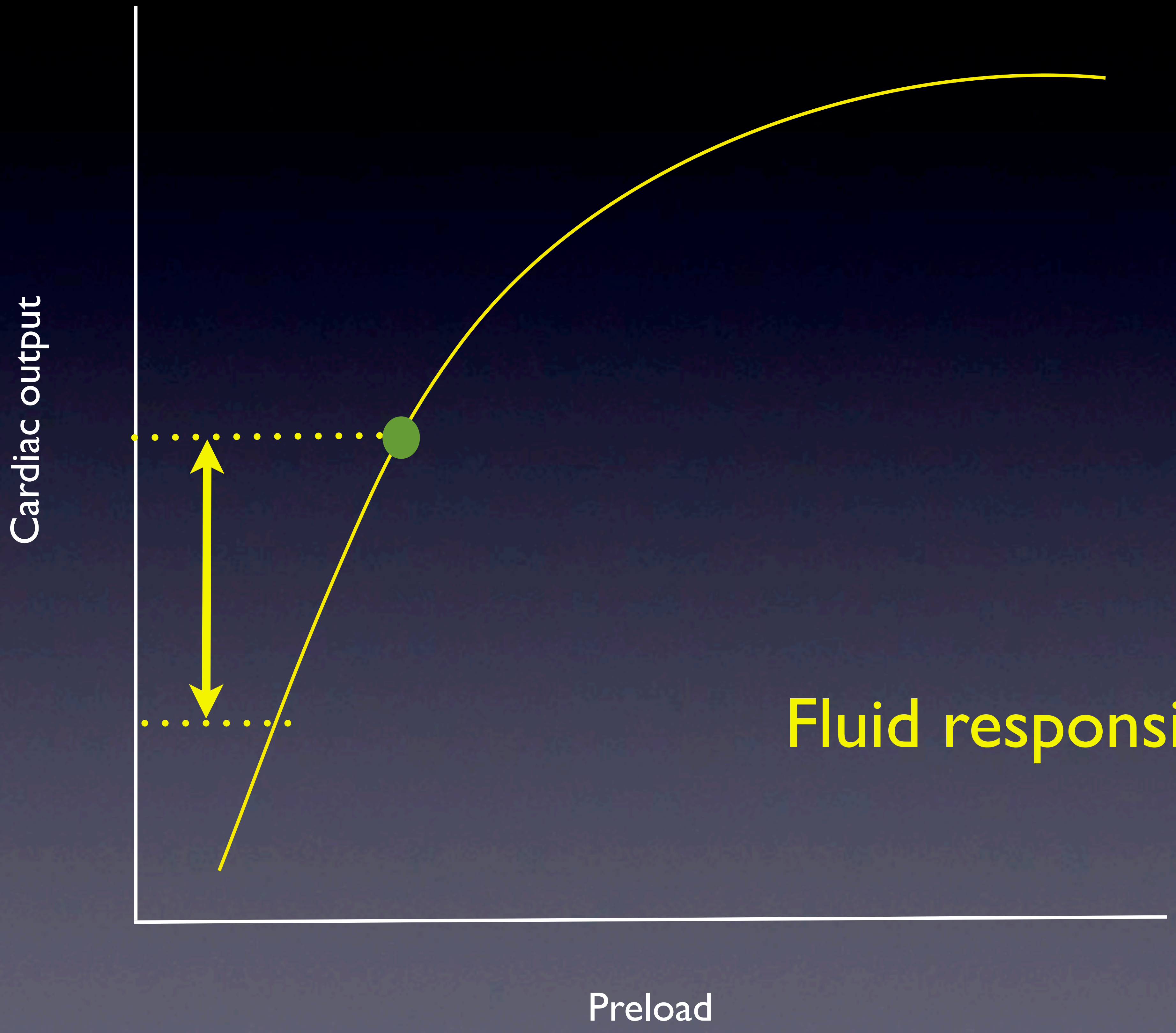

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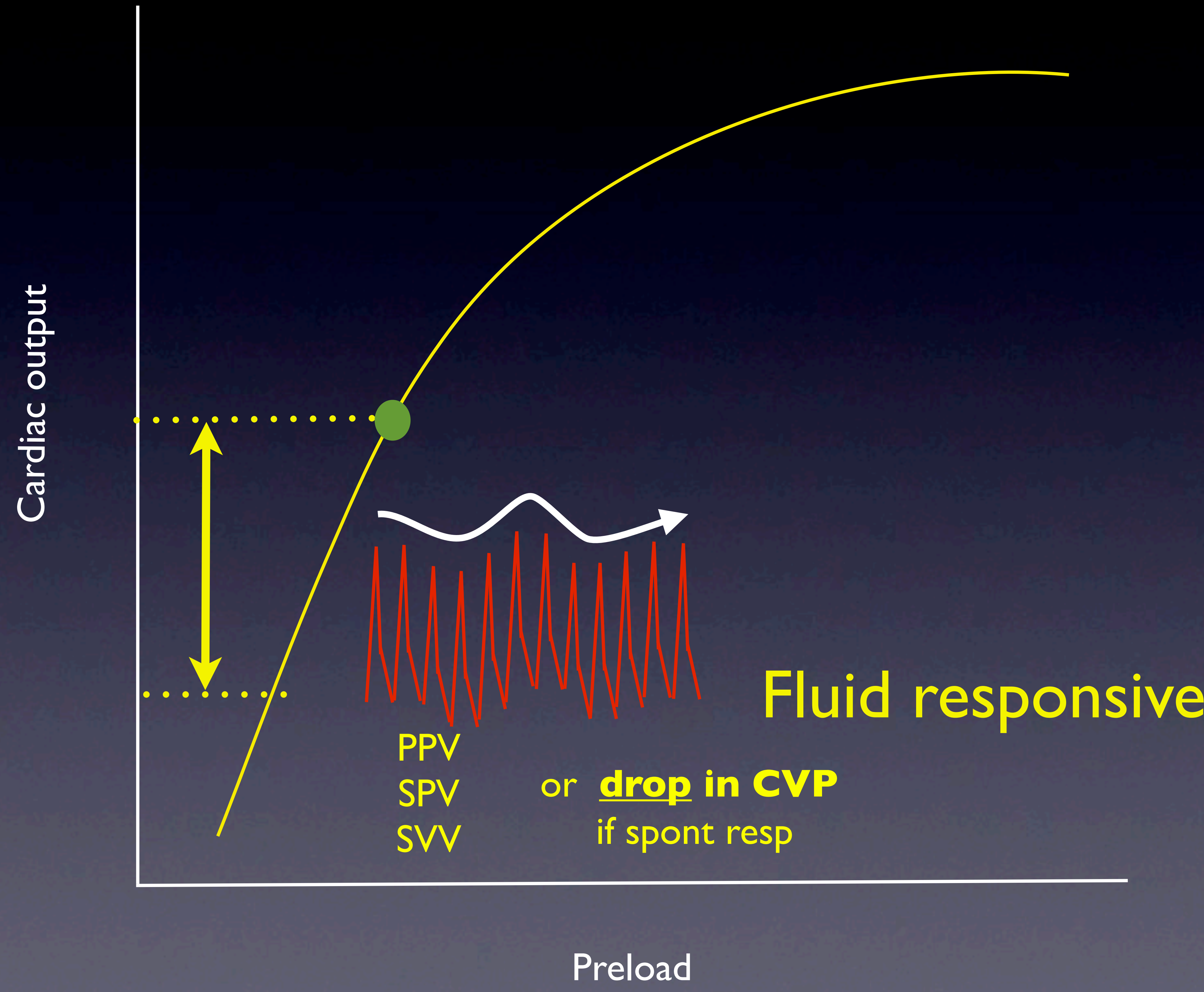

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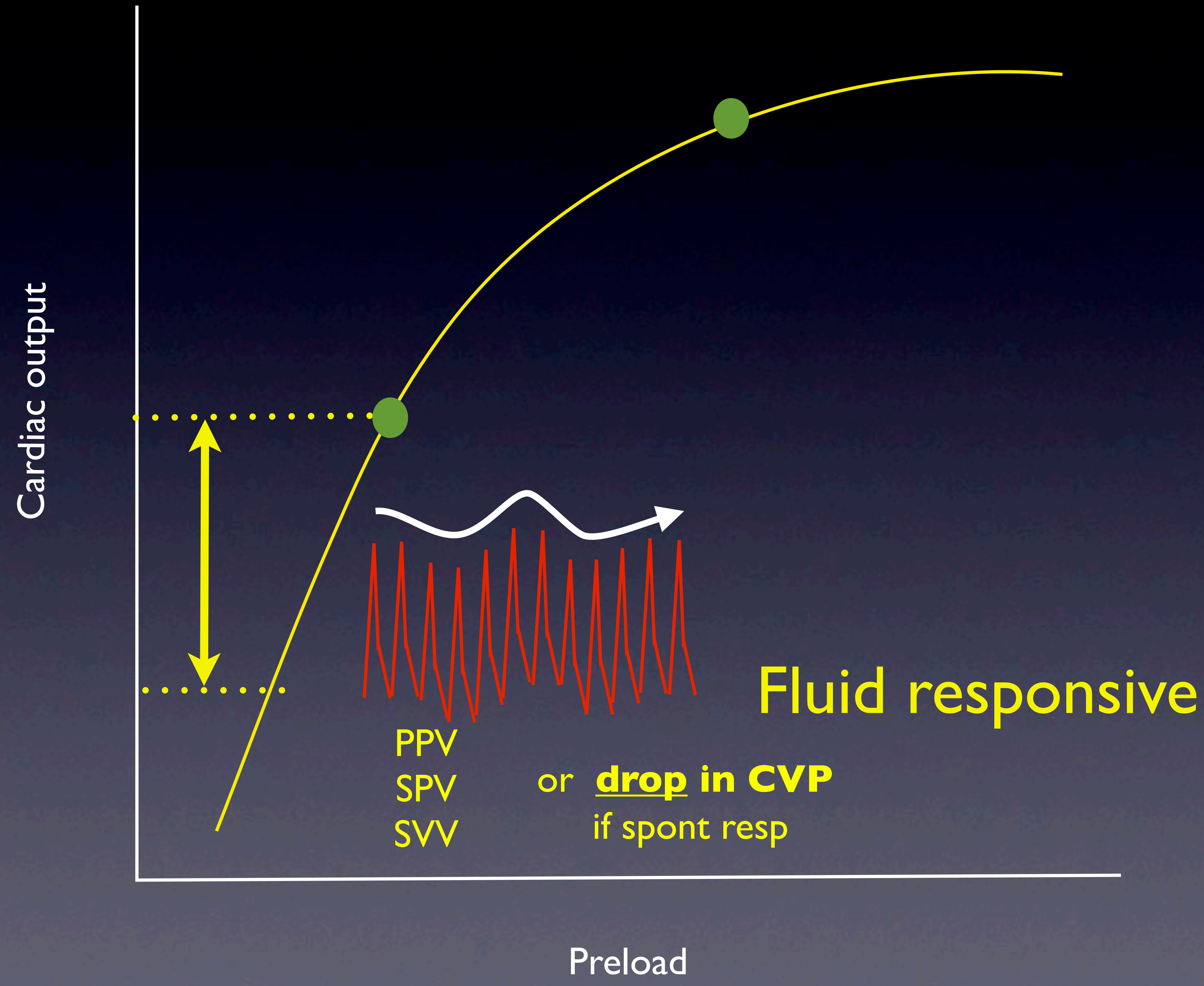

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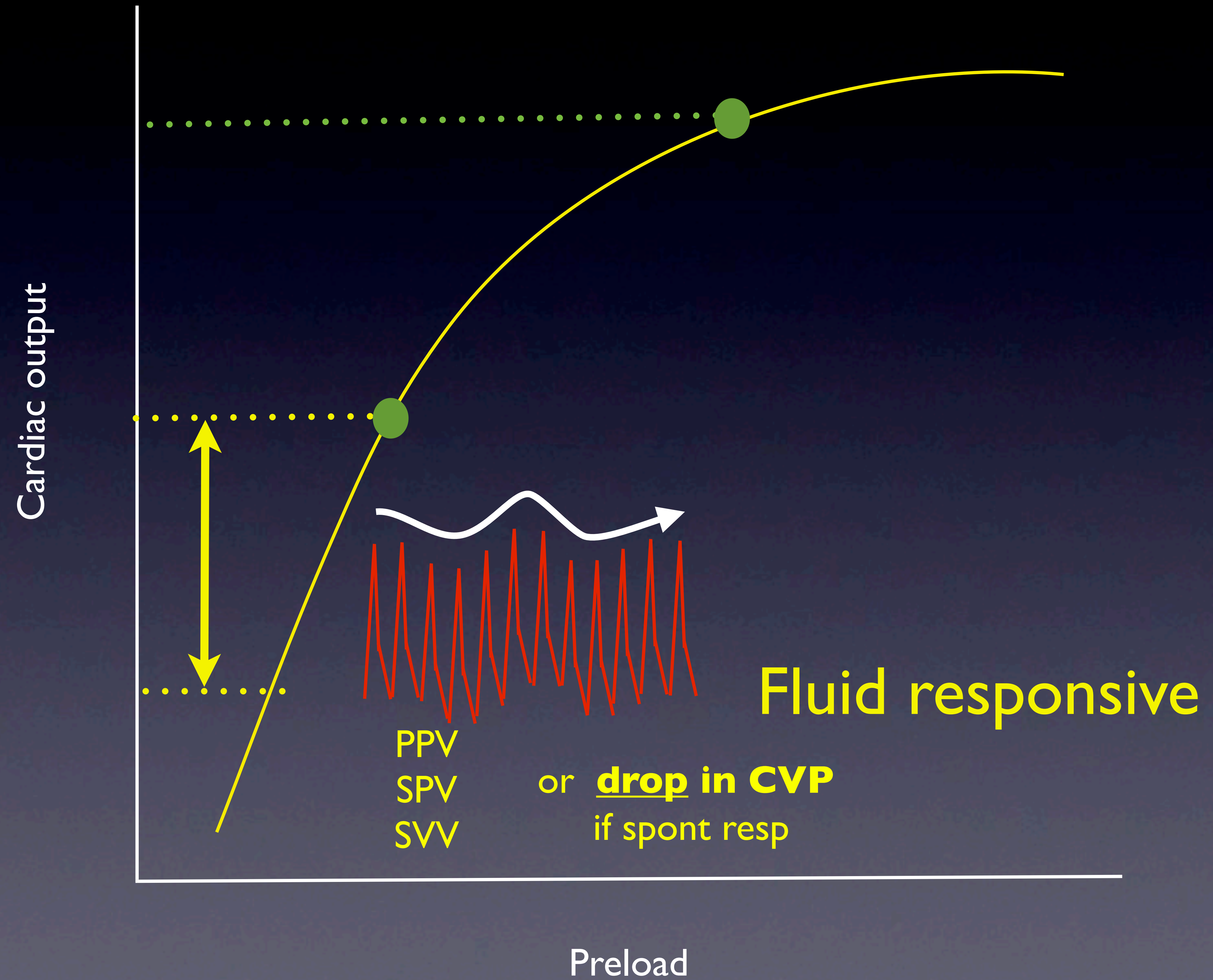

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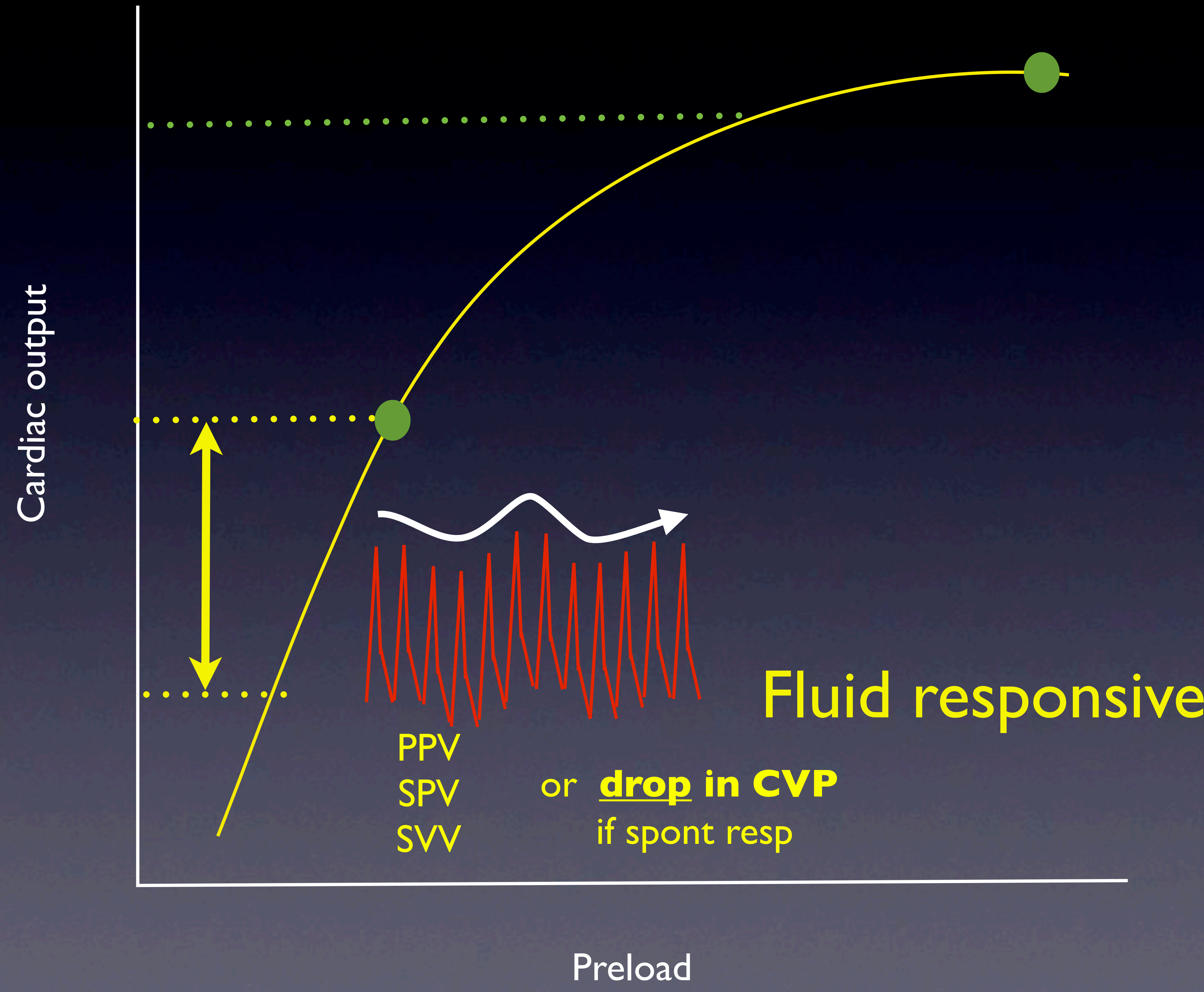

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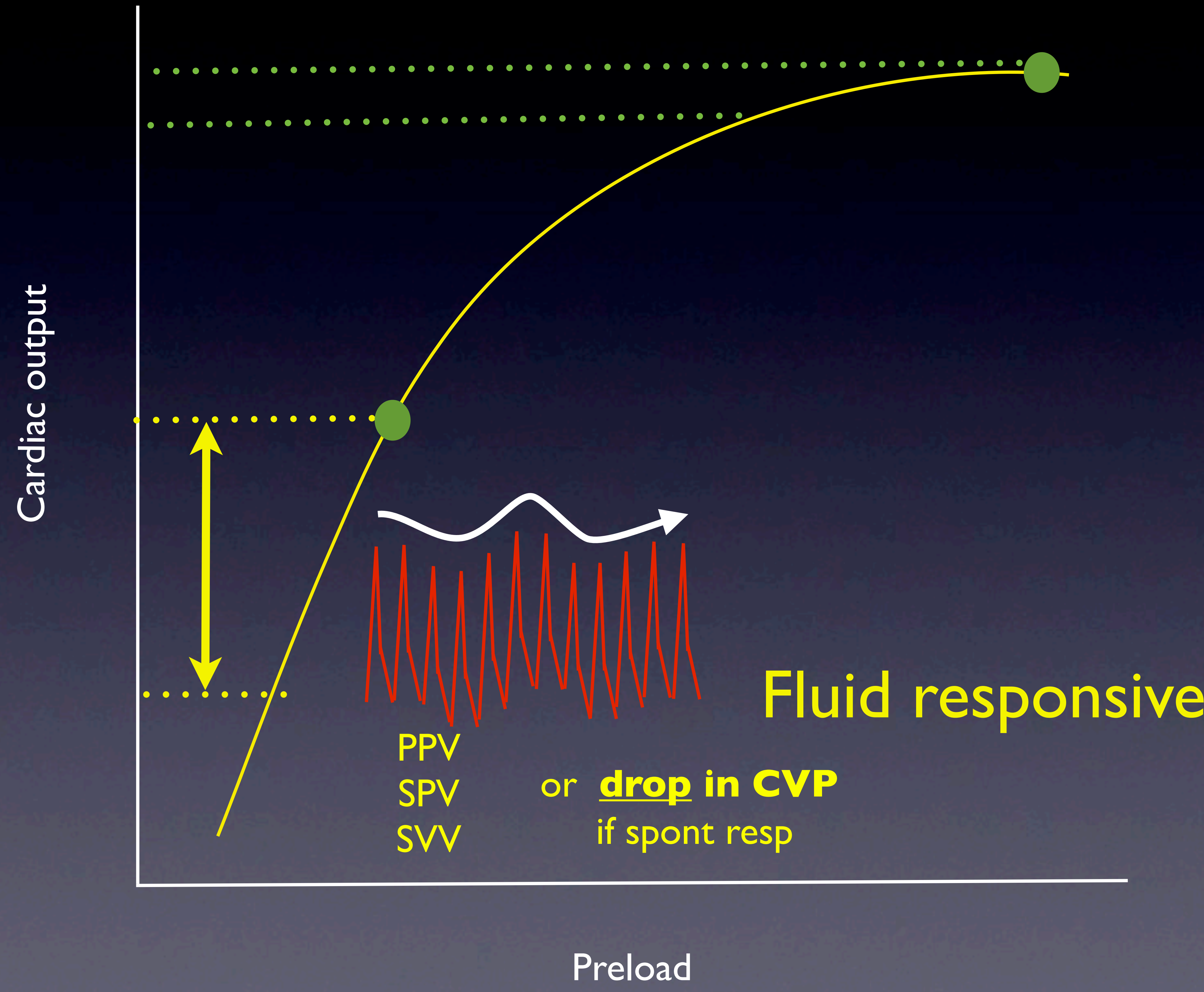

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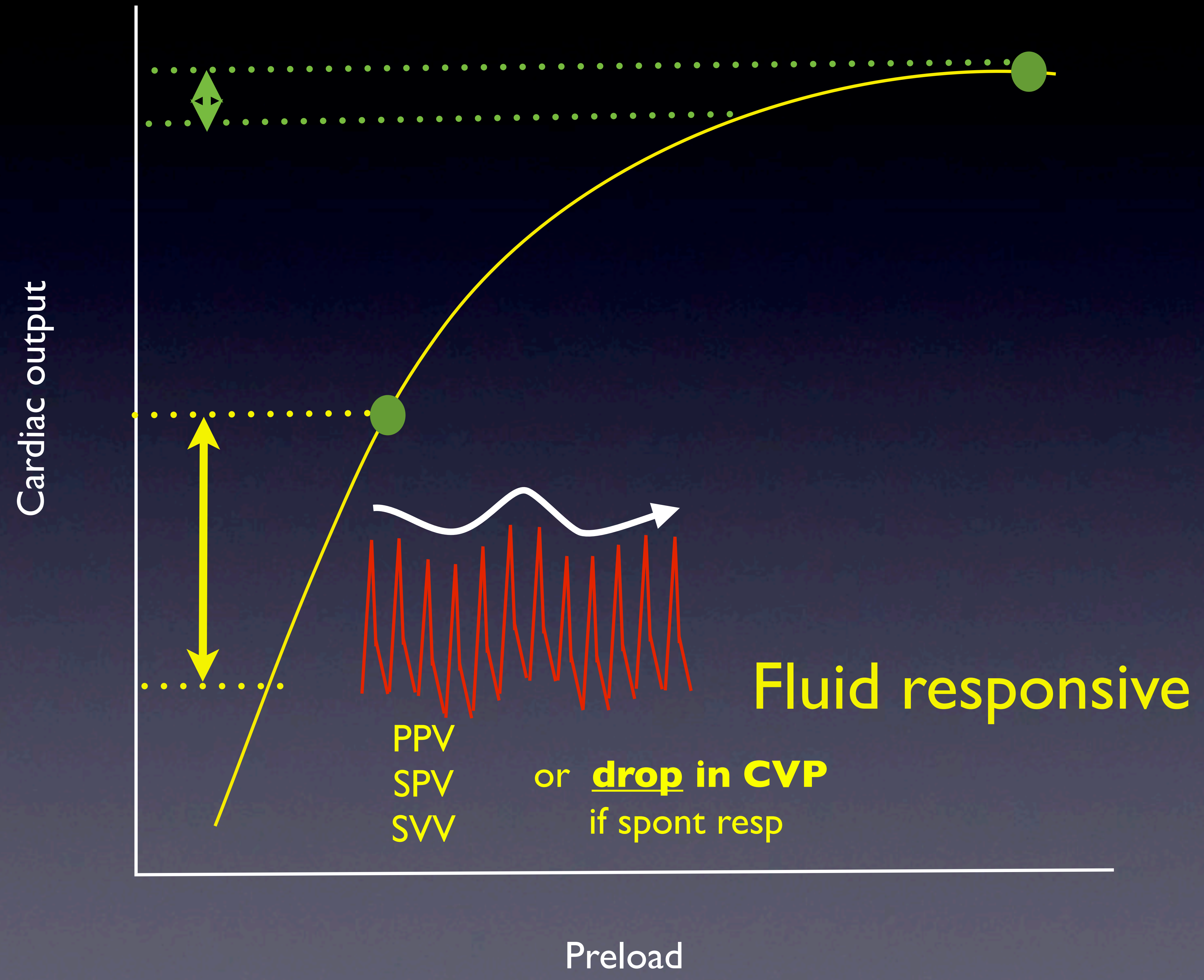

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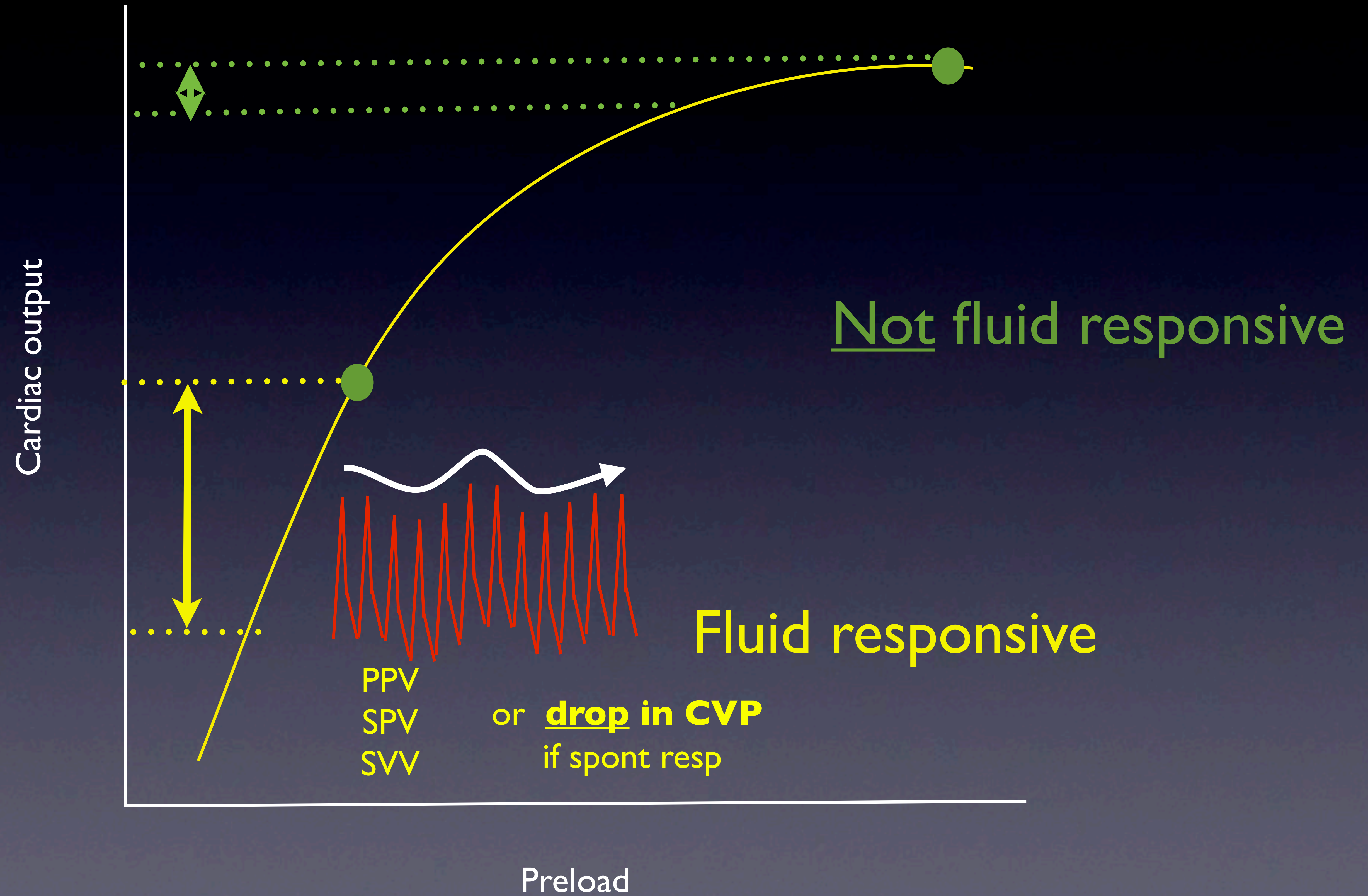

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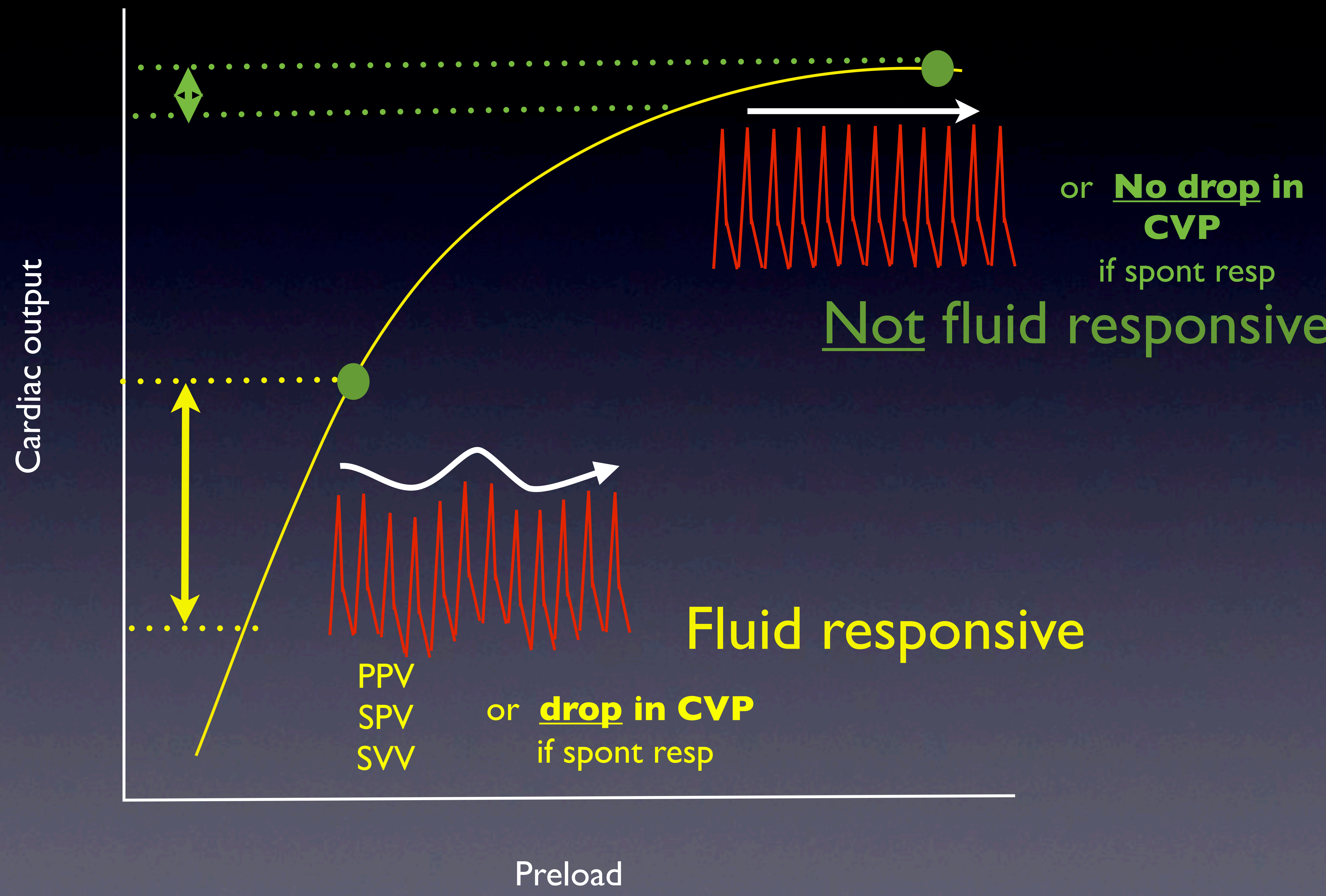
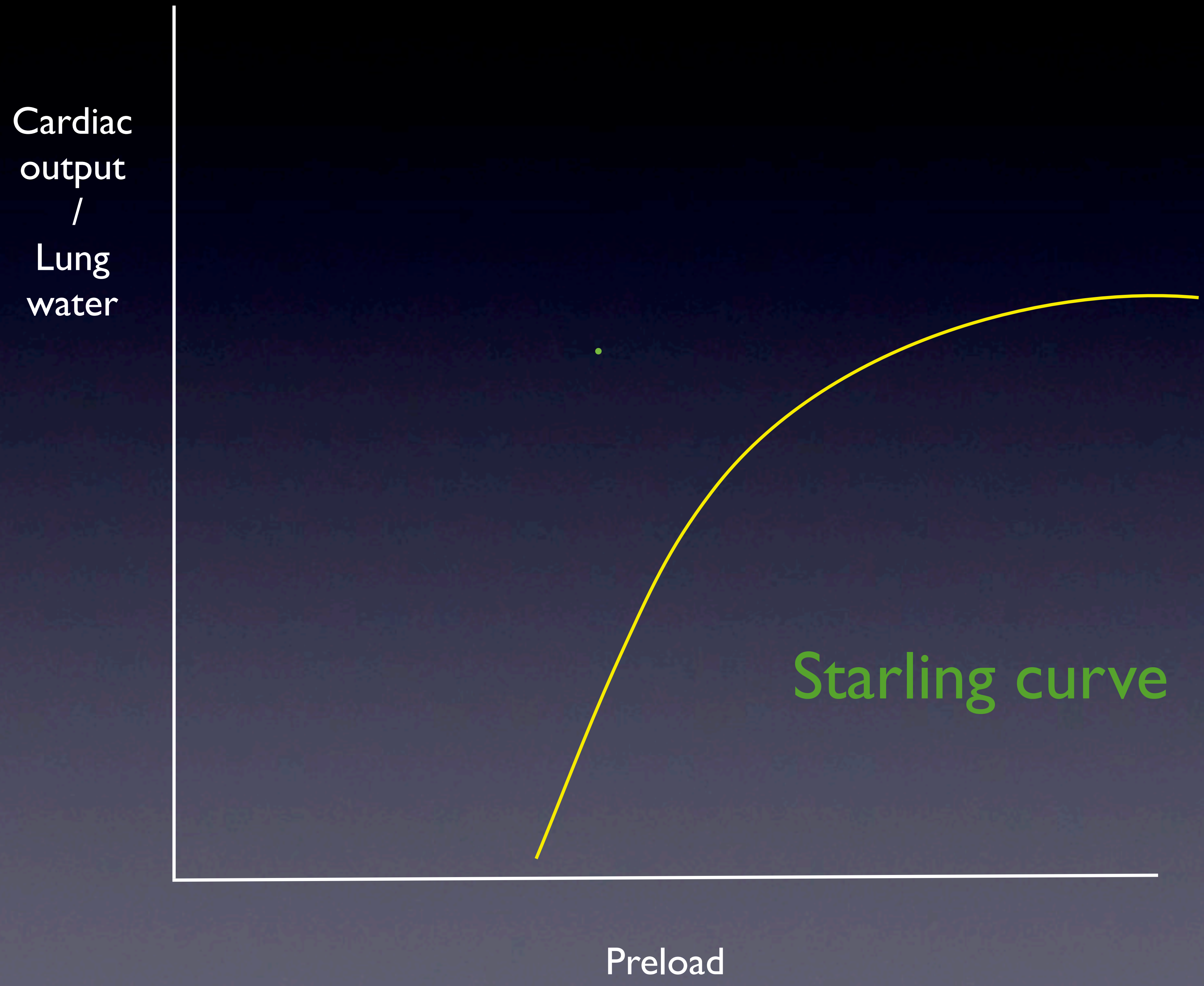


Why try <u>predicting</u> fluid responsiveness?



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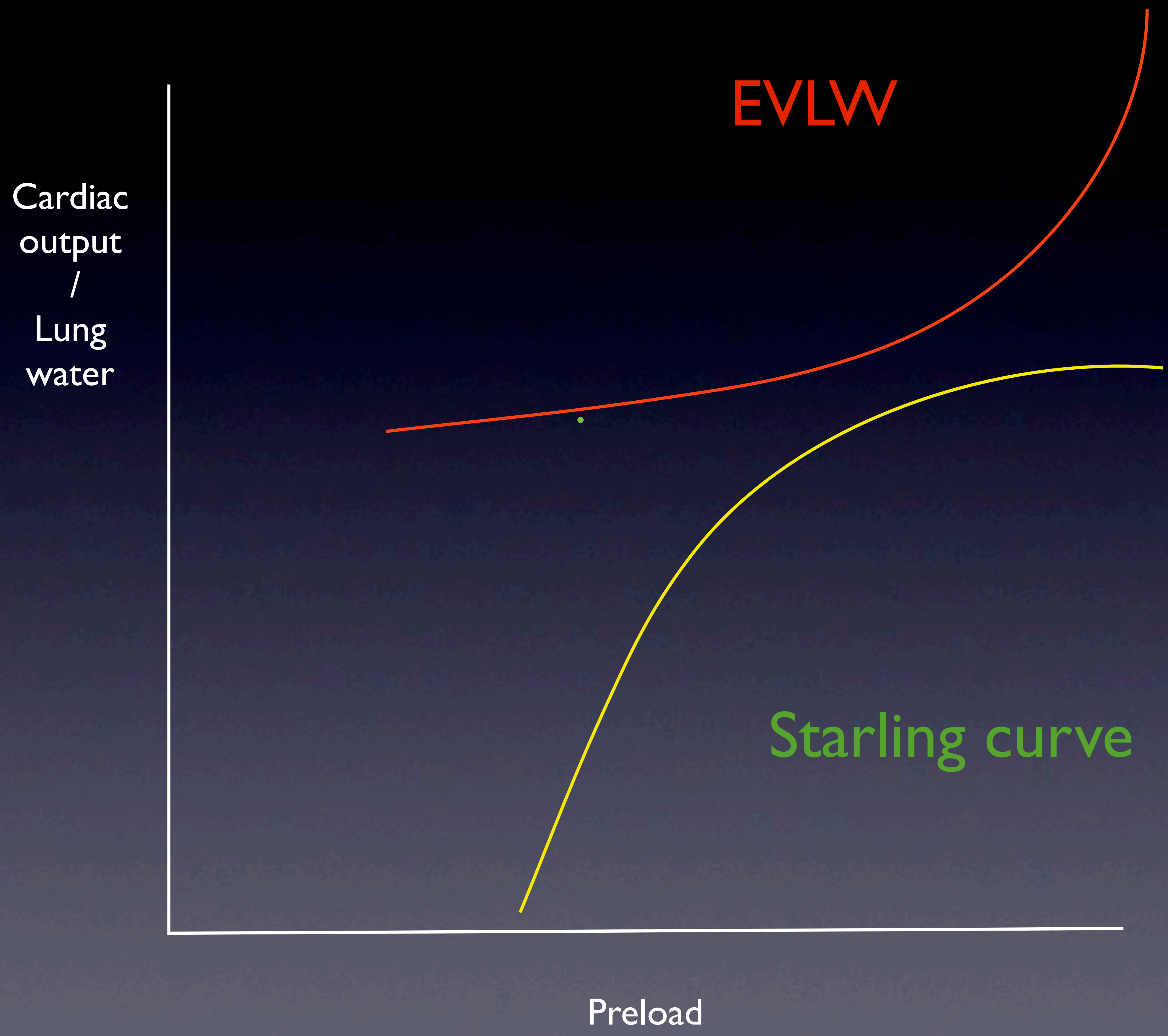

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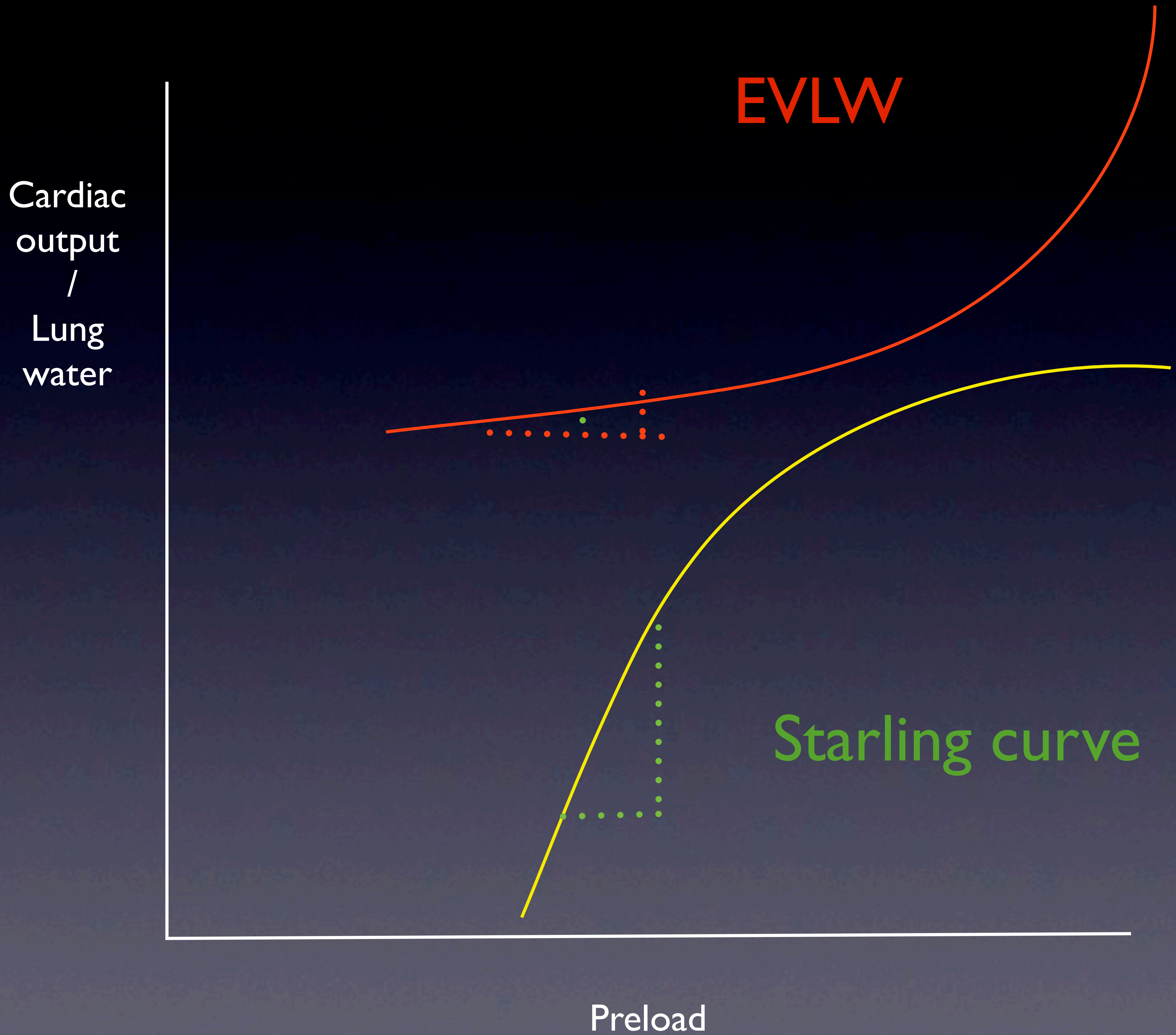

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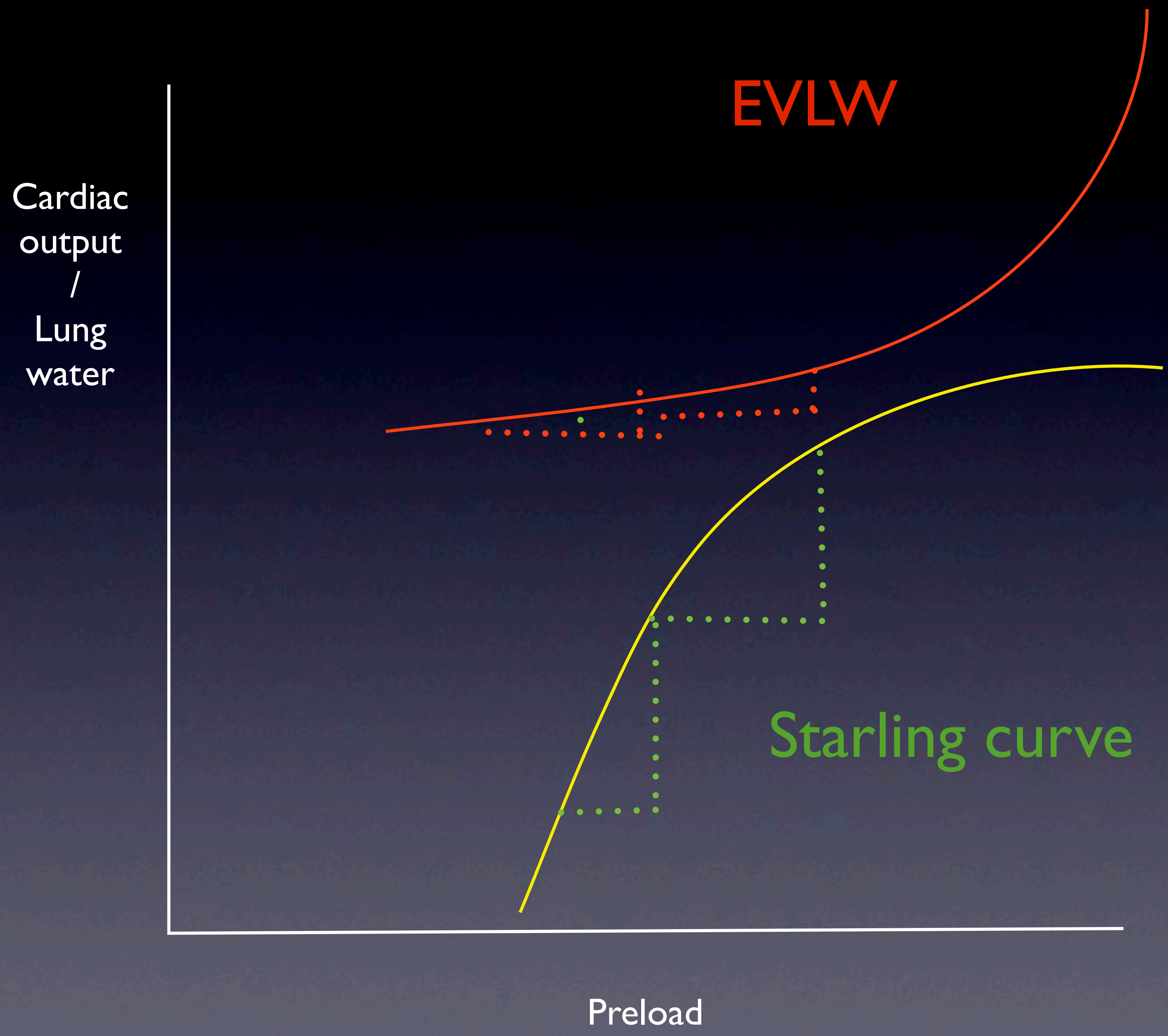

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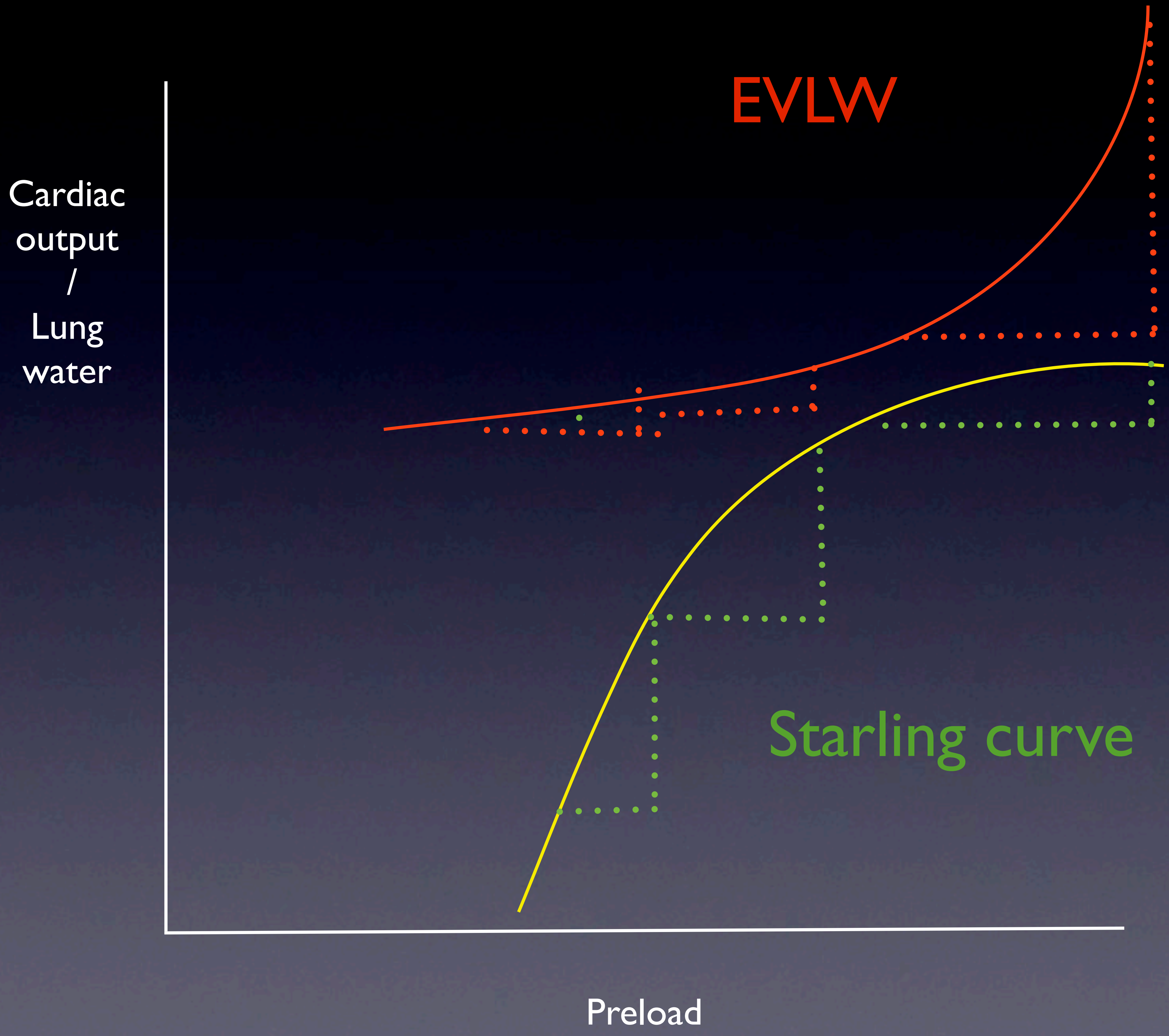

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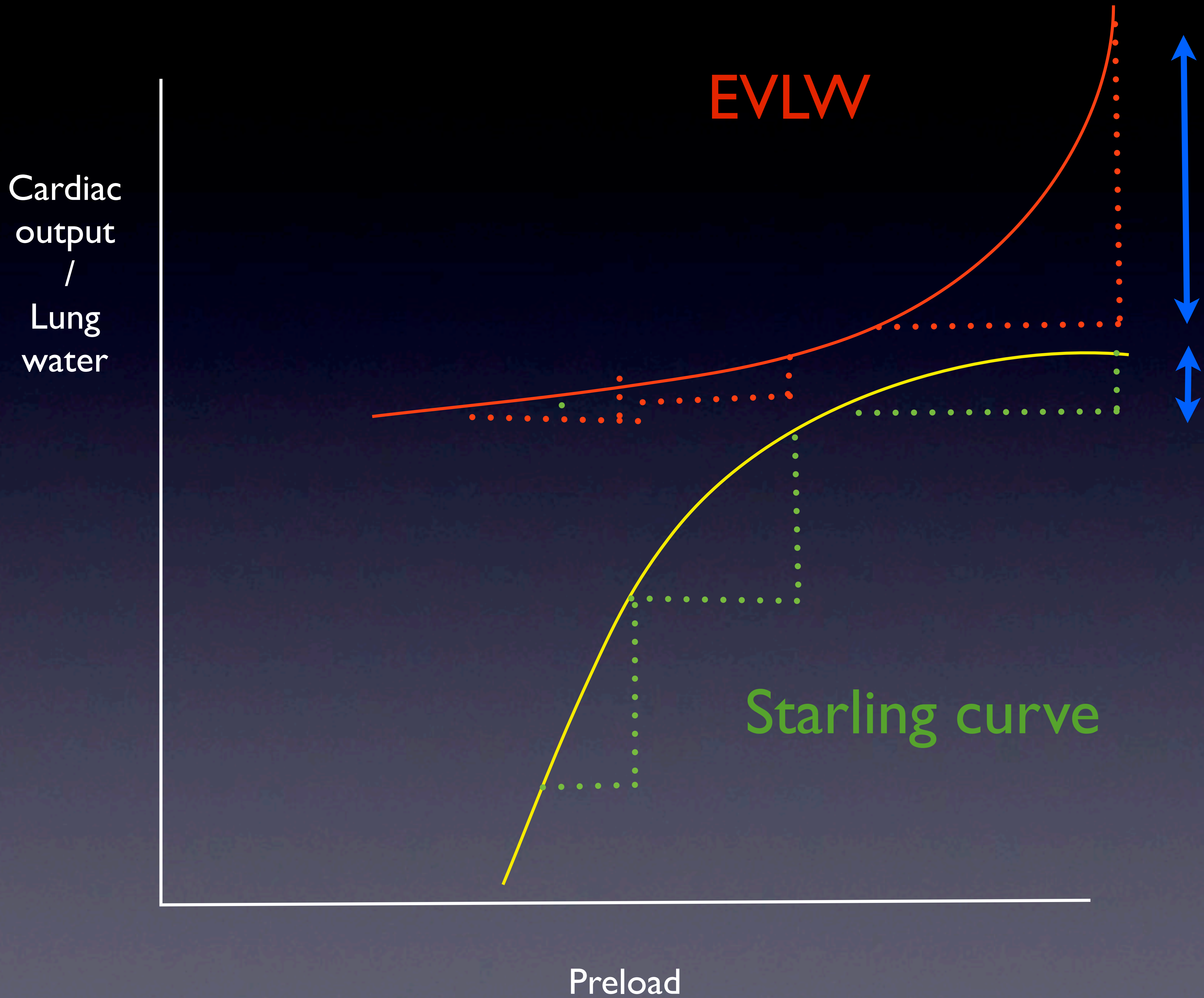

How to tell if fluid responsive

How to tell if fluid responsive

Either

How to tell if fluid responsive

Either

❖Give a bolus and watch response

How to tell if fluid responsive

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- Probably safe if <u>small</u> volumes required

How to tell if fluid responsive

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❖Give a bolus and watch response

- Probably safe if small volumes required
- If no risk of pulmonary oedema

How to tell if fluid responsive

Either

❖Give a bolus and watch response

- Probably safe if small volumes required
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Or

How to tell if fluid responsive

Either

❖Give a bolus and watch response

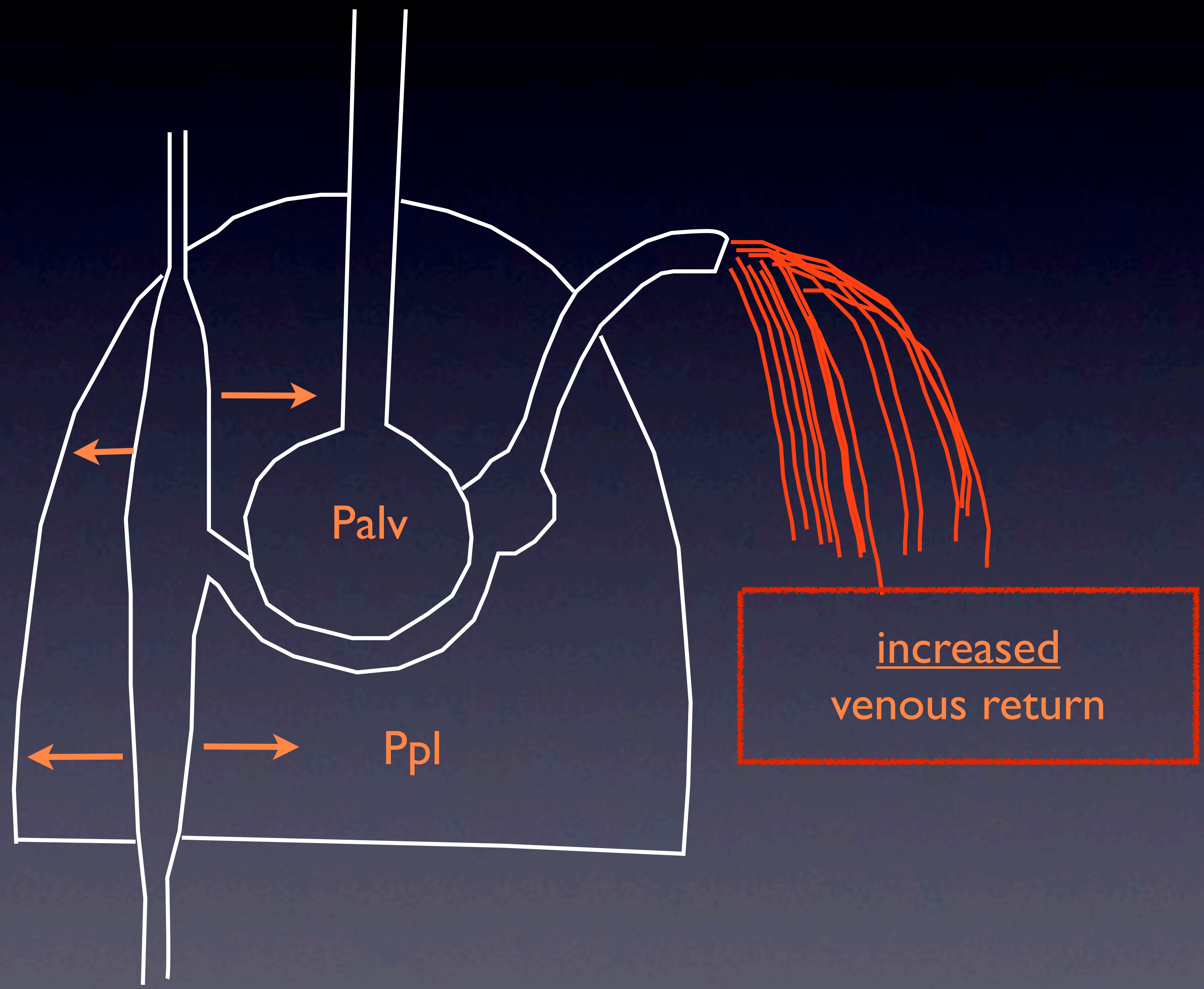
- Probably safe if <u>small</u> volumes required
- If no risk of pulmonary oedema

Or

❖Try to **<u>predict</u>** how patient will respond

Spontaneous ventilation

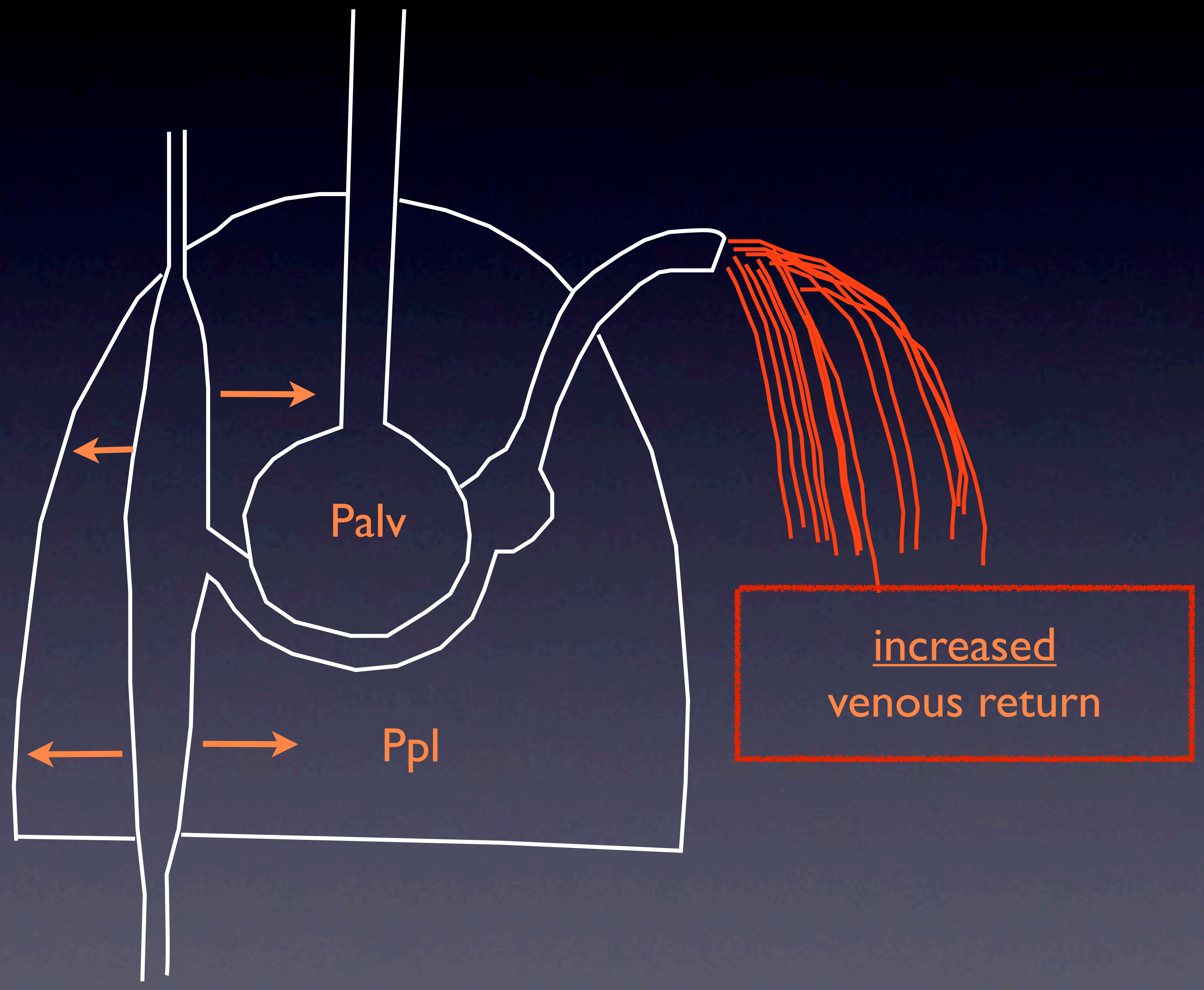
Spontaneous ventilation



CVP decreases

Spontaneous ventilation

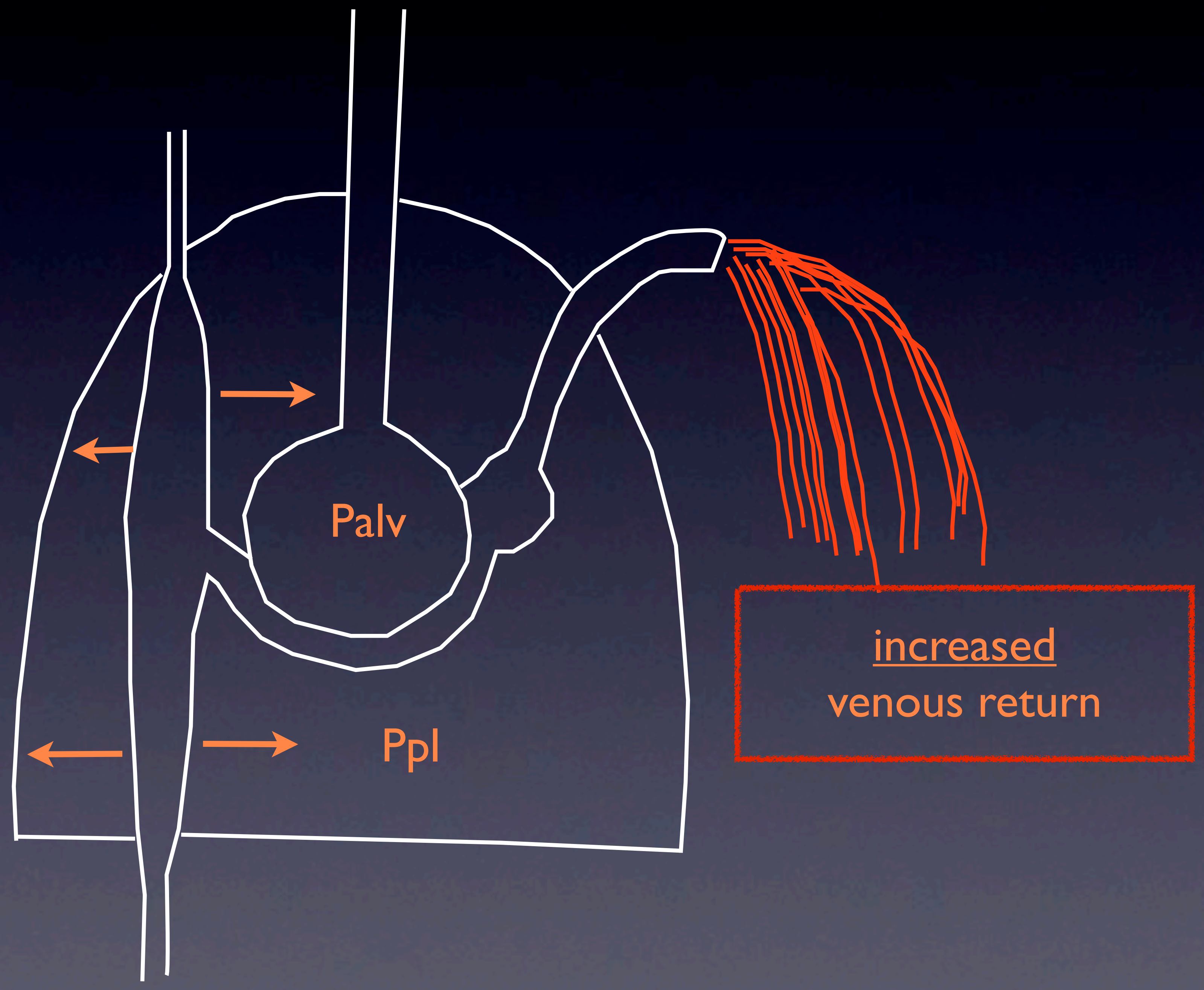
the pleural pressure drops



CVP decreases

Spontaneous ventilation

the pleural pressure drops
-> the rt. atrium/vena cavae expand (**if compliant**)



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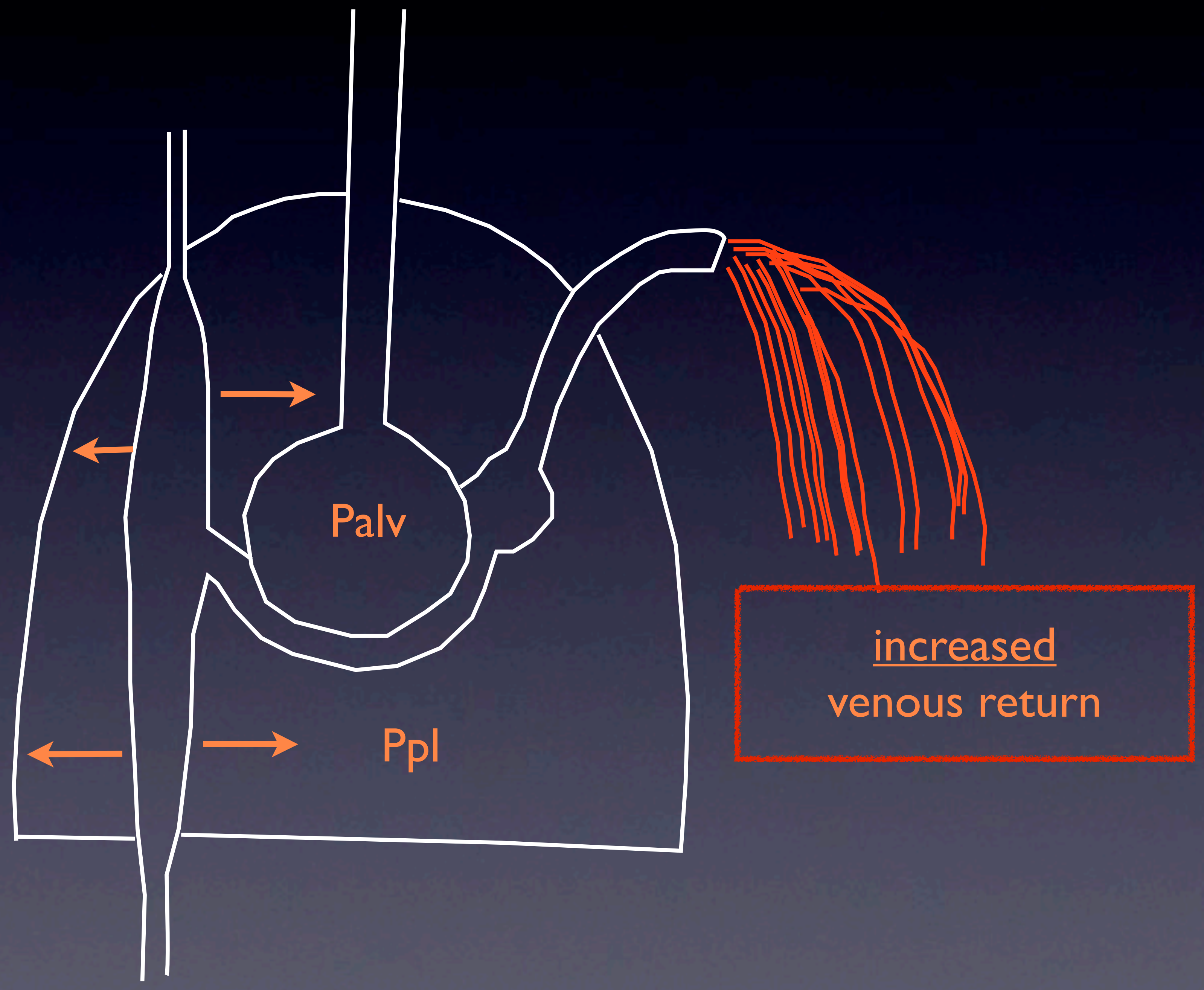
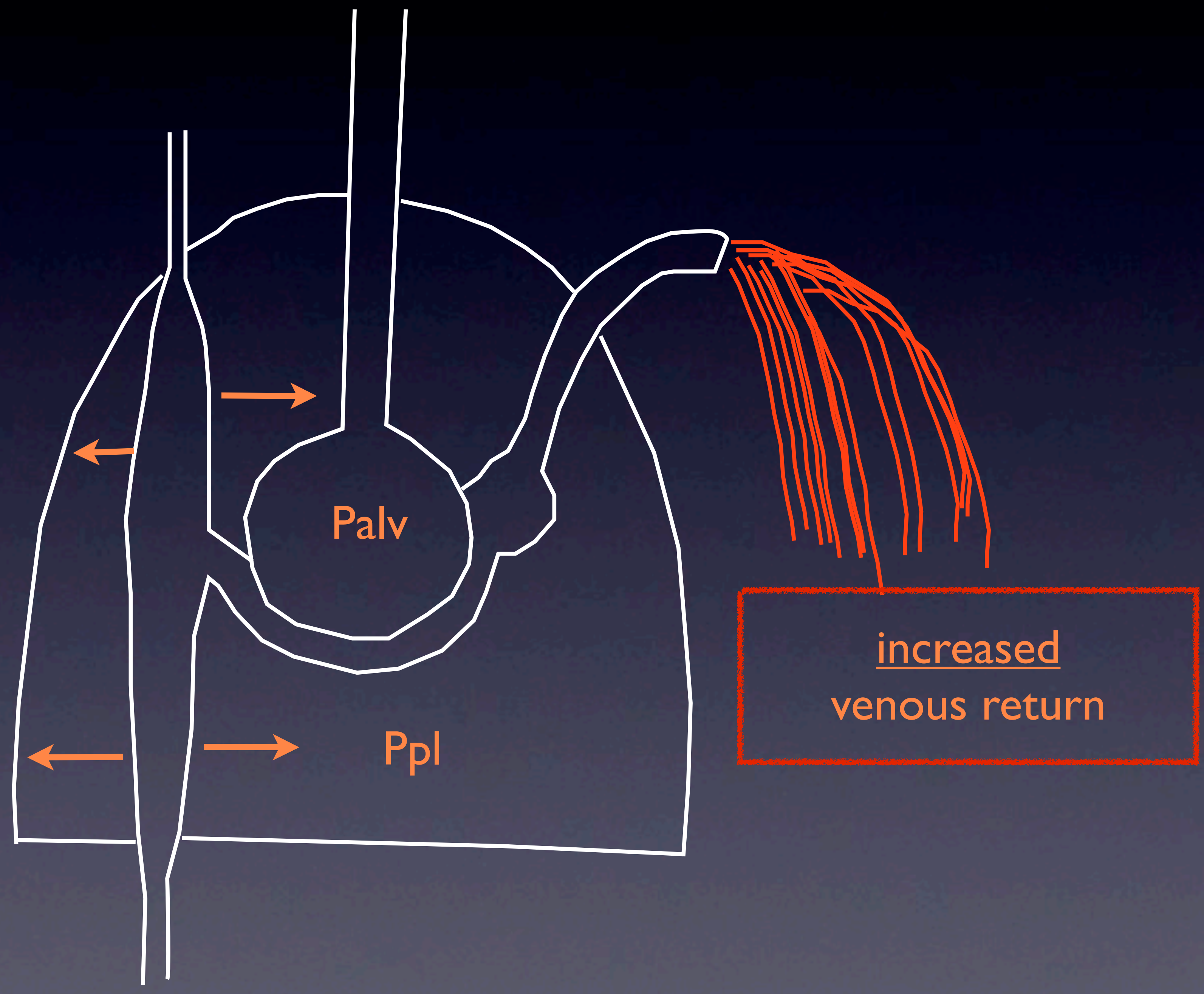
-> the CVP drops



CVP decreases

Spontaneous ventilation

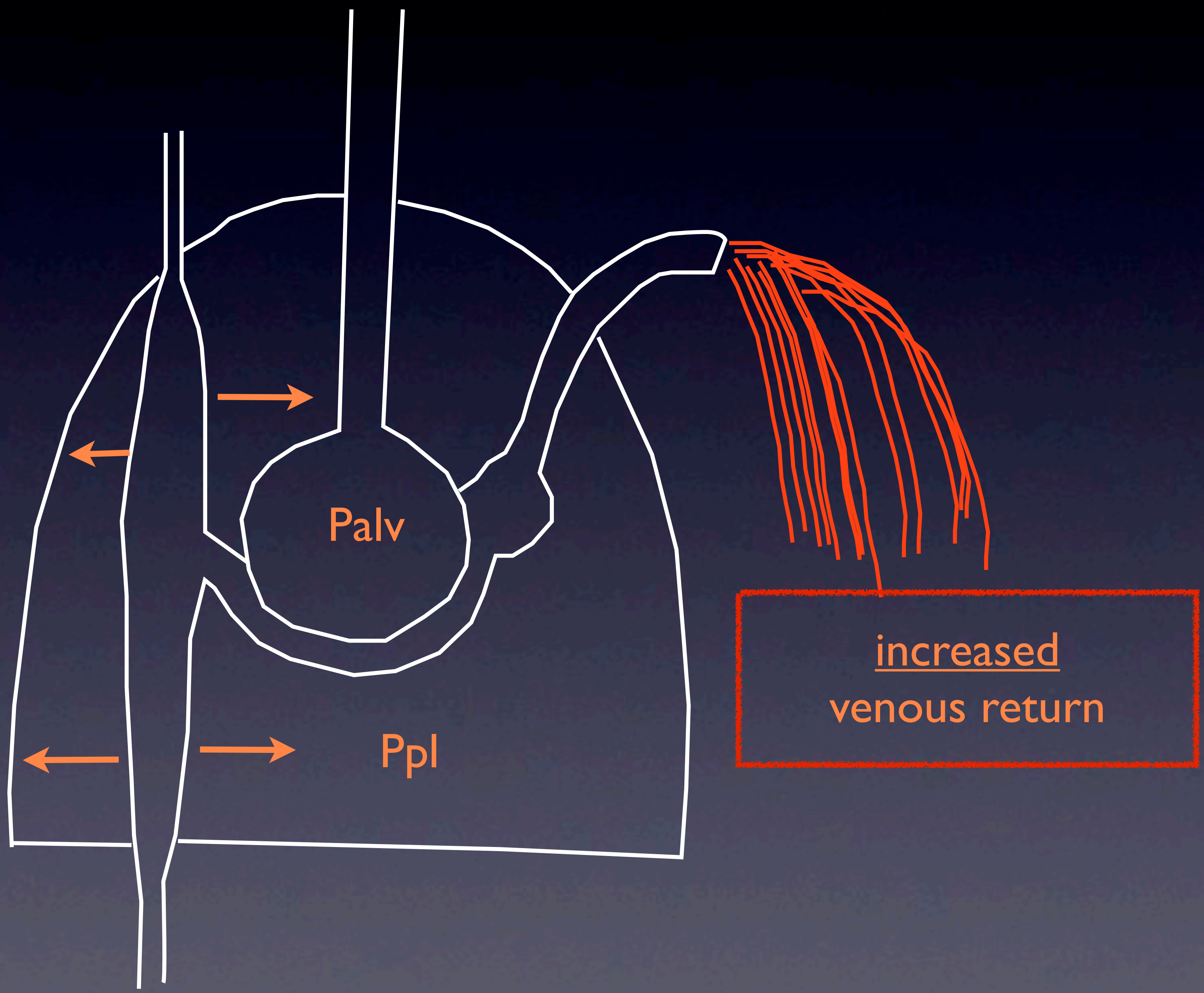
the pleural pressure drops
-> the rt. atrium/vena cavae expand (**if compliant**)
-> the CVP drops
-> sucking more blood into the chest



CVP decreases

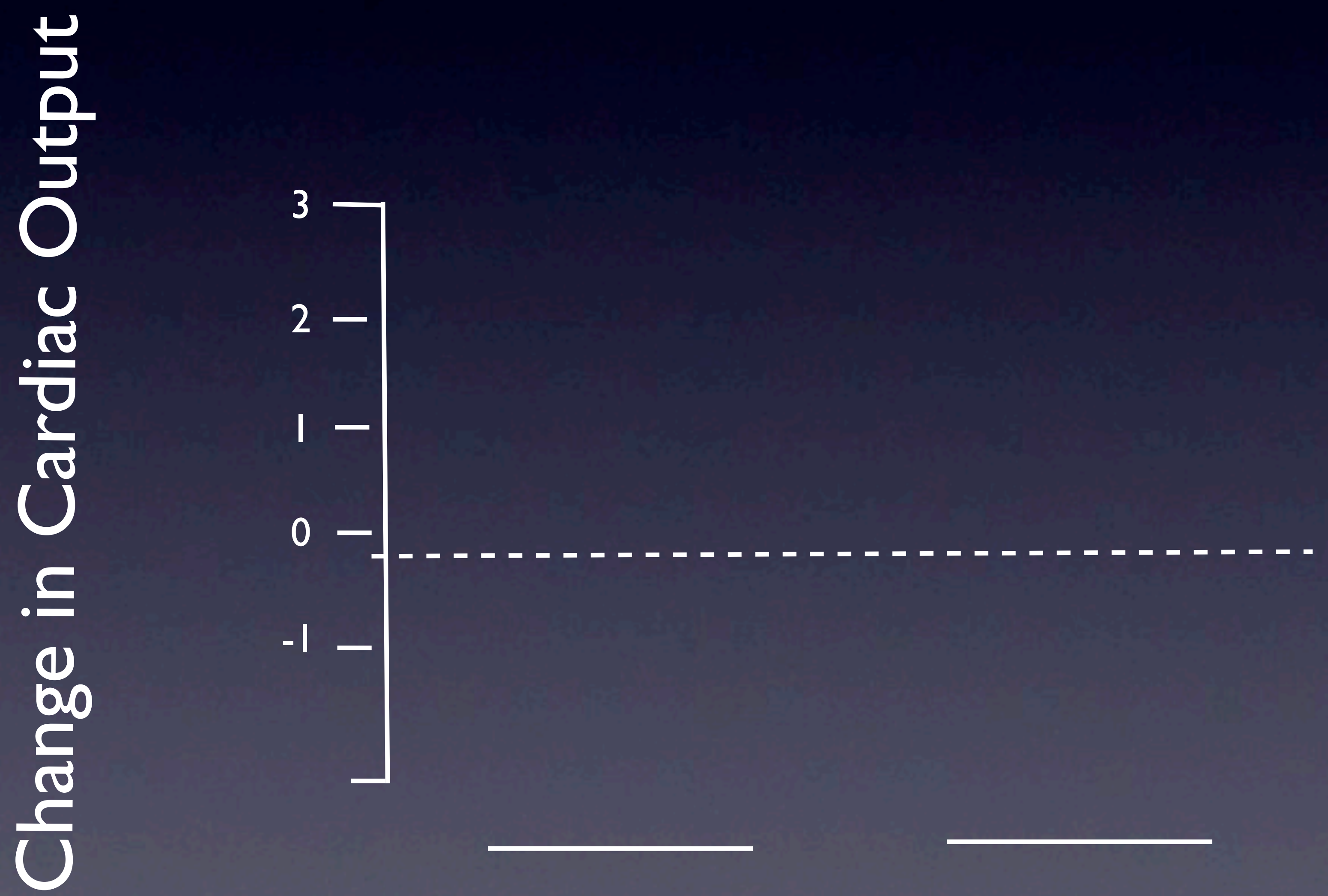
Spontaneous ventilation

the pleural pressure drops
-> the rt. atrium/vena cavae expand (**if compliant**)
-> the CVP drops
-> sucking more blood into the chest
->venous return and cardiac output increased



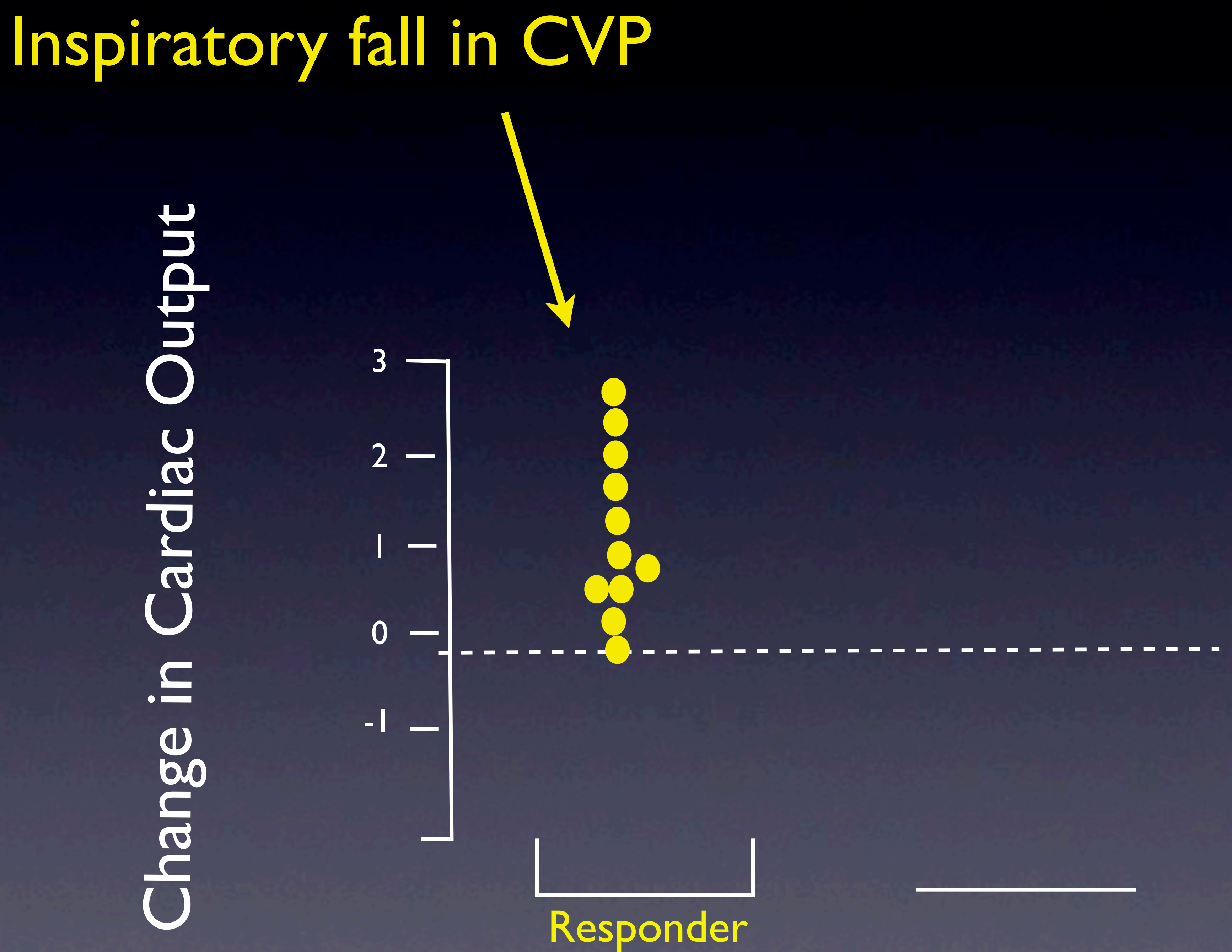
CVP decreases

Change in CVP and spontaneous ventilation - Does it work ?



Current Opinion in Critical Care 2005, 11:264 -270

Change in CVP and spontaneous ventilation - Does it work ?



Current Opinion in Critical Care 2005, 11:264 -270

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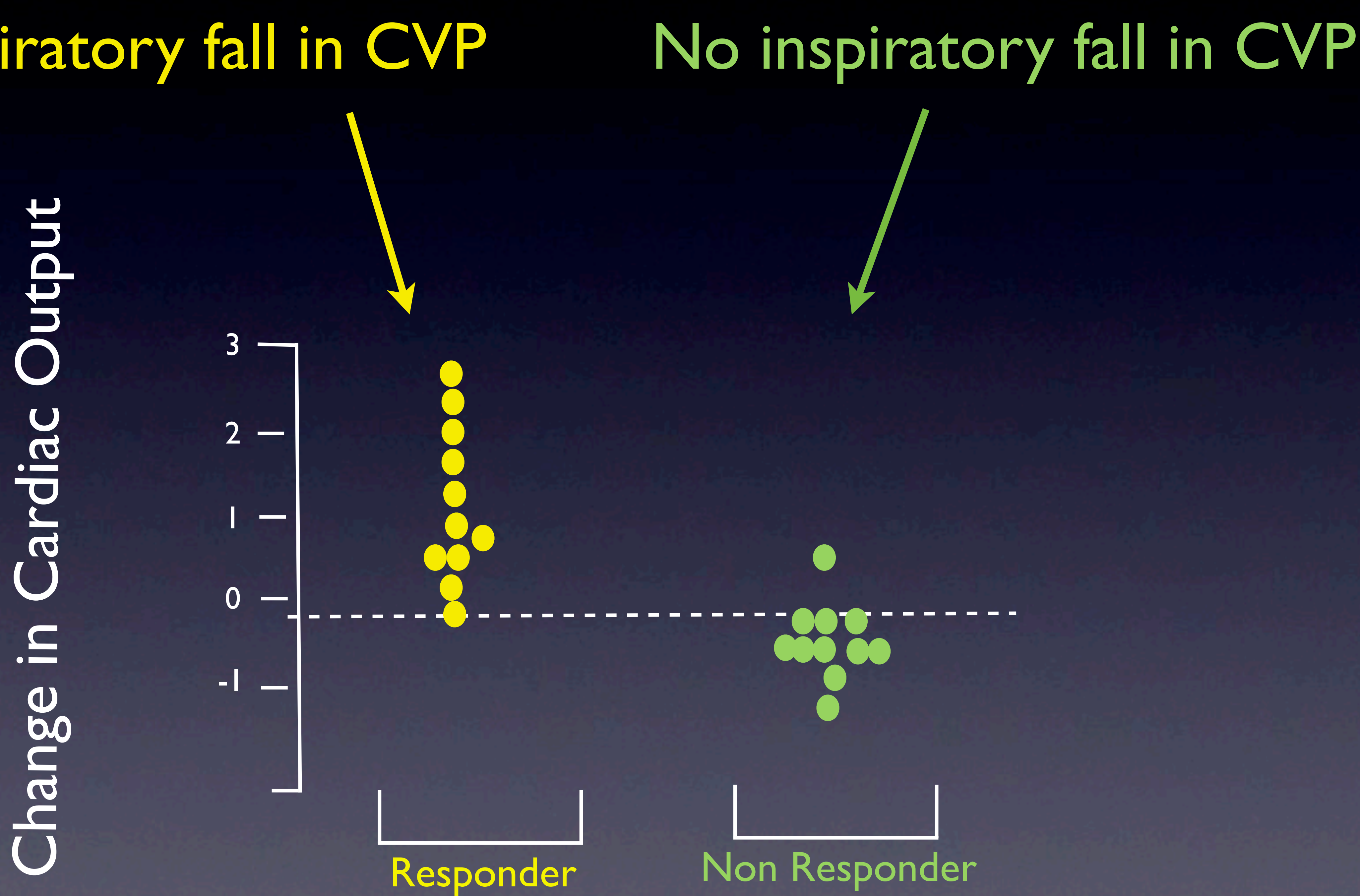


Current Opinion in Critical Care 2005, 11:264 -270

Pulse oximeter plethysmographic waveform changes in awake, spontaneously breathing, hypovolemic volunteers

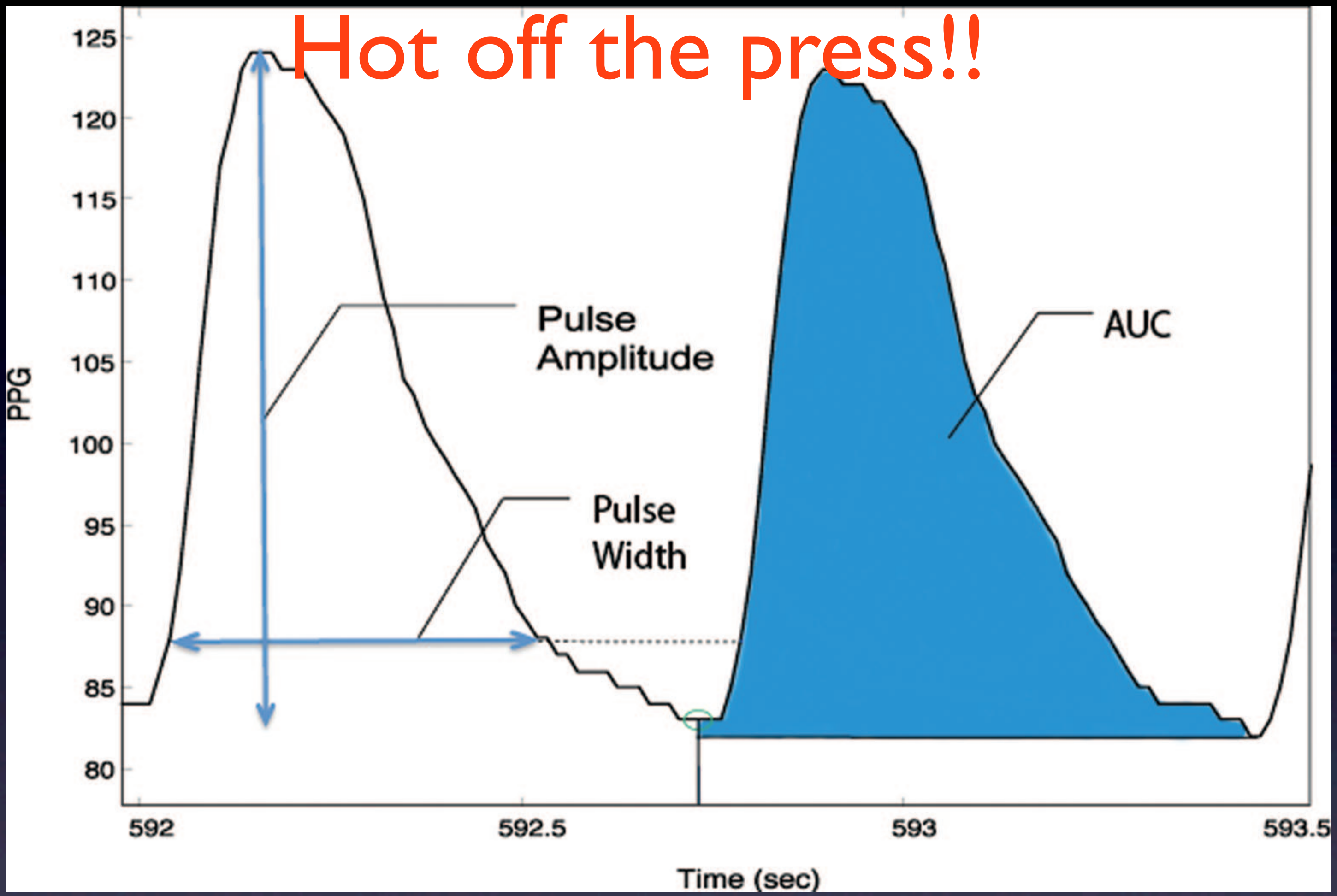
Anesth Analg 2011;112: 368 –74

Pulse oximeter plethysmographic waveform changes in awake, spontaneously breathing, hypovolemic volunteers

Hot off the press!!

Anesth Analg 2011;112: 368 –74

Pulse oximeter plethysmographic waveform changes in awake, spontaneously breathing, hypovolemic volunteers



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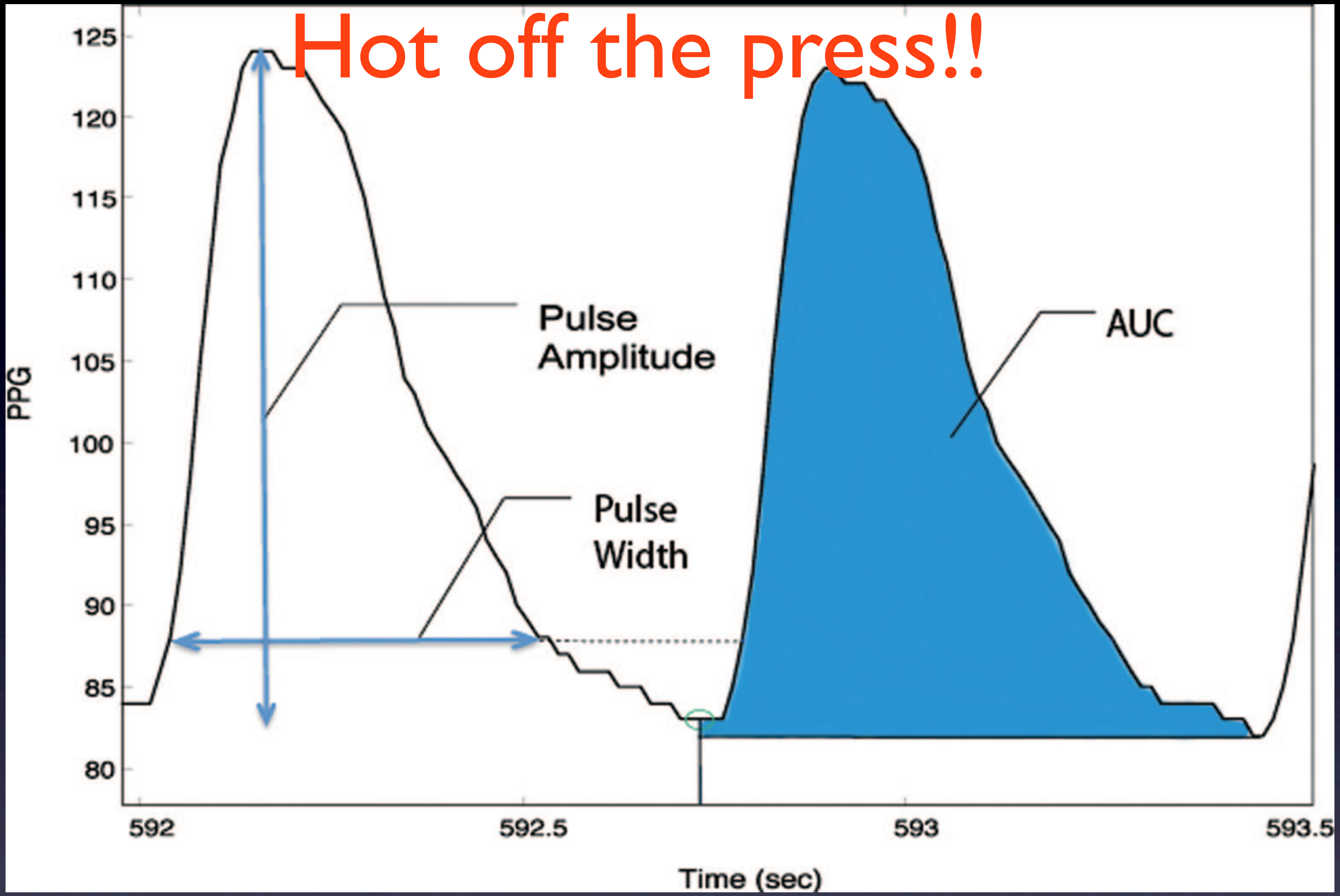

"These results support the use of pulse oximeter waveform analysis as a potential diagnostic tool to **detect clinically significant hypovolemia <u>before</u>** the onset of cardiovascular decompensation in spontaneously breathing patients"

Anesth Analg 2011;112: 368 –74

Cardiac output still inadequate and Patient <u>not</u> fluid responsive?

Cardiac output still inadequate and Patient <u>not</u> fluid responsive?

- ➪ Raise the **<u>B.P.</u>** with inotropes/vasopressors

Cardiac output still inadequate and Patient <u>not</u> fluid responsive?

➪ Raise the **<u>B.P</u>.** with inotropes/vasopressors

➪ Is **C.O.** adequate (ex. clinically,ScvO2, lactate clearance etc) ?

Cardiac output still inadequate and Patient not fluid responsive?

- ⇨ Raise the **B.P.** with inotropes/vasopressors
- ⇨ Is **C.O.** adequate (ex. clinically,ScvO2, lactate clearance etc) ?
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Cardiac output still inadequate and Patient not fluid responsive?

- ⇨ Raise the **B.P.** with inotropes/vasopressors

- ⇨ Is **C.O.** adequate (ex. clinically,ScvO2, lactate clearance etc) ?

  - ⇨ If not - Dobutamine/RBCs

- ⇨ ?? Resuscitate the microcirculation

Inadequate 02 delivery
-there is not a moment to lose!
"Golden hour"

Analogous to fibrinolysis and myocardial infarction!

Time is Life !

"Golden hour" shown in :

AWiggers,C m J Physiol 144: 91-101, 1945
Santy, P. et al, Shock Traumatique dans les blessures de Guerre. Bull. Med. Soc. Chir., 1918, 44:205
CHEST 2002; 121:877–905
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Time is Life !

"Golden hour" shown in :

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Time is Life !

“Golden hour” shown in :

- ❖Haemorrhagic shock
- ❖Trauma
- ❖Major Pulmonary Embolism
- ❖Septic shock

AWiggers,C m J Physiol 144: 91-101, 1945
Santy, P. et al, Shock Traumatique dans les blessures de Guerre. Bull. Med. Soc. Chir., 1918, 44:205
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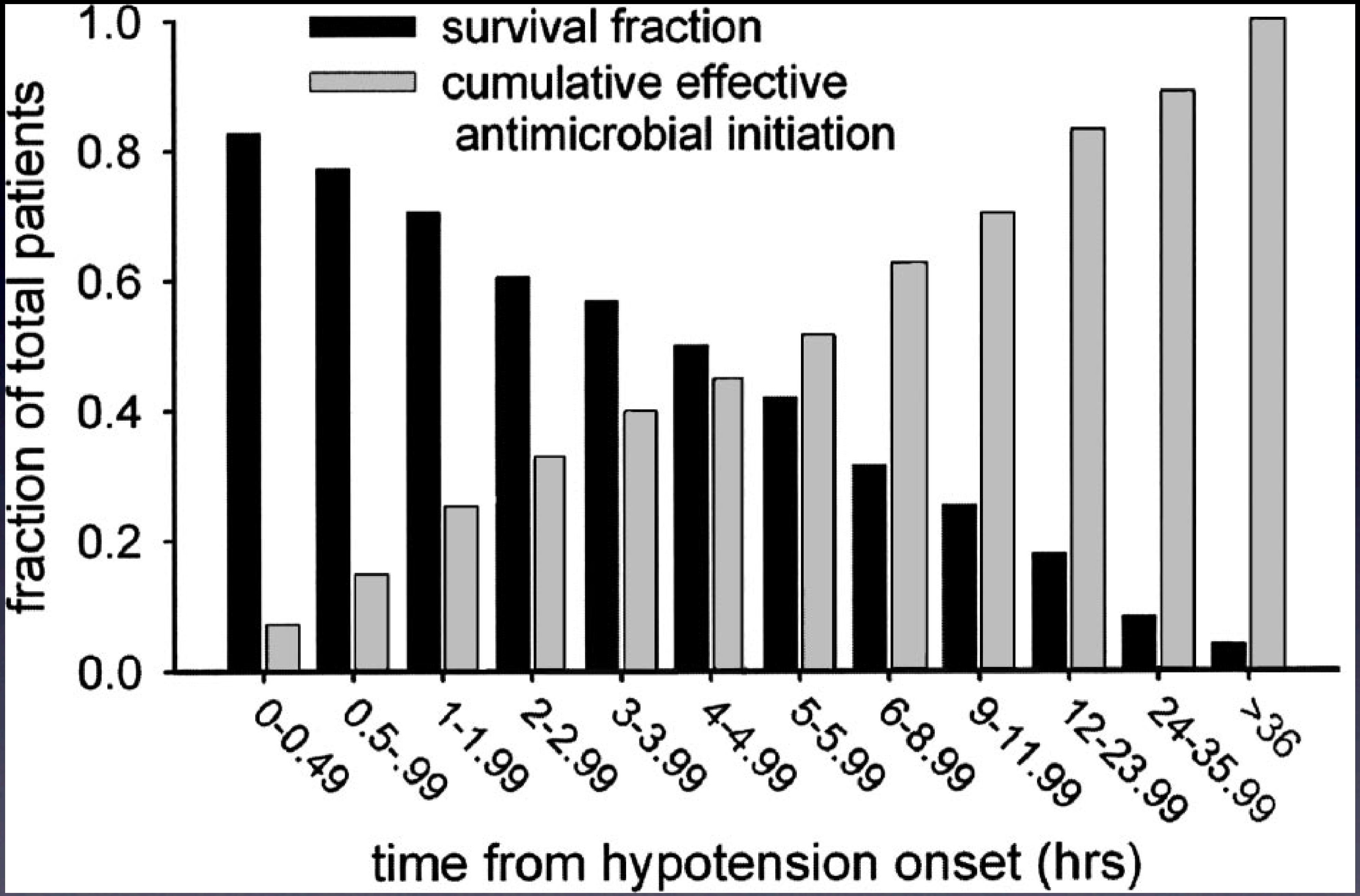
Time is Life !

Crit Care Med 2006; 34:1589–1596

Time is Life !



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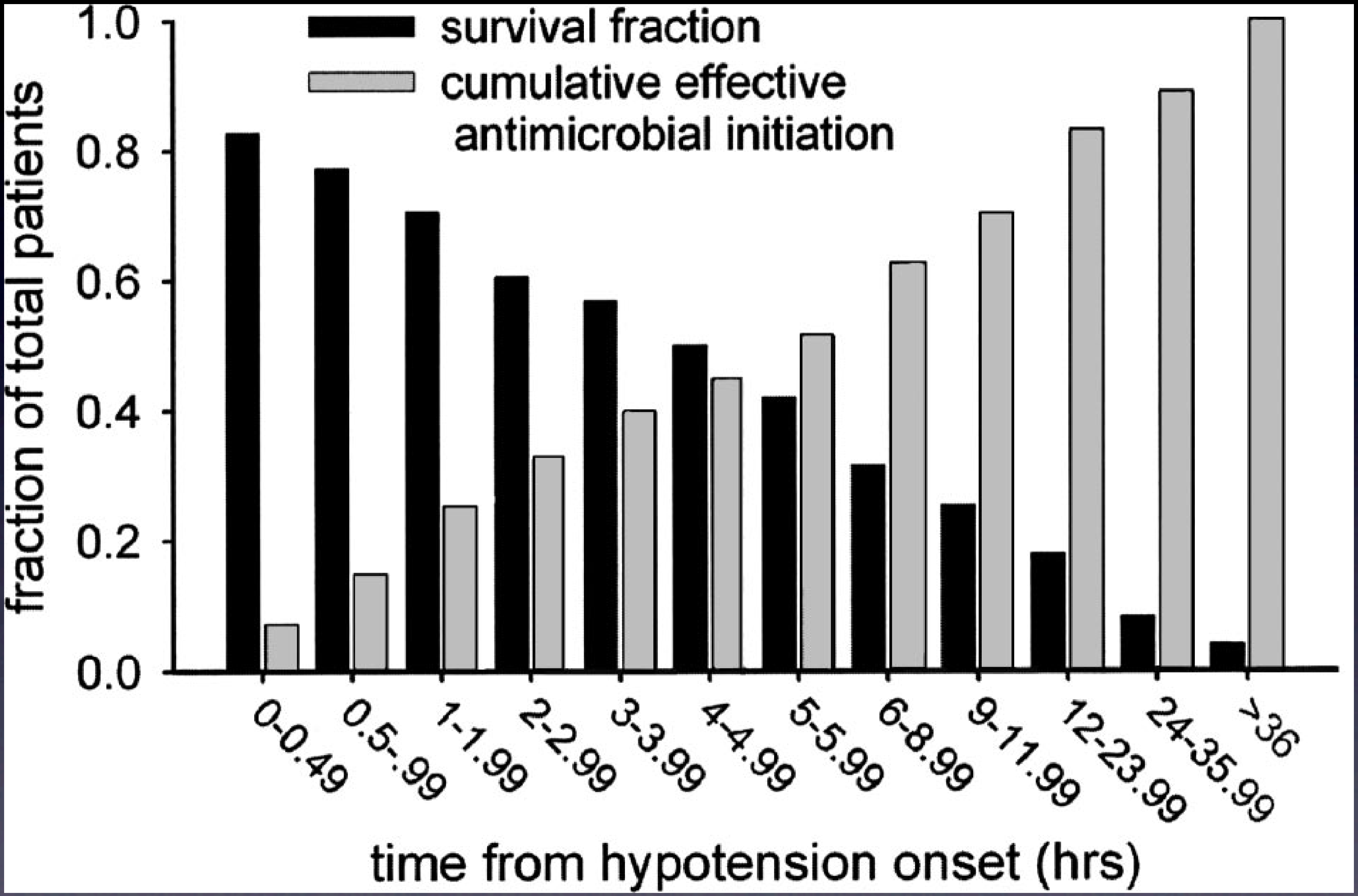


8% more die with each hours delay!

Crit Care Med 2006; 34:1589–1596

Clinical Case

Clinical Case

55 yr old male pedestrian v car

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

Distended abdomen

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

Distended abdomen

Resuscitated with colloid / crystalloid

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

Distended abdomen

Resuscitated with colloid / crystalloid

In pain, so you give morphine

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

Distended abdomen

Resuscitated with colloid / crystalloid

In pain, so you give morphine

What happens?

Clinical Case

55 yr old male pedestrian v car

Taken to A+E

Fractured femoral shaft

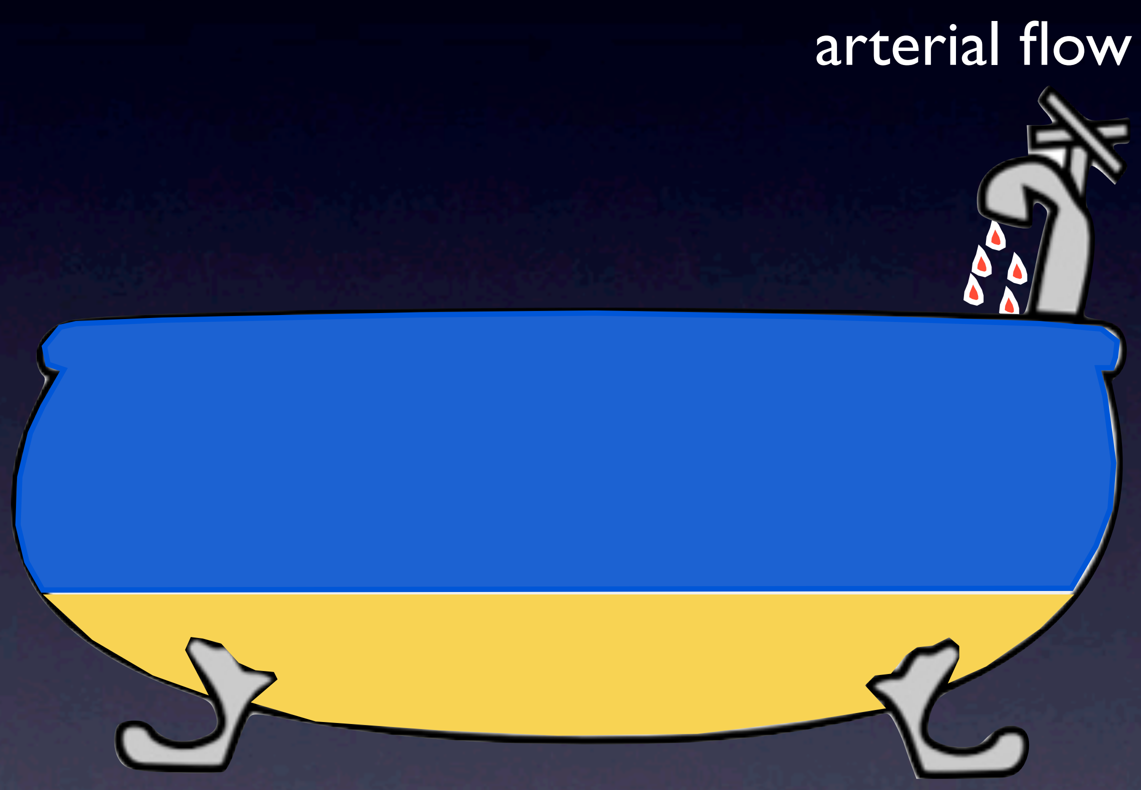
Distended abdomen

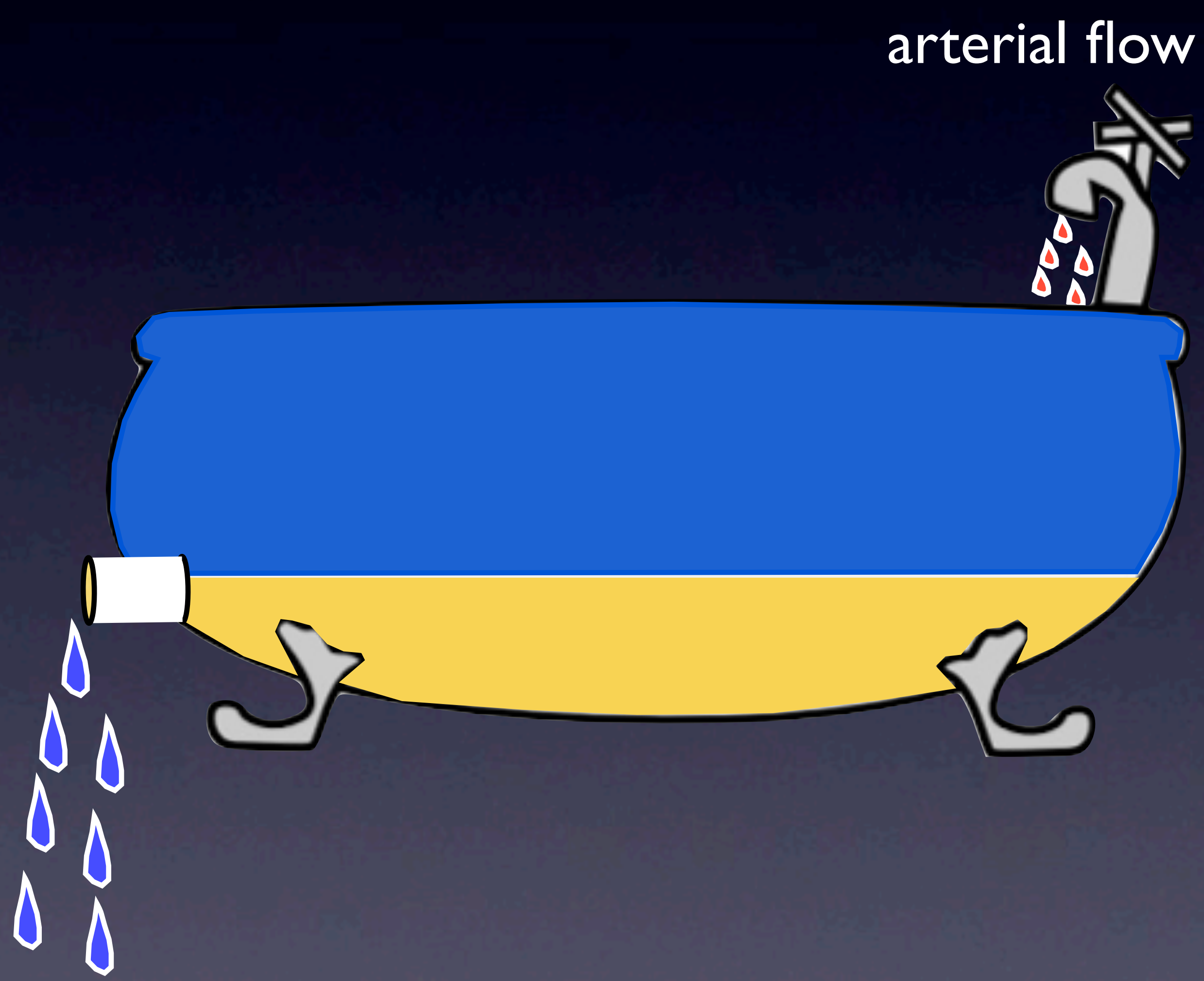
Resuscitated with colloid / crystalloid

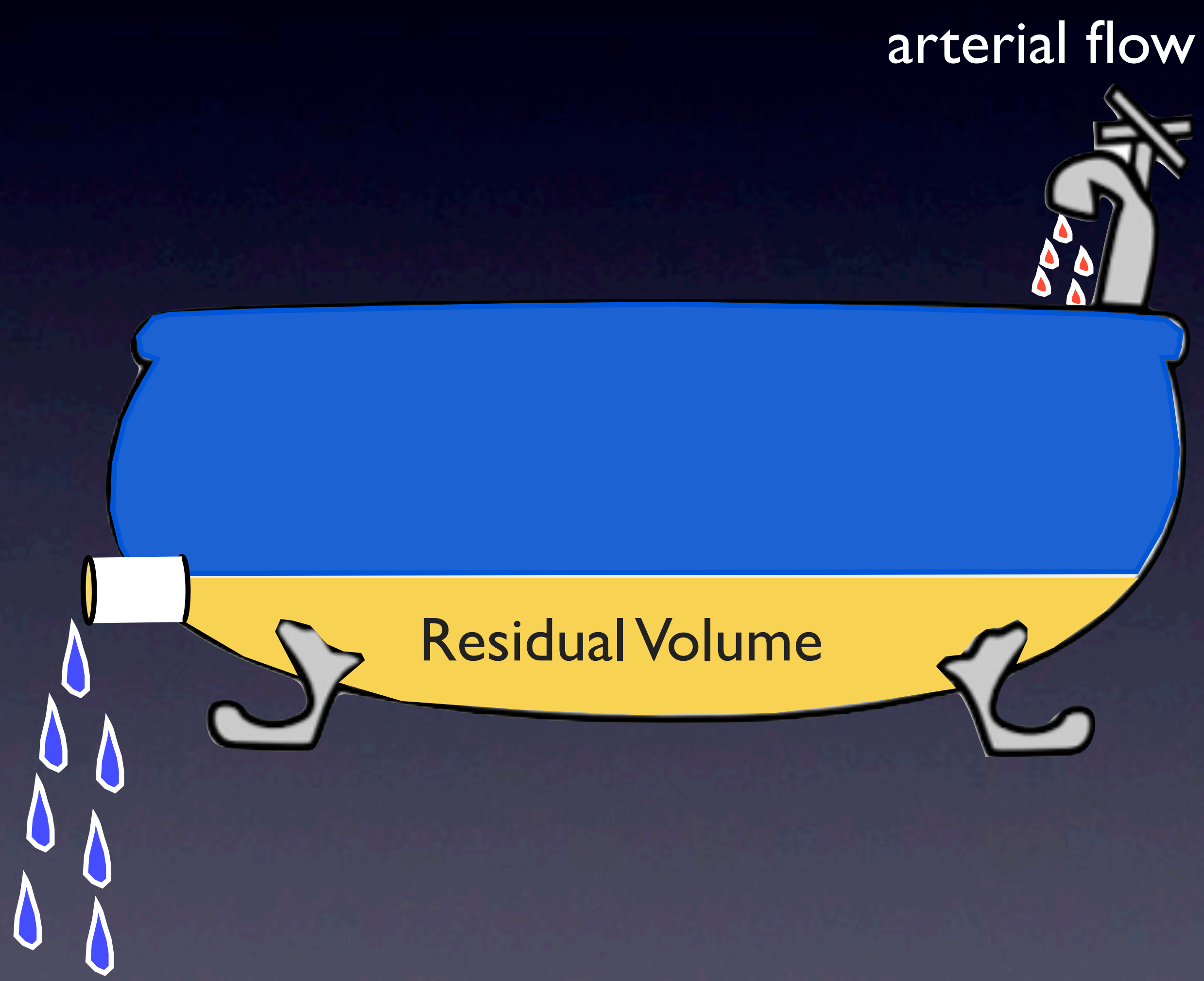
In pain, so you give morphine

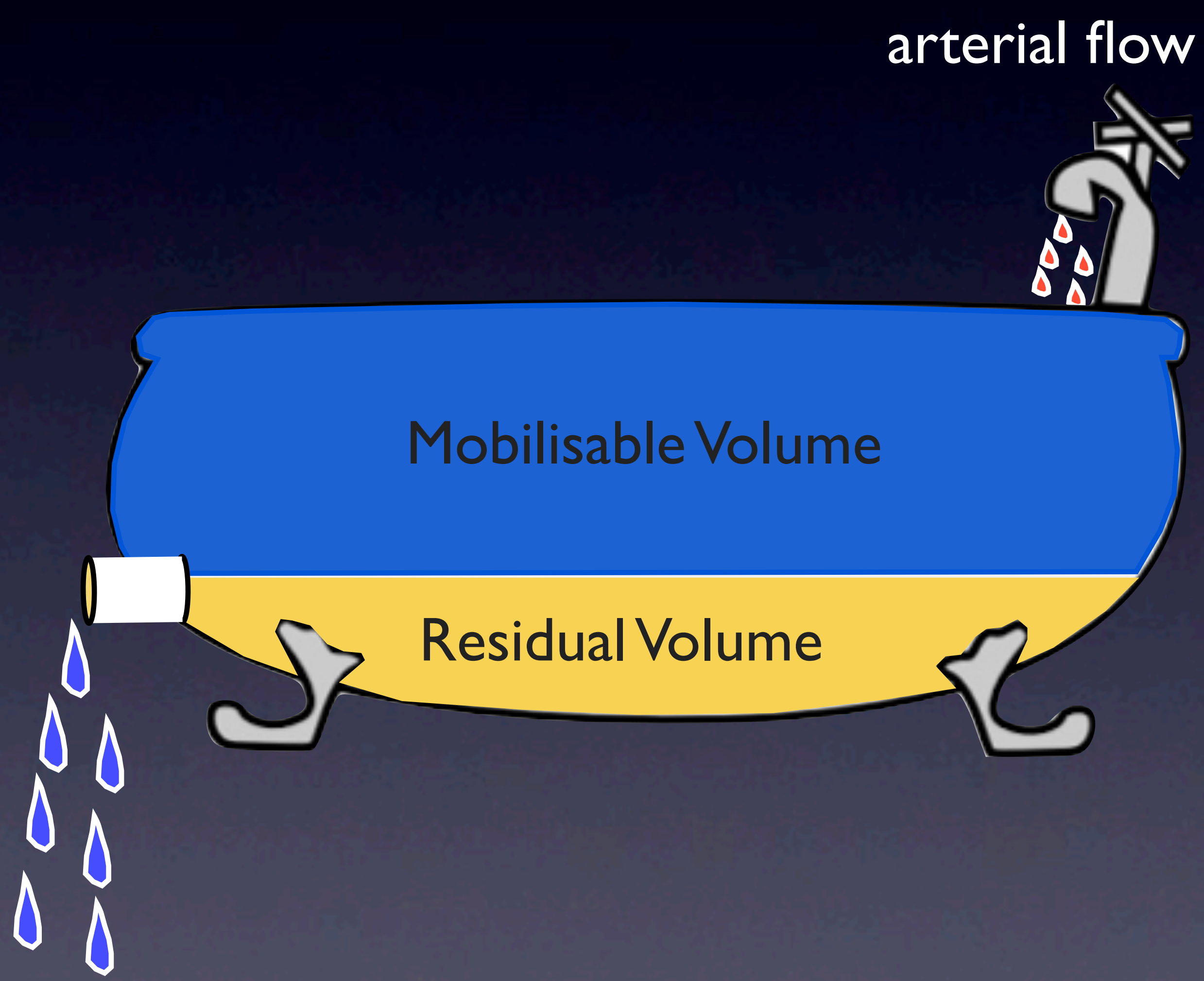
What happens?

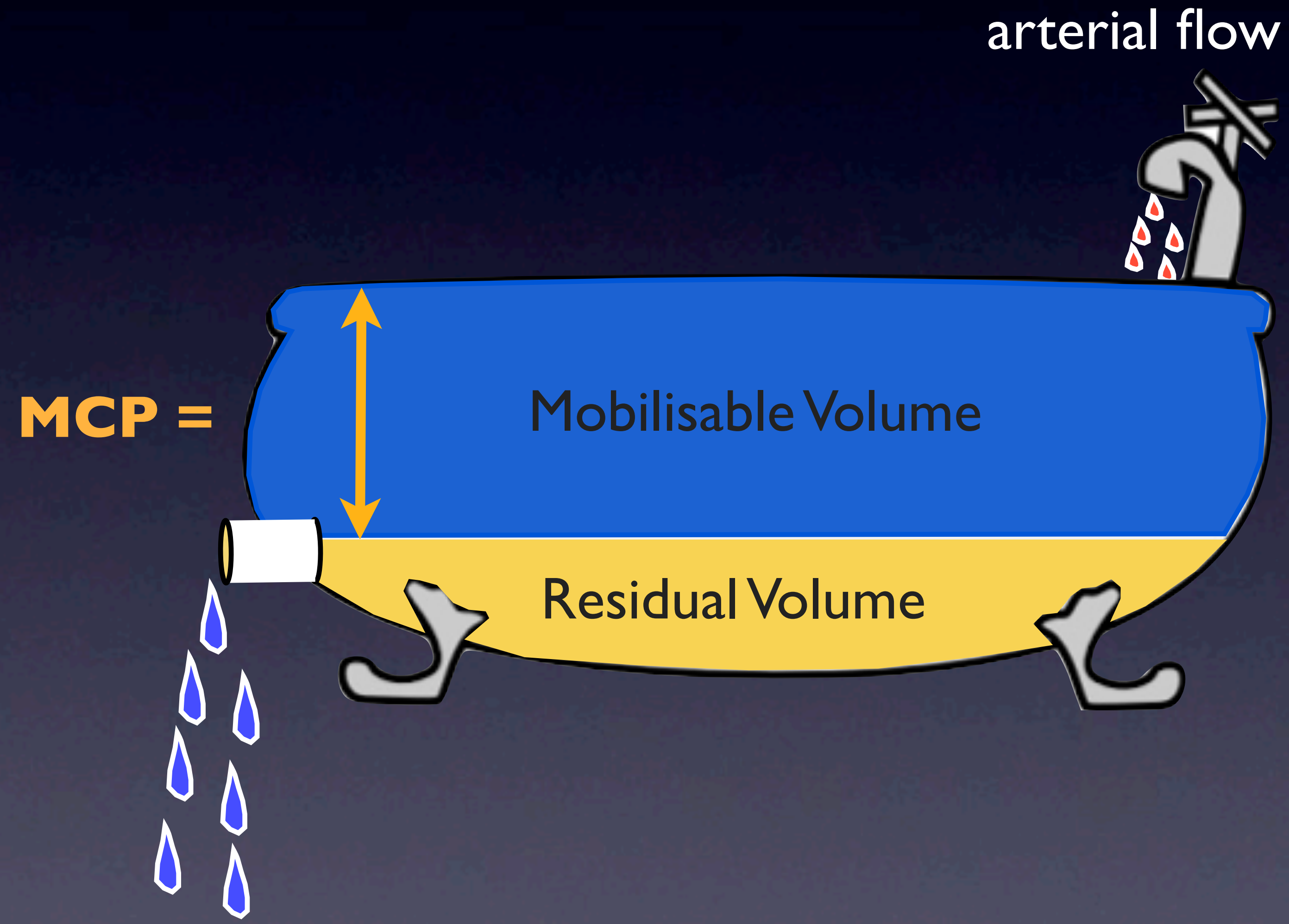
Why?

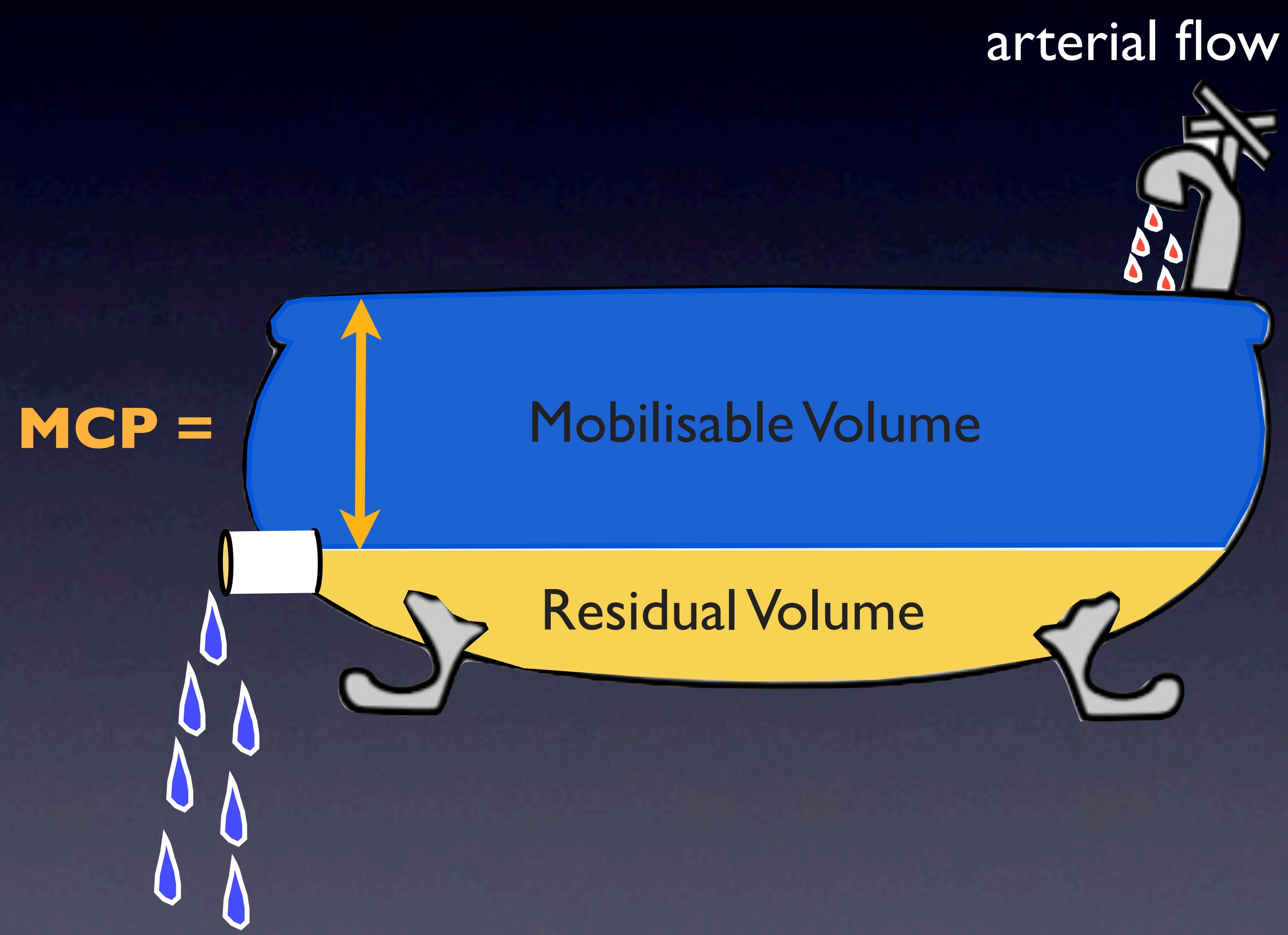

arterial flow


arterial flow

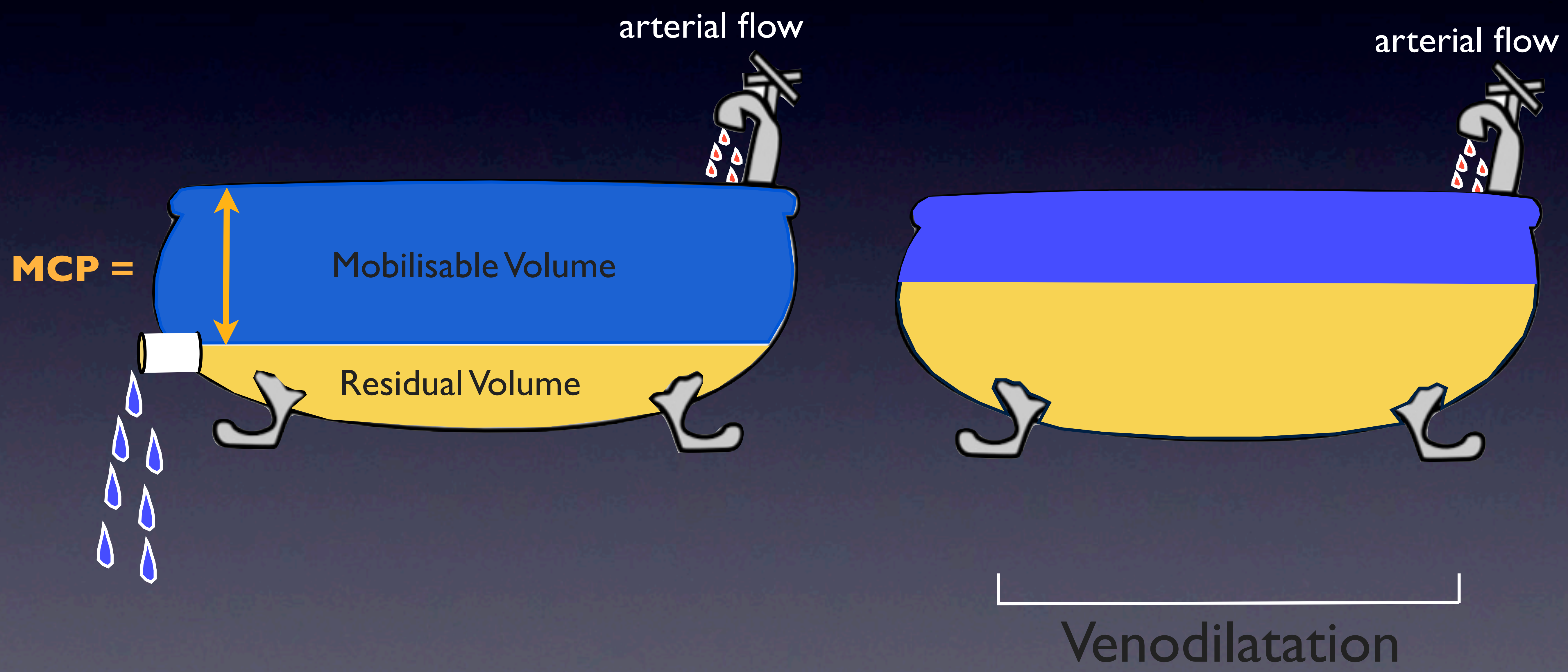

arterial flow
Residual Volume

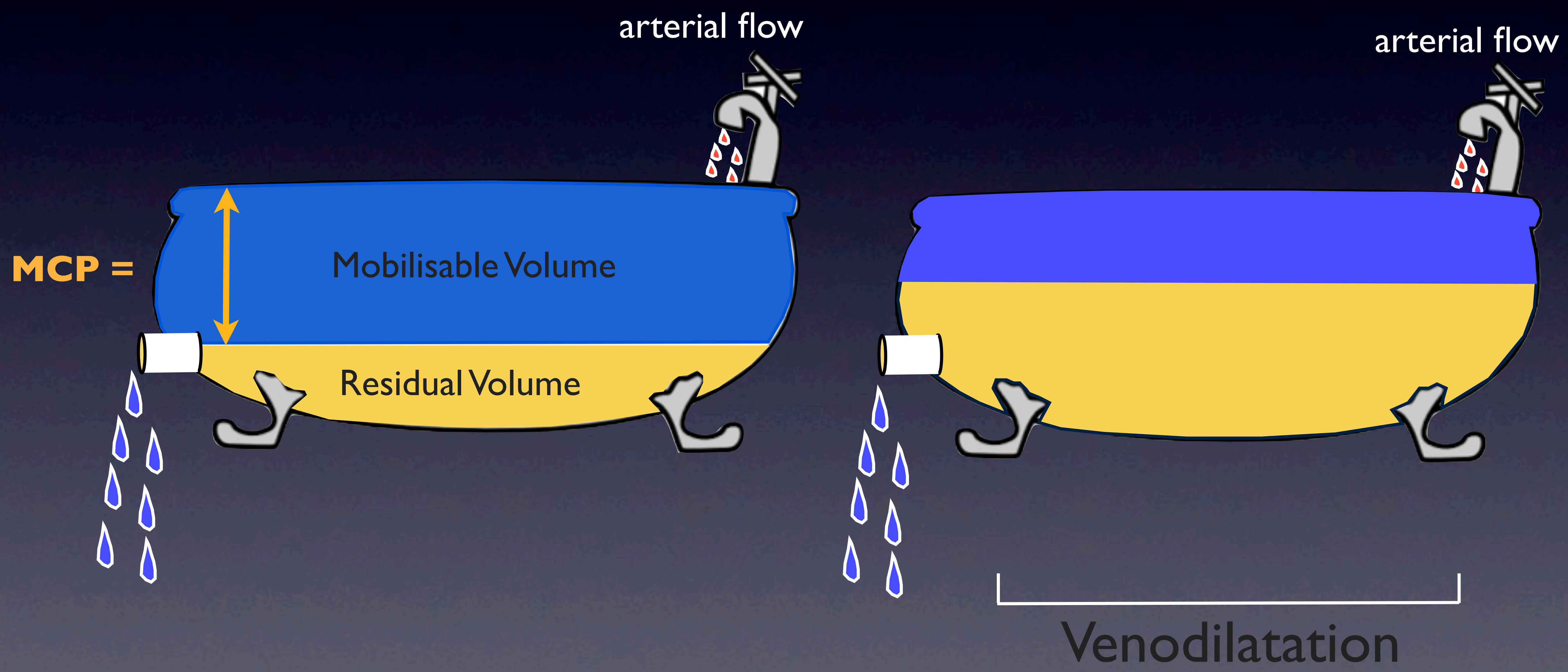

arterial flow
Mobilisable Volume
Residual Volume


arterial flow
MCP =
Mobilisable Volume
Residual Volume



Venodilatation


arterial flow
MCP =
Mobilisable Volume
Residual Volume
arterial flow
Venodilatation


arterial flow
MCP =
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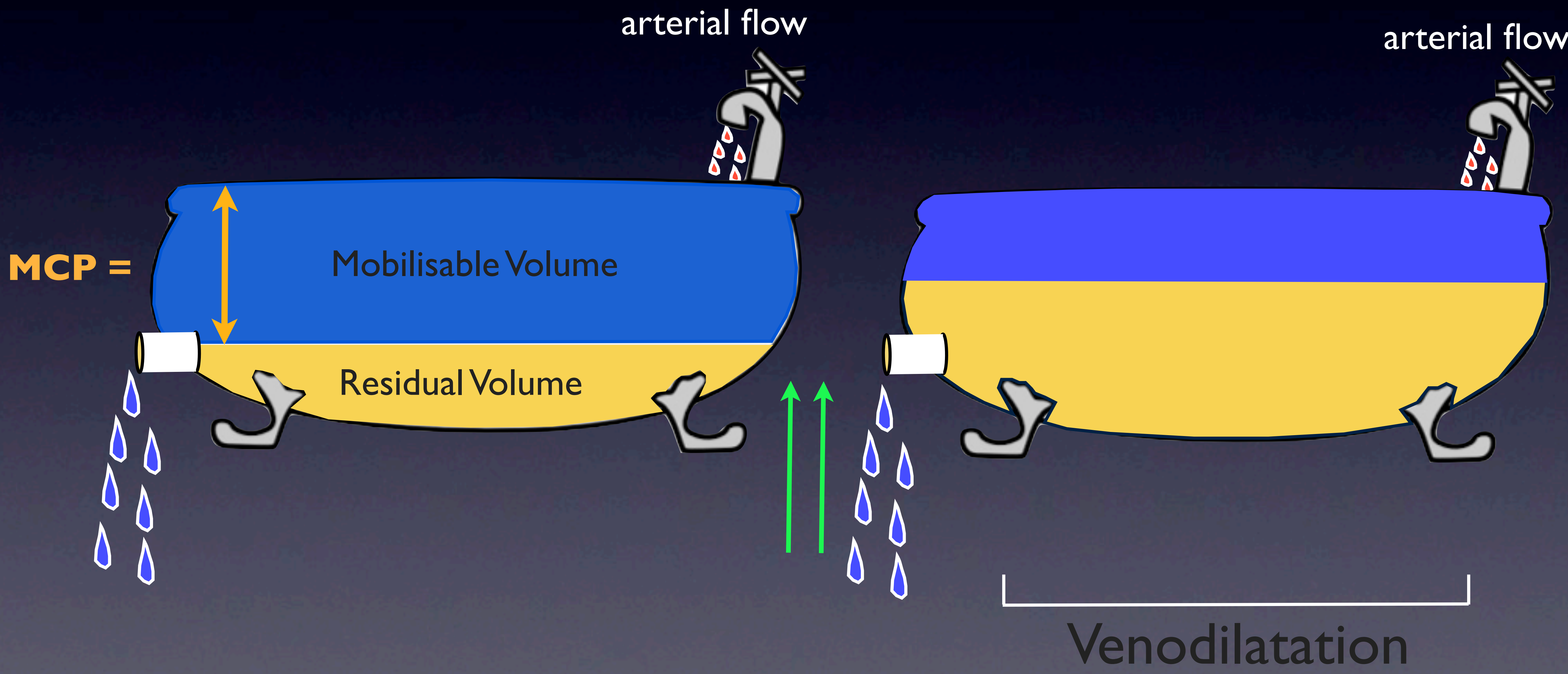
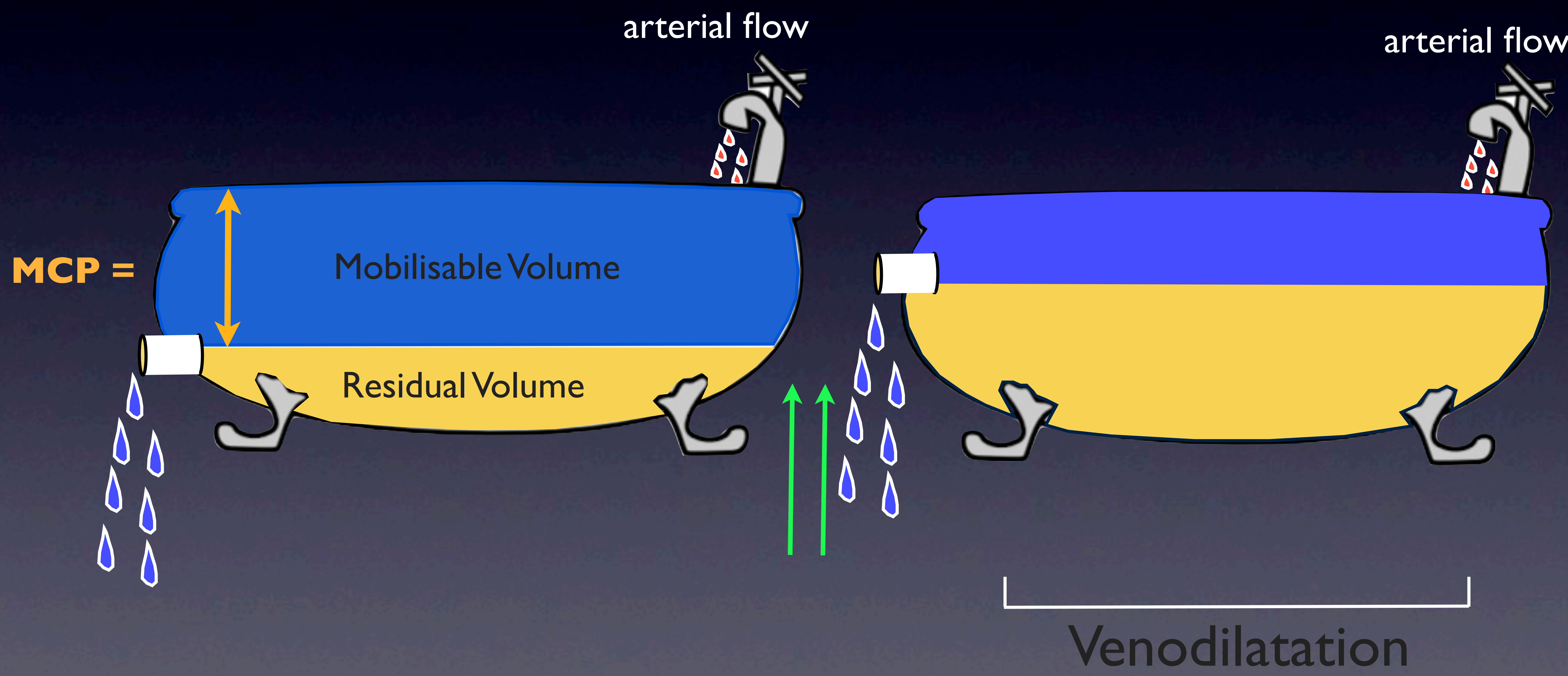
arterial flow
Venodilatation



arterial flow
MCP =
Mobilisable Volume
Residual Volume
arterial flow
Venodilatation


arterial flow
MCP =
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arterial flow
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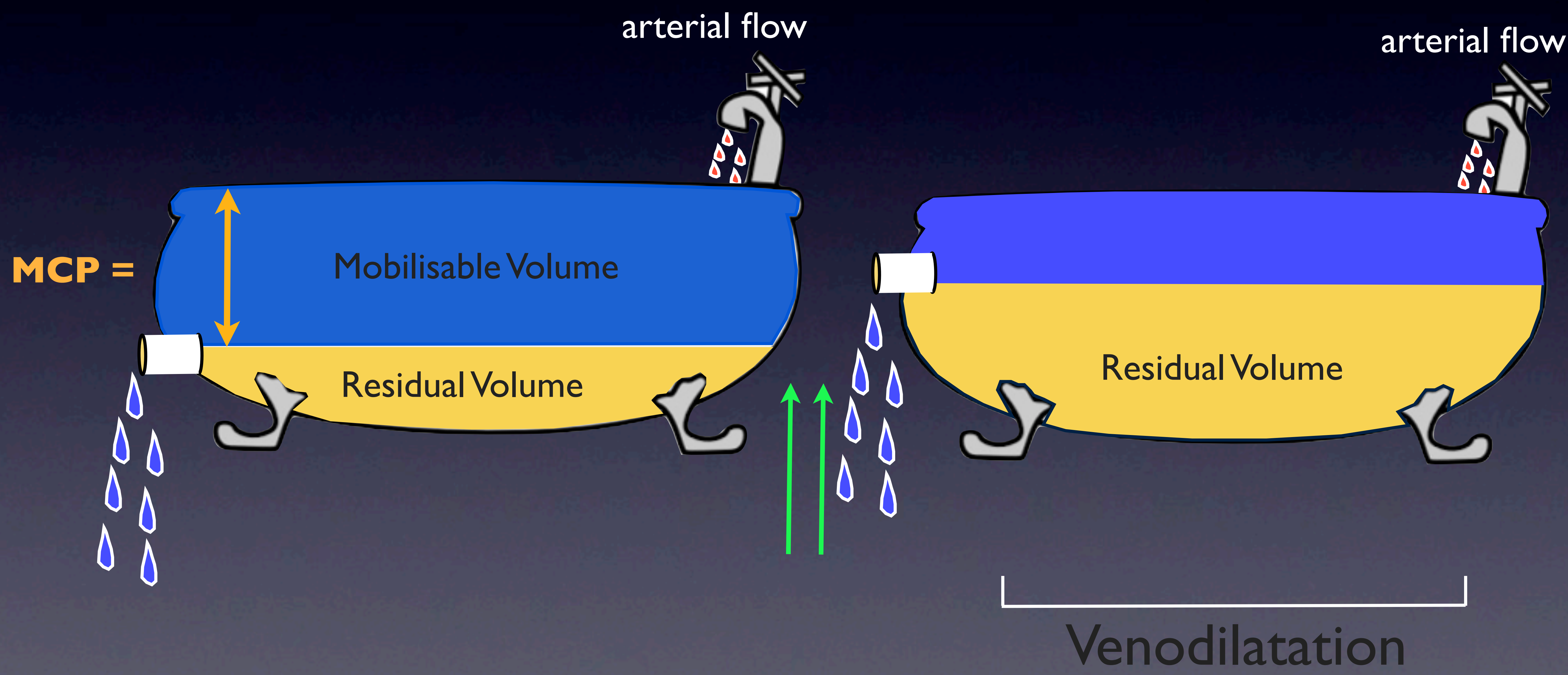
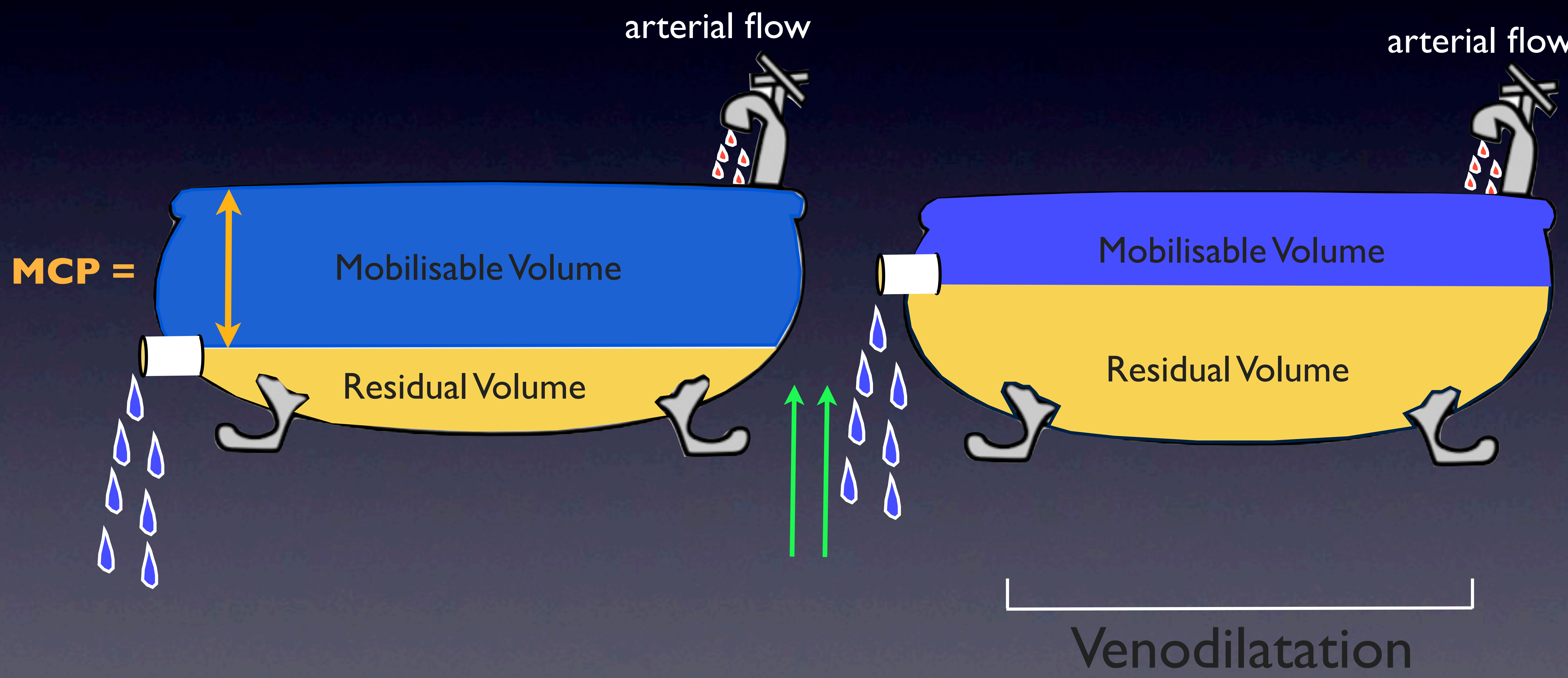


arterial flow
MCP =
Mobilisable Volume
Residual Volume
arterial flow
Residual Volume
Venodilatation


arterial flow
MCP =
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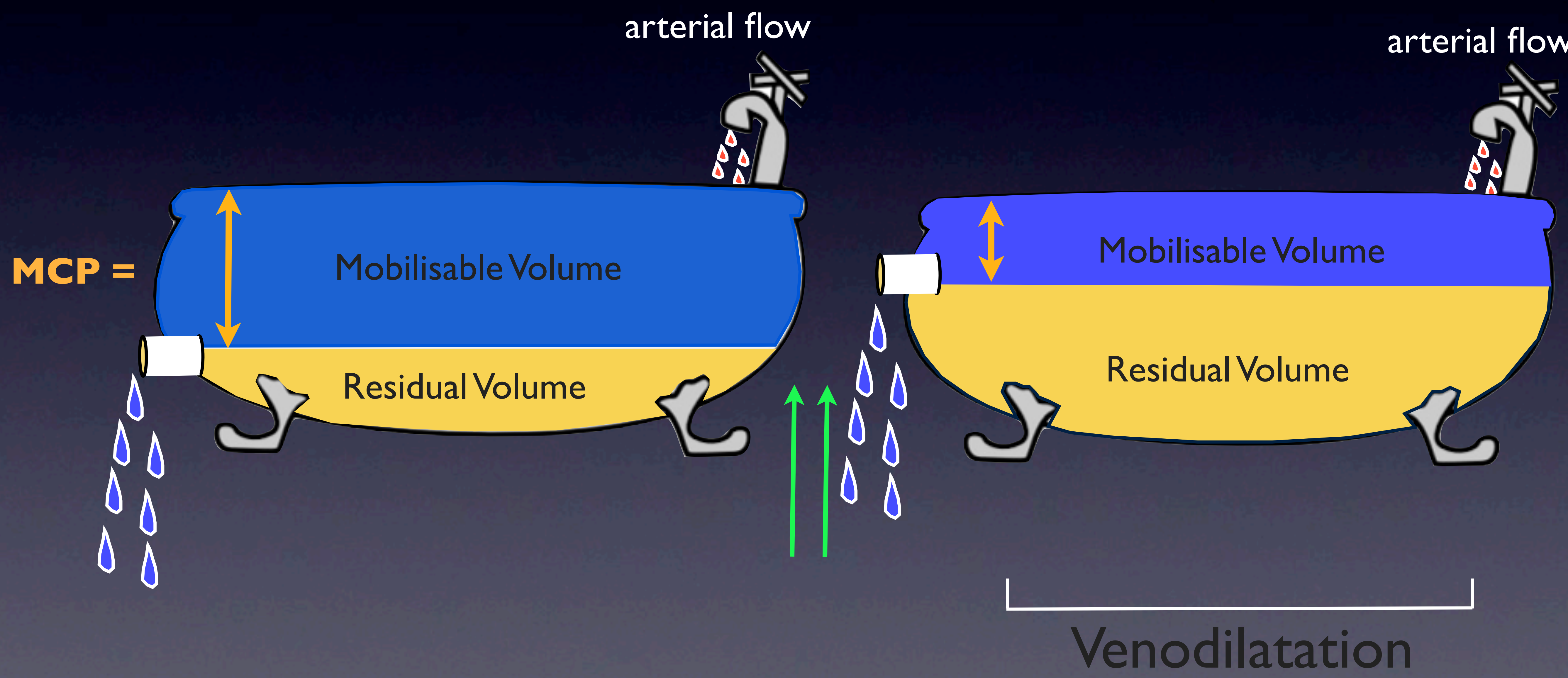
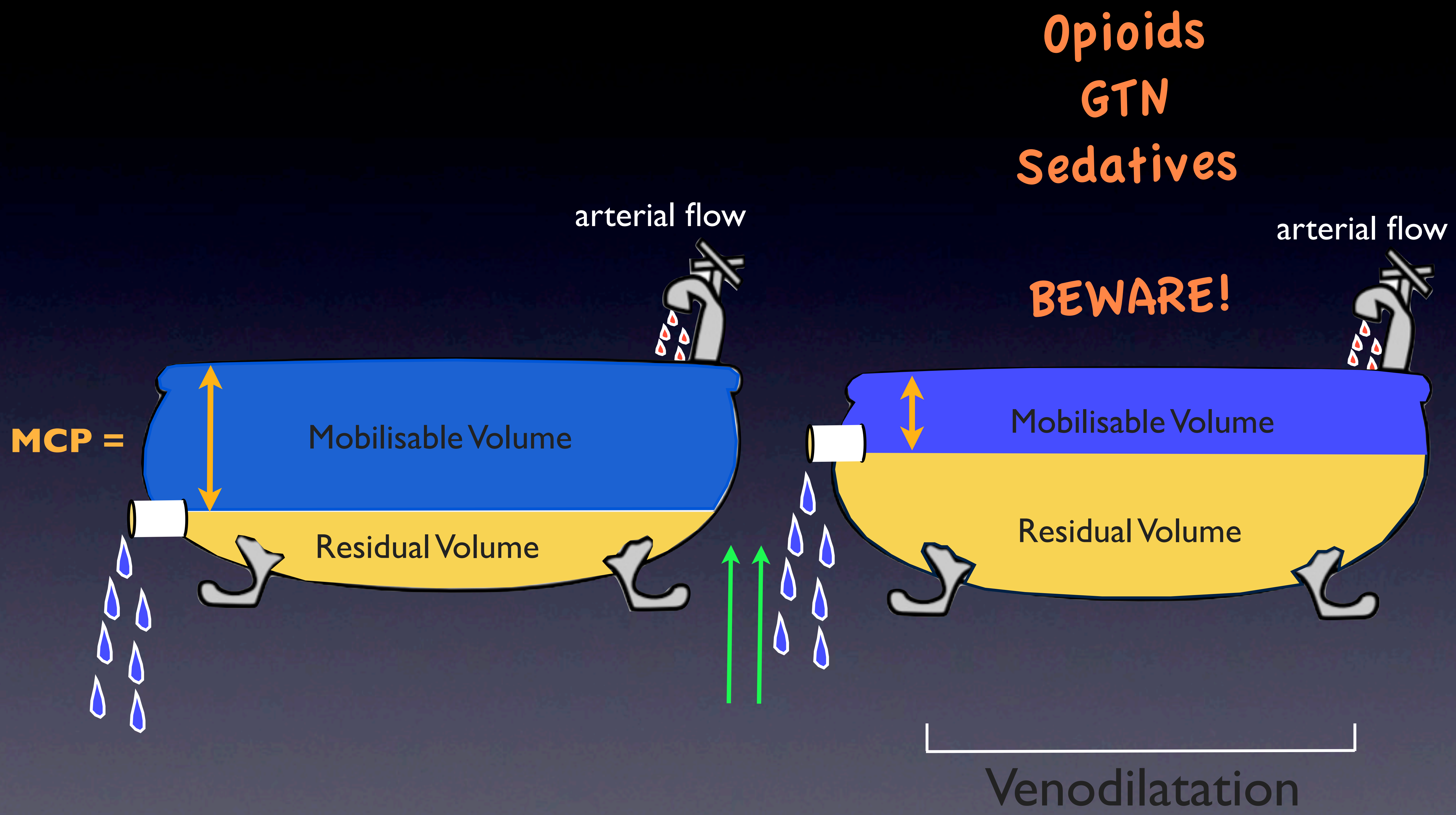
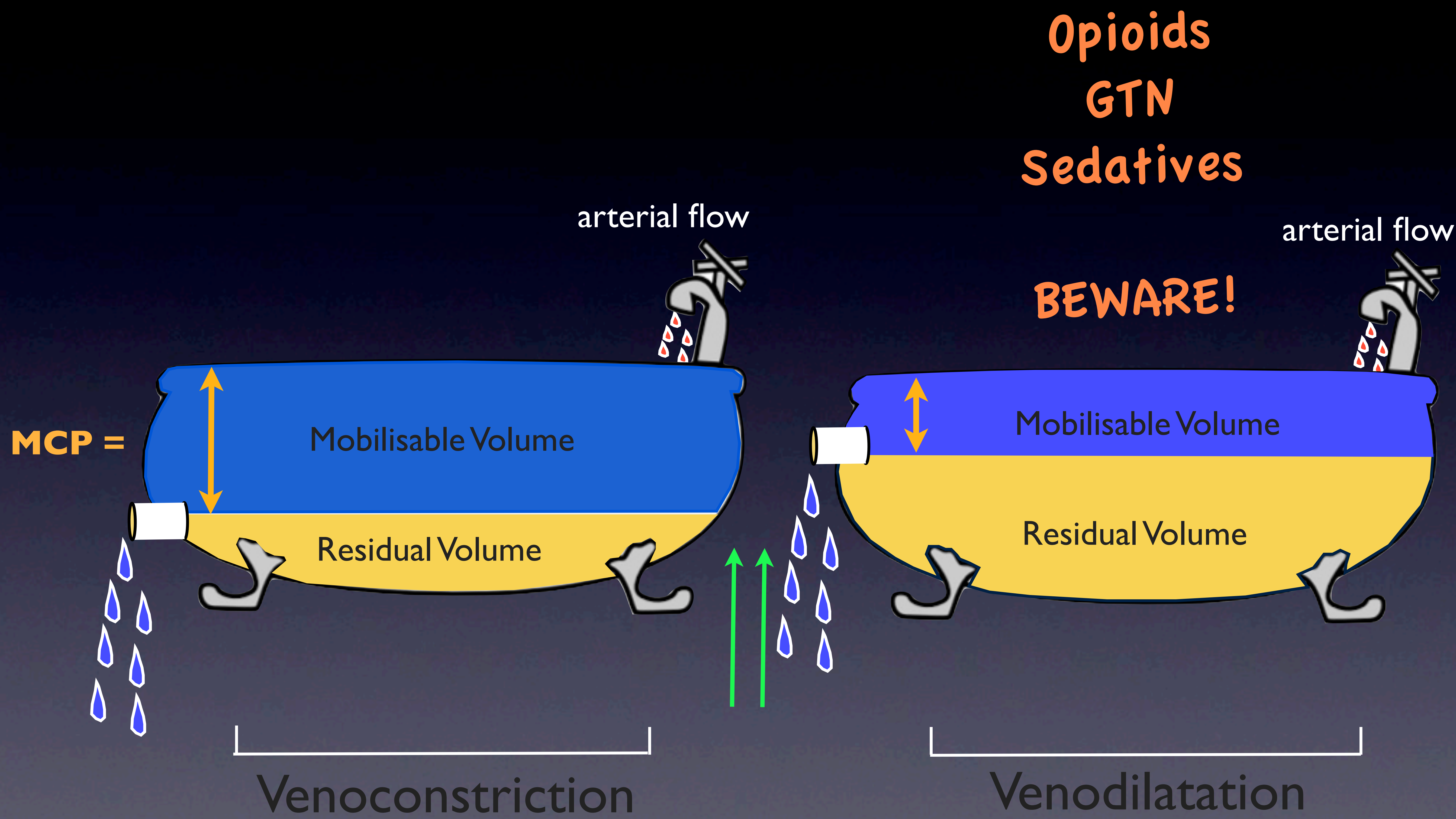
arterial flow
Mobilisable Volume
Residual Volume
Venodilatation


arterial flow
arterial flow
MCP =
Mobilisable Volume
Residual Volume
Mobilisable Volume
Residual Volume
Venodilatation

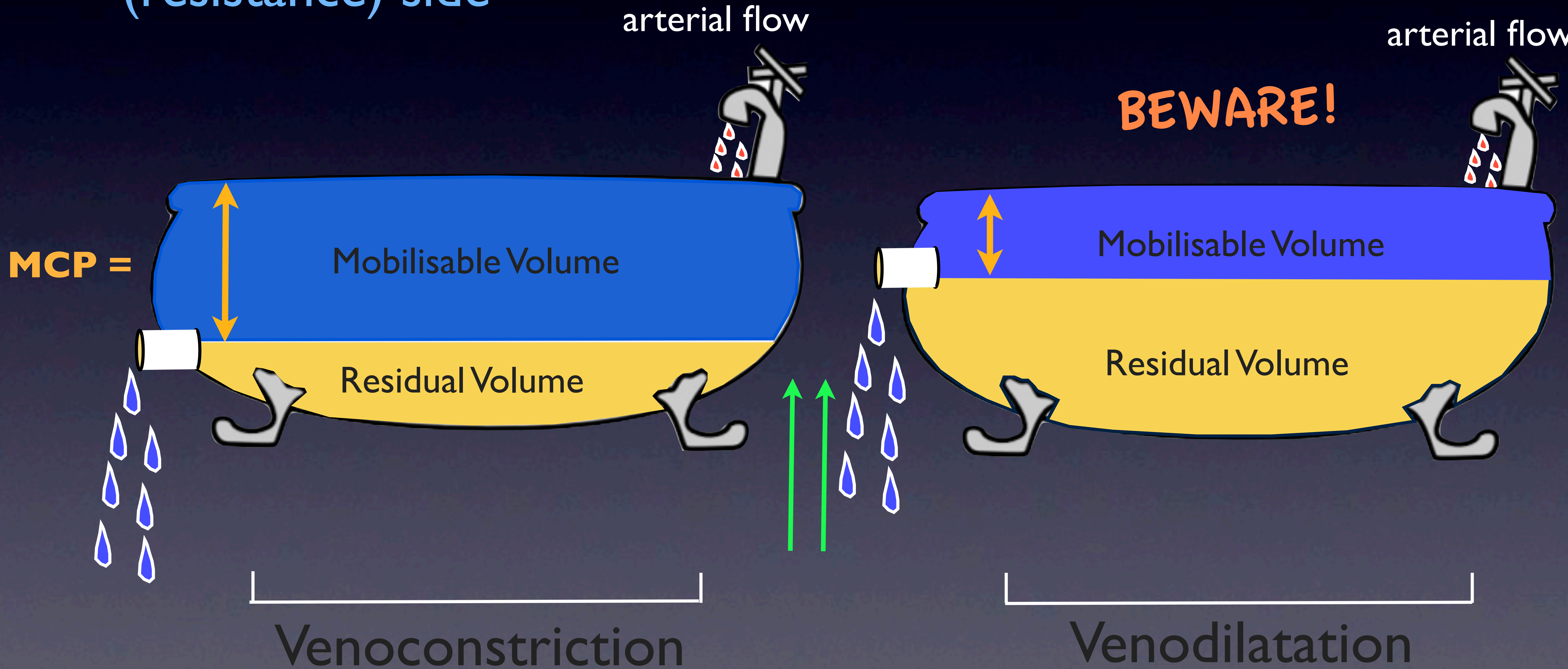

Opioids
GTN
Sedatives
arterial flow
arterial flow
BEWARE!
MCP =
Mobilisable Volume
Residual Volume
Mobilisable Volume
Residual Volume
Venodilatation

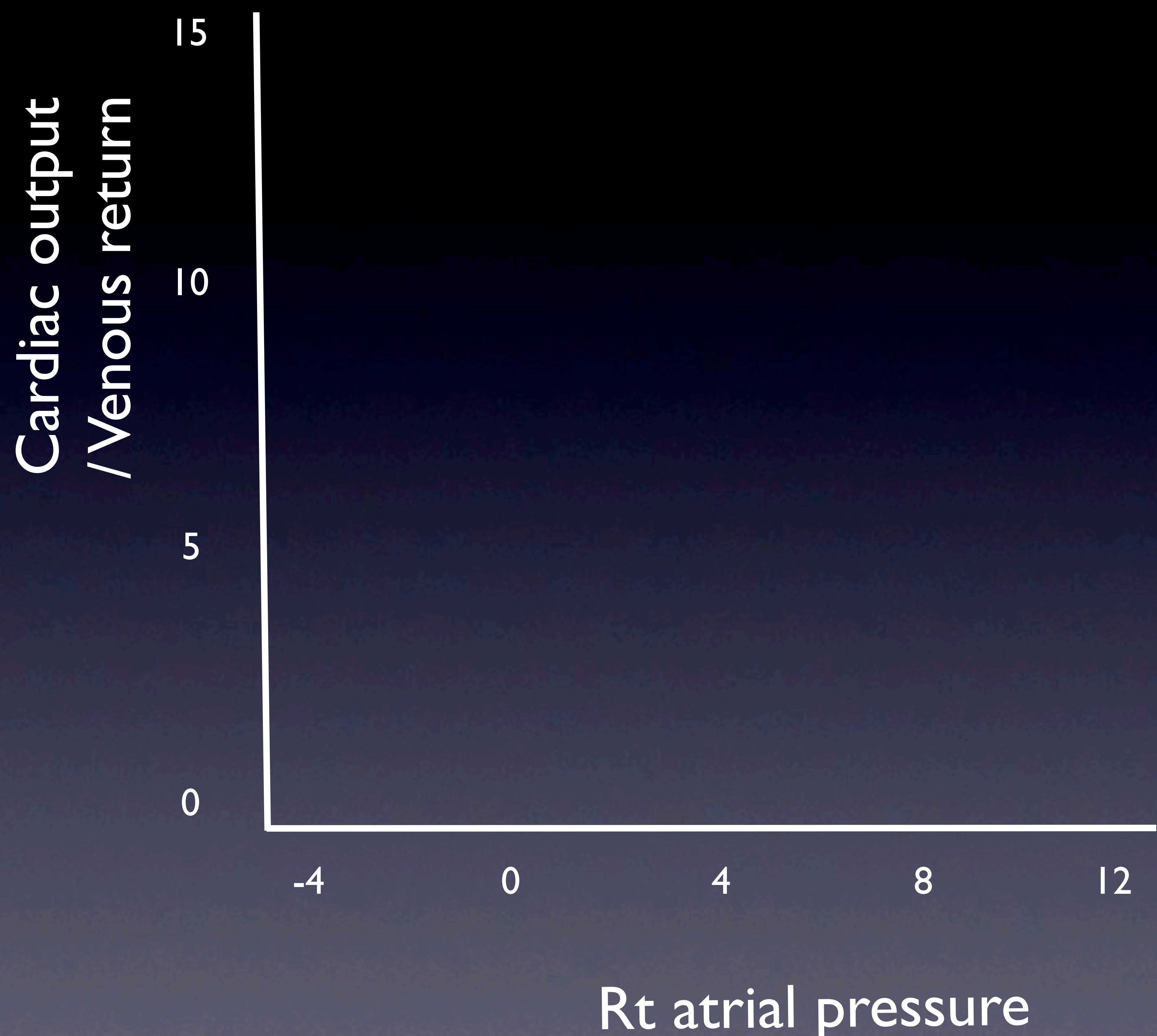


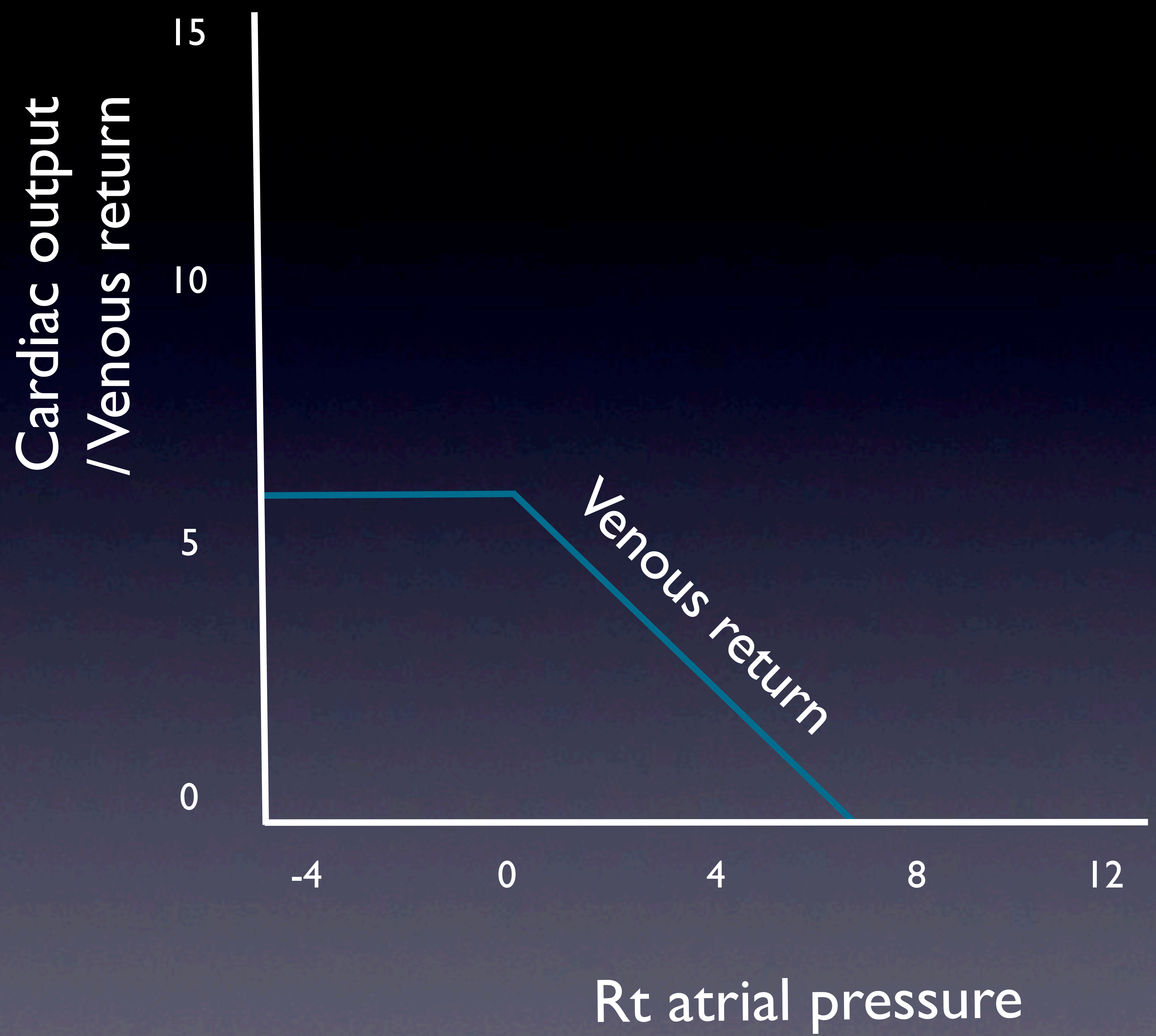
Opioids
GTN
Sedatives
arterial flow
arterial flow
BEWARE!
MCP =
Mobilisable Volume
Residual Volume
Mobilisable Volume
Residual Volume
Venoconstriction
Venodilatation

Vasopressors are 5 X more potent on the venous (capacity) side then on the arterial (resistance) side

Opioids
GTN
Sedatives




Cardiac output
/Venous return
15
10
5
0
-4
0
4
8
12
Rt atrial pressure



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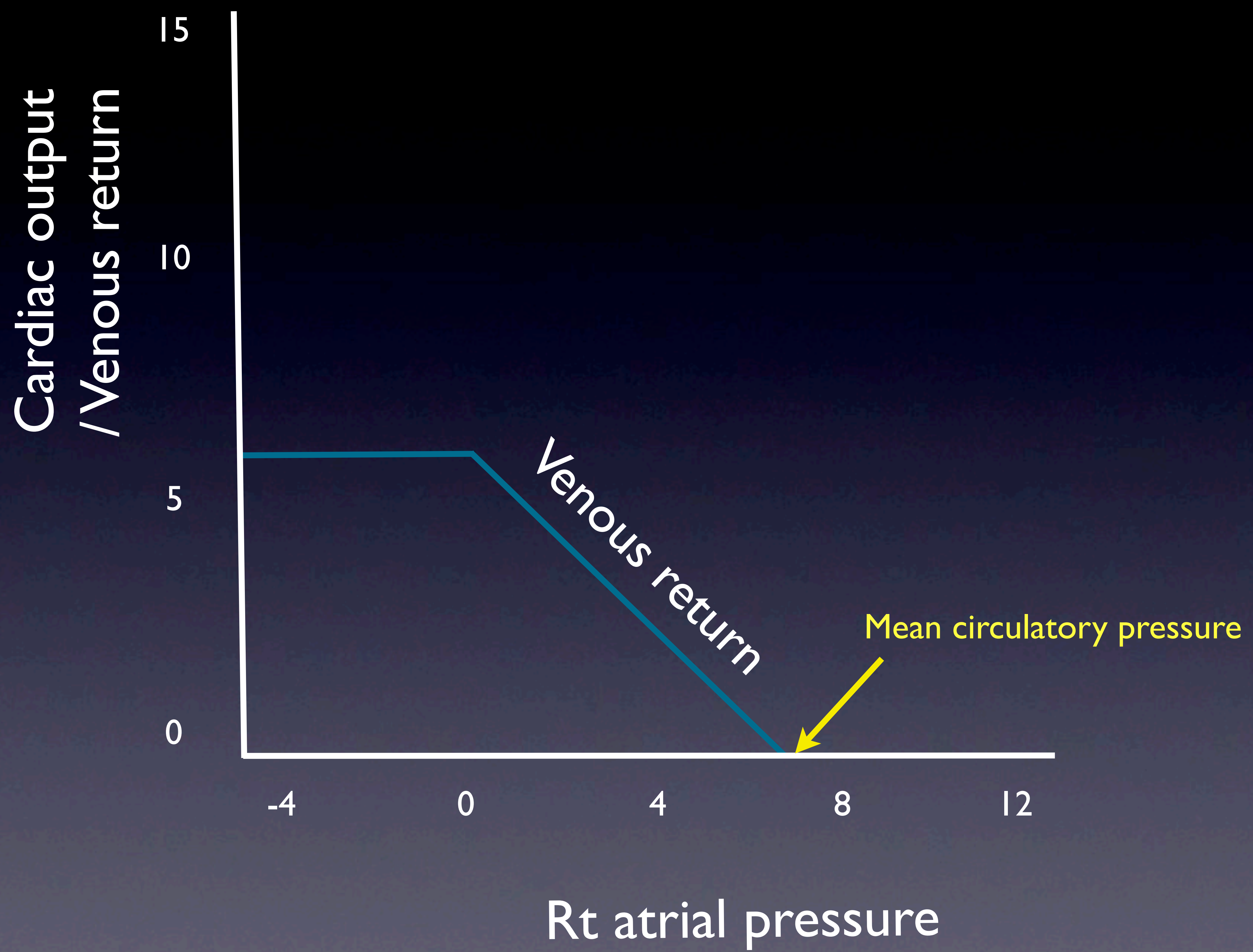
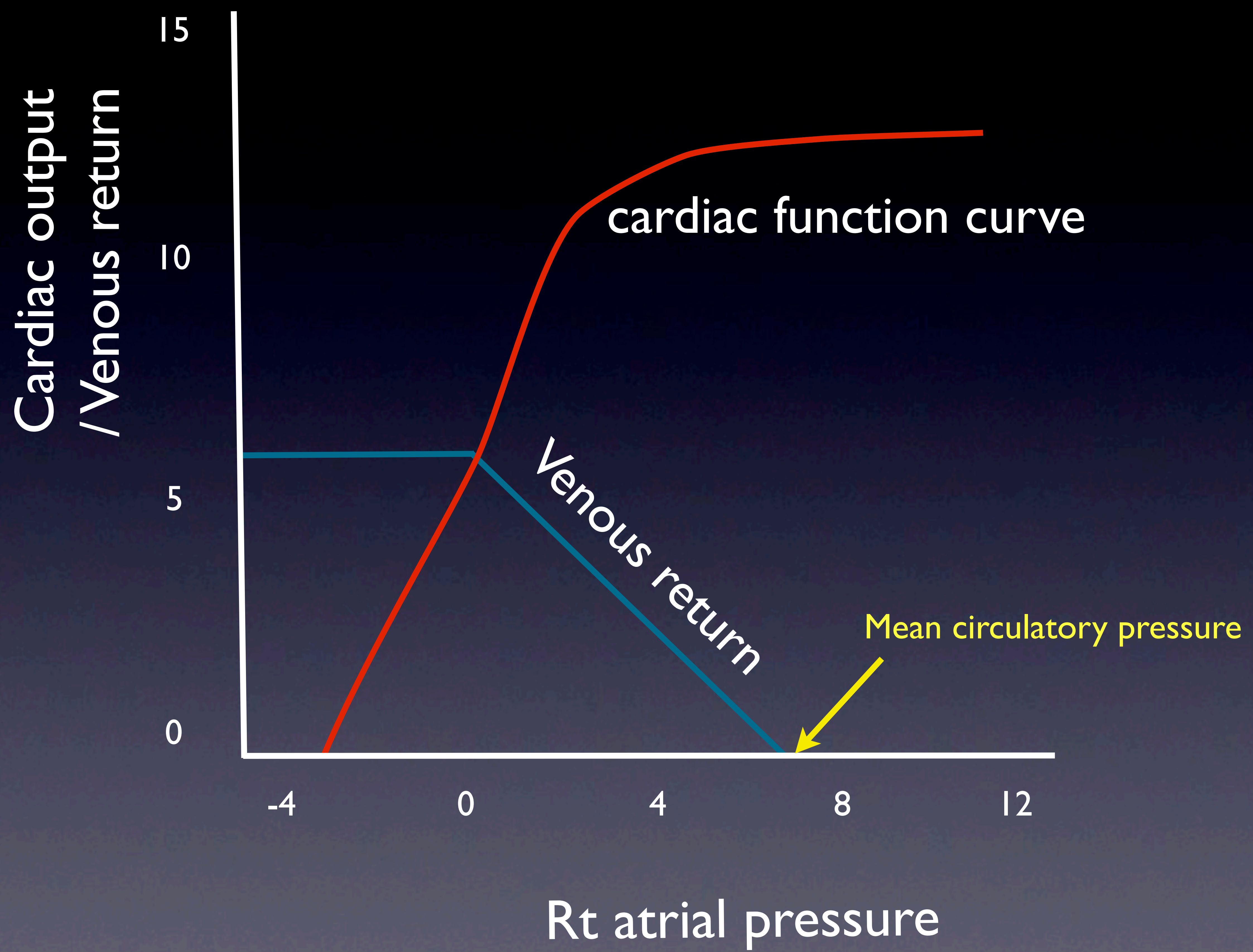
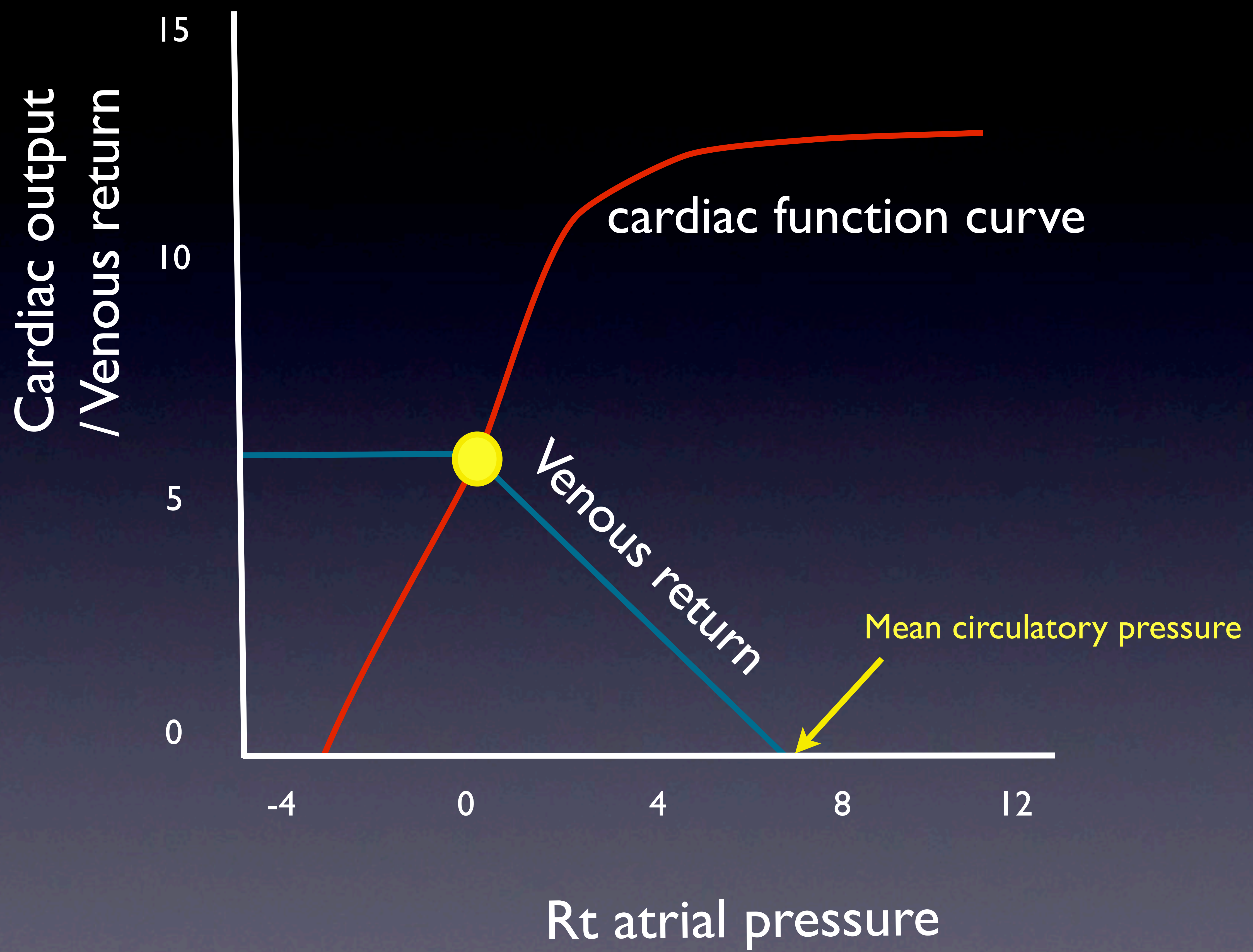


15
10
5
0
Cardiac output
/Venous return
Venous return
Mean circulatory pressure
-4
0
4
8
12
Rt atrial pressure


Cardiac output
/Venous return
15
10
5
0
cardiac function curve
Venous return
Mean circulatory pressure
-4
0
4
8
12
Rt atrial pressure


Cardiac output
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Venous return
Mean circulatory pressure
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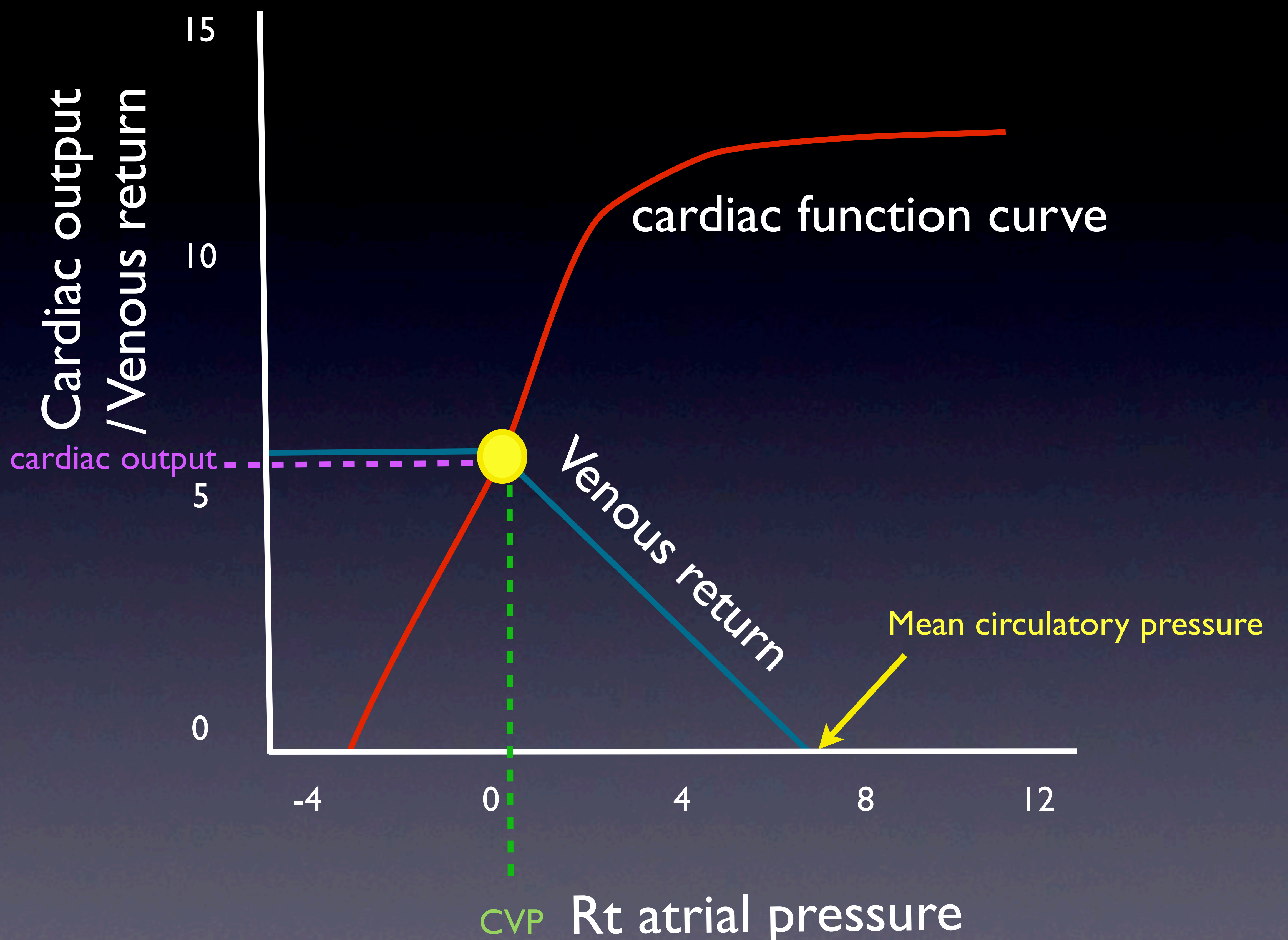
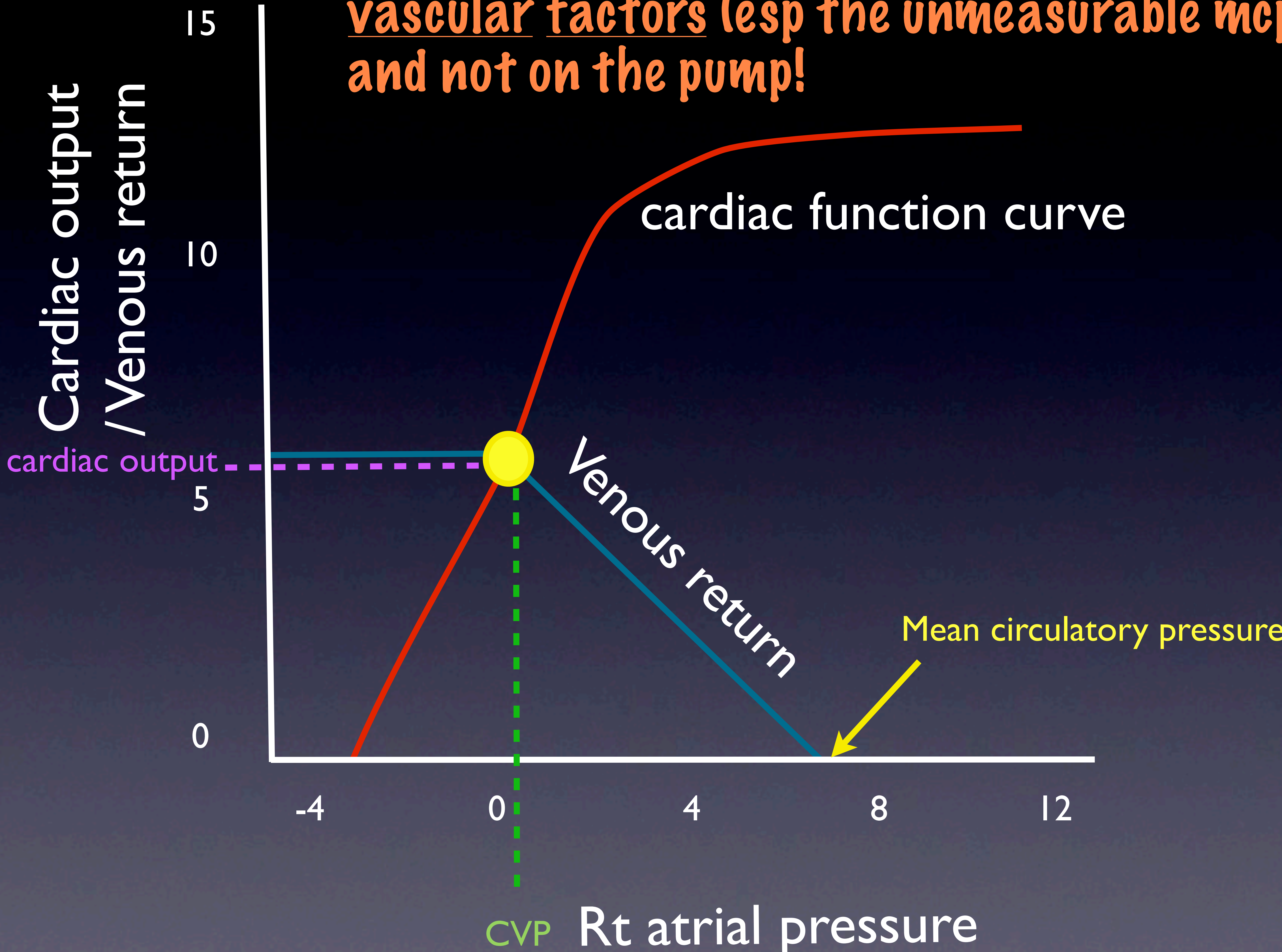
8
12
Rt atrial pressure

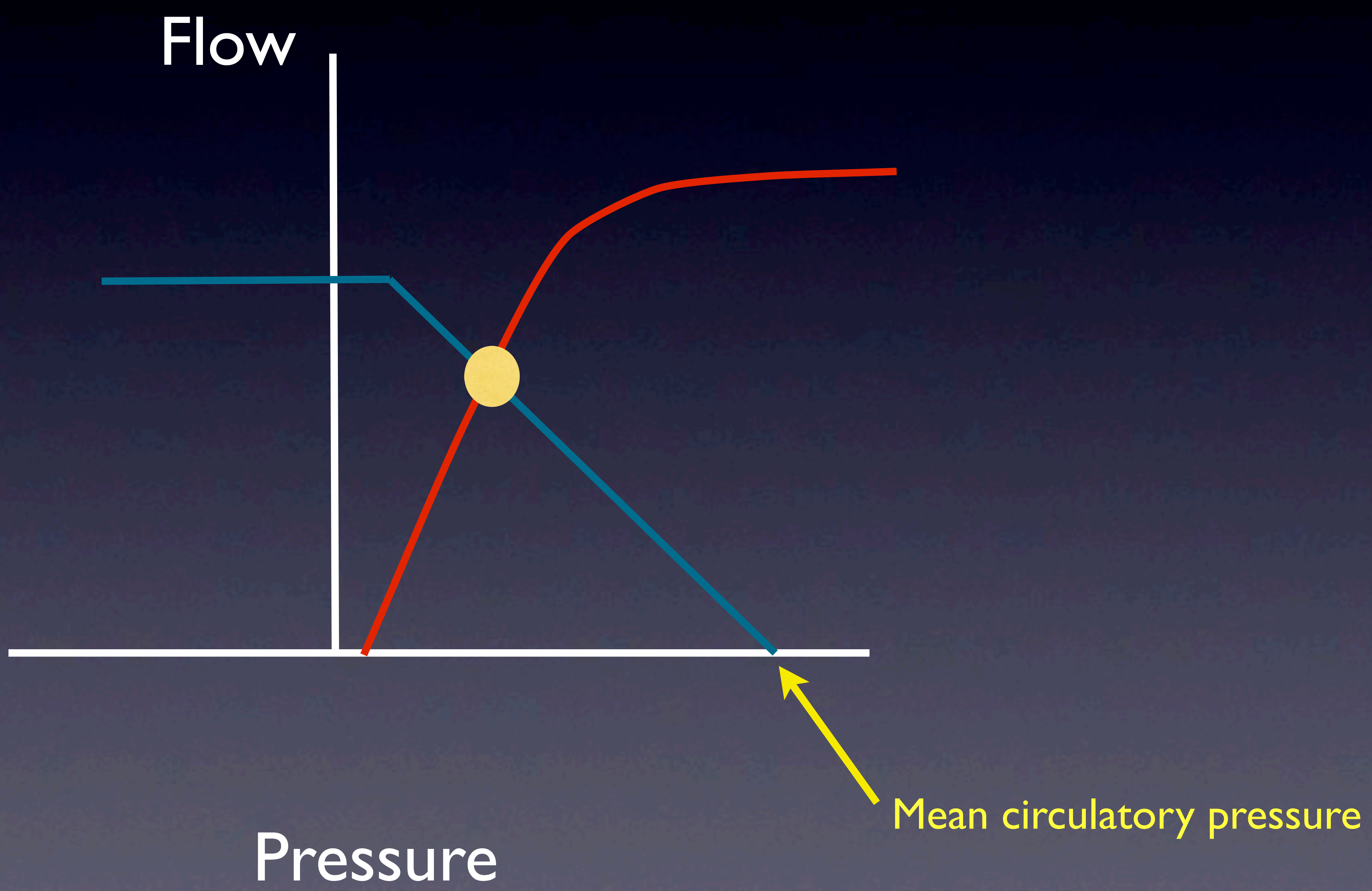


15
10
5
0
Cardiac output
/Venous return
cardiac output
cardiac function curve
Venous return
Mean circulatory pressure
-4
0
4
8
12
CVP
Rt atrial pressure

Venous return (ie cardiac filling) depends on <u>vascular</u> <u>factors</u> (esp the unmeasurable mcp) and not on the pump!

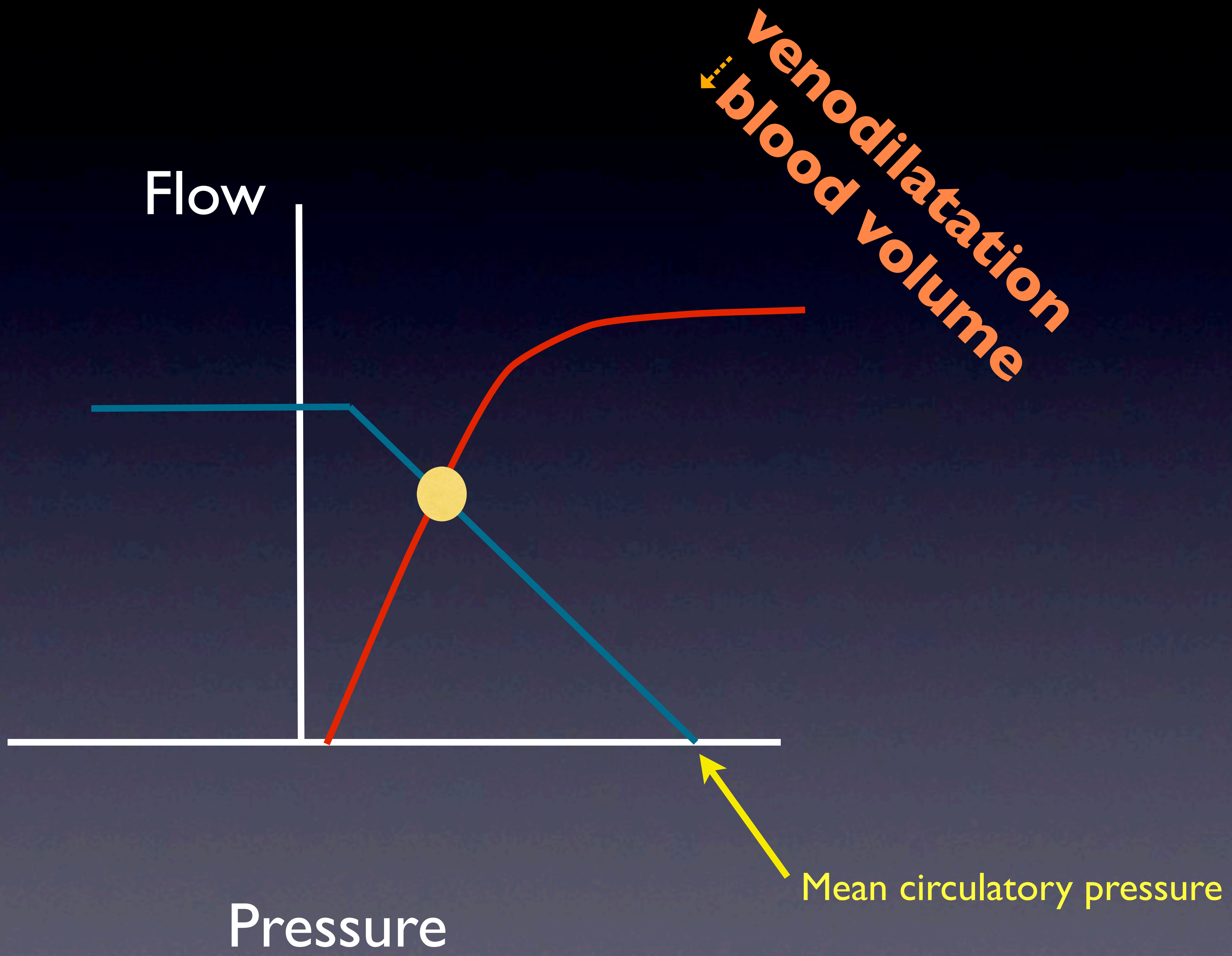


Venous return curve



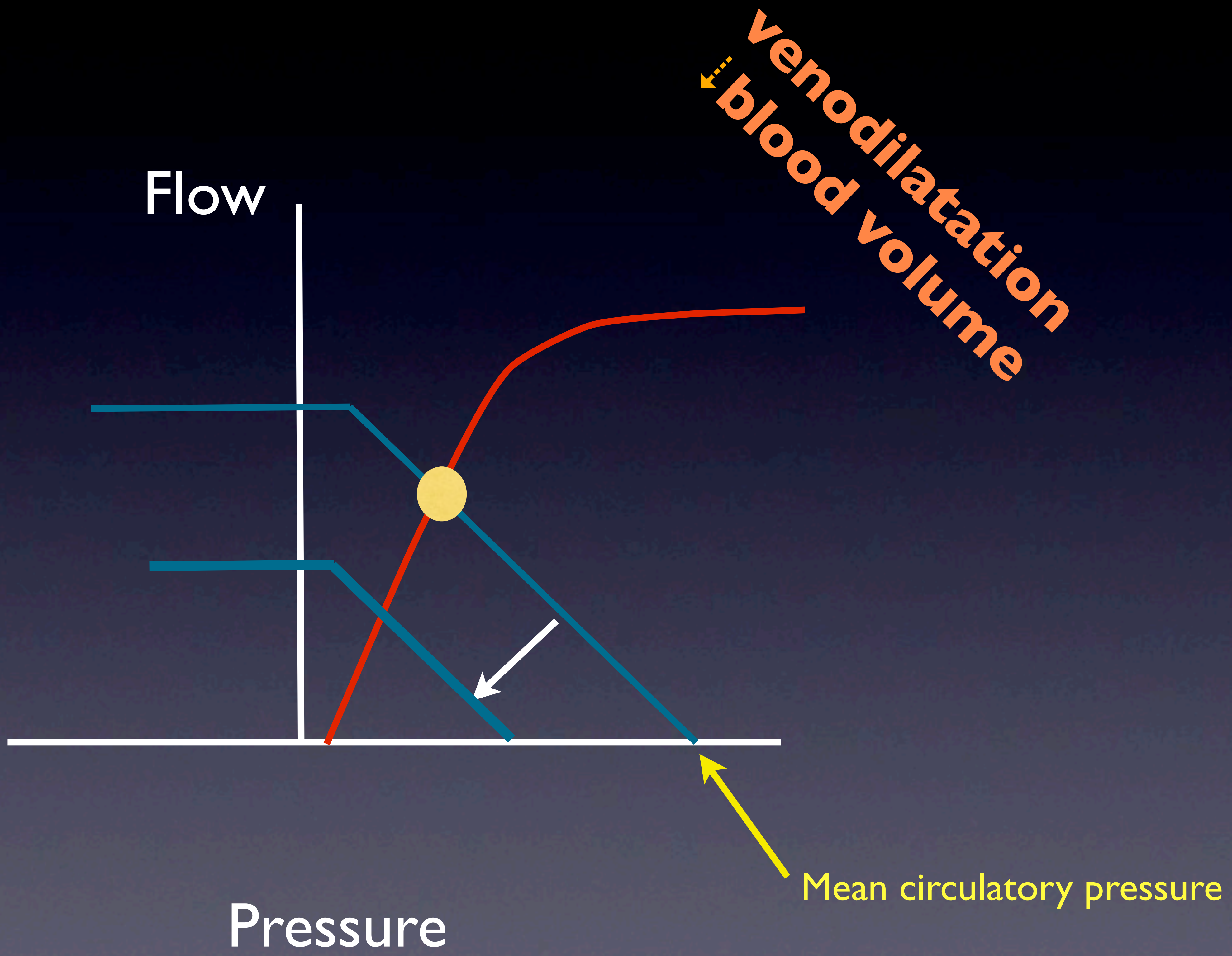
Current Opinion in Critical Care 2005, 11:264 -270

Venous return curve



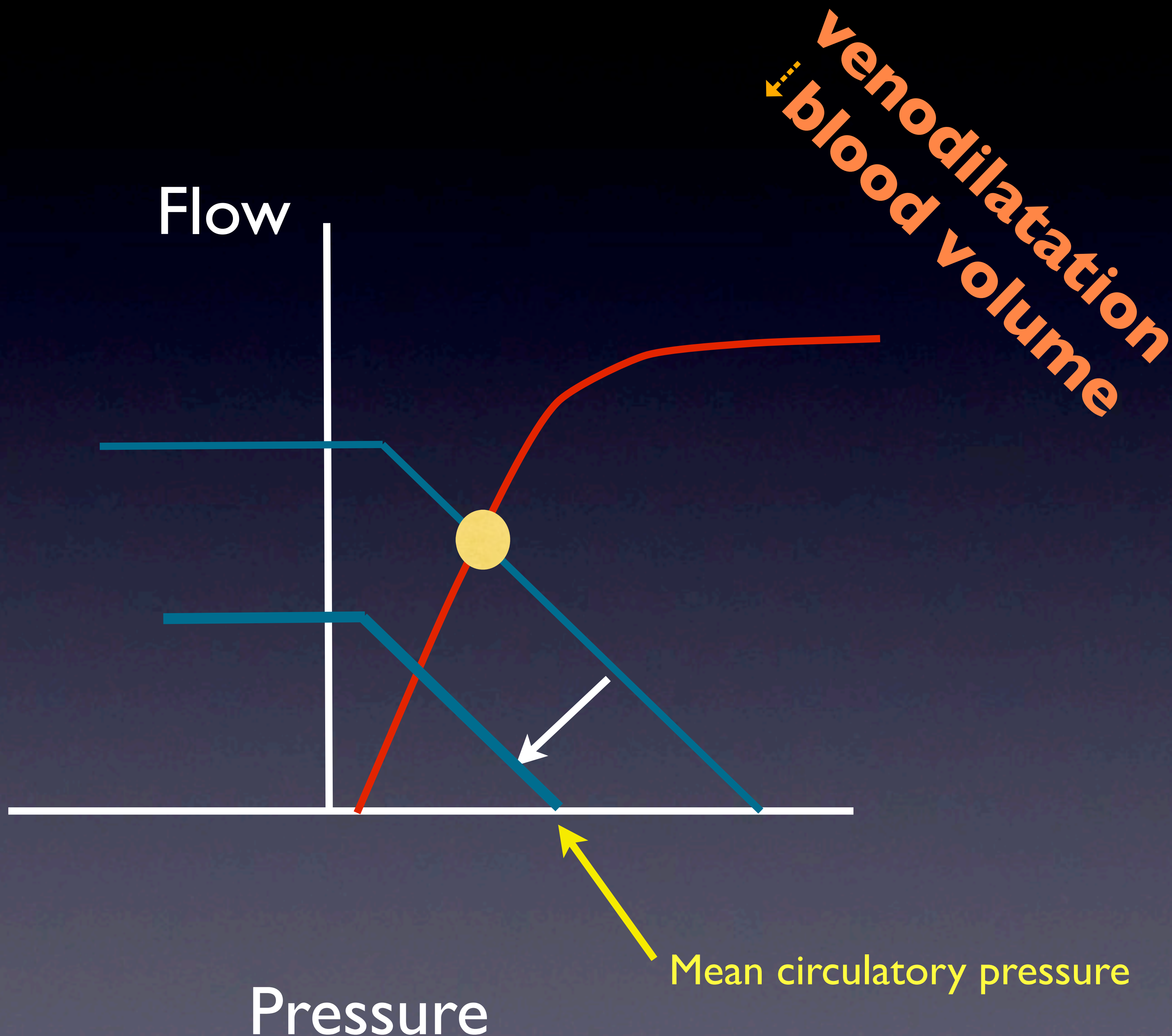
Current Opinion in Critical Care 2005, 11:264 -270

Venous return curve



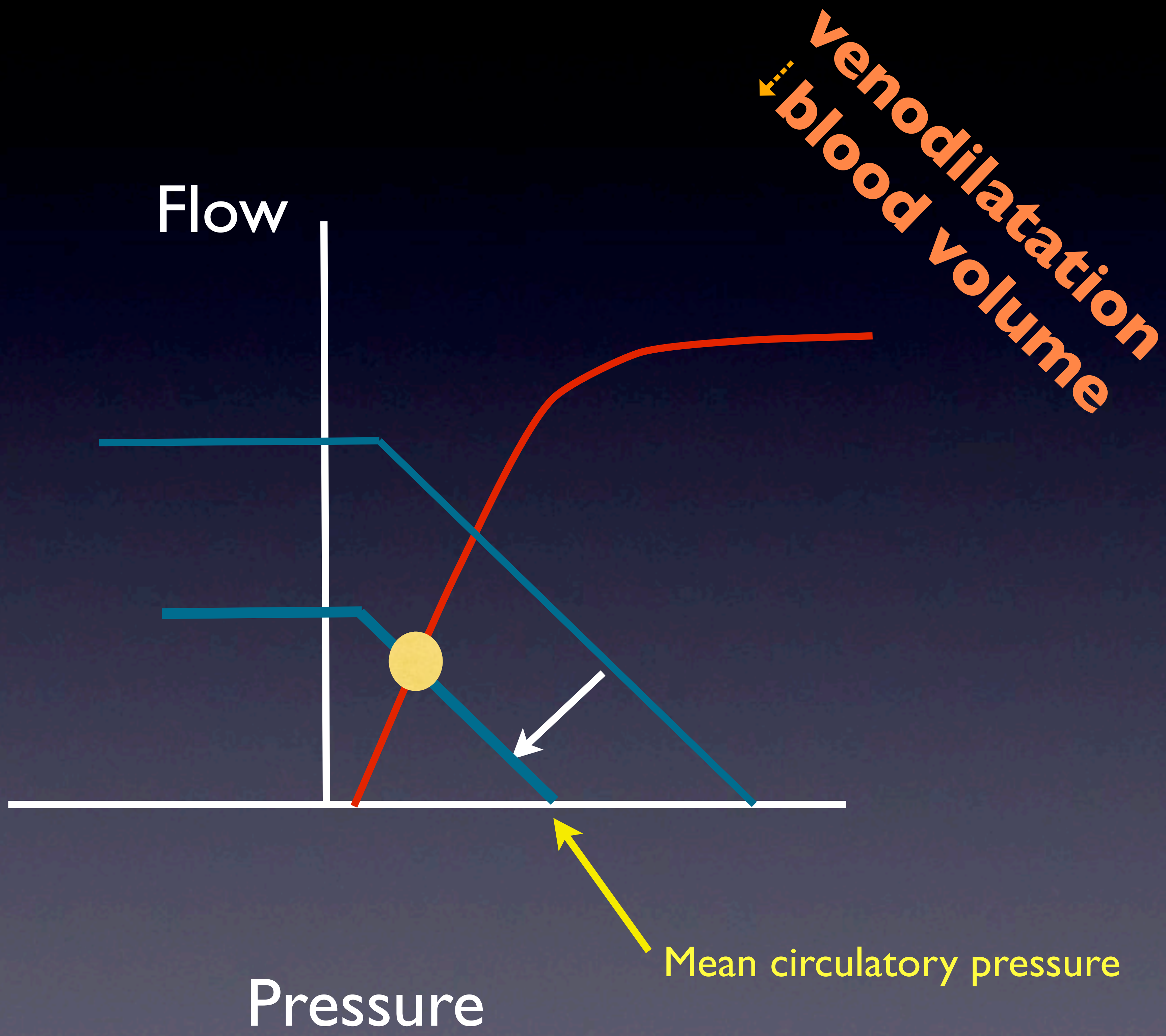
Current Opinion in Critical Care 2005, 11:264 -270

Venous return curve



Current Opinion in Critical Care 2005, 11:264 -270

Venous return curve



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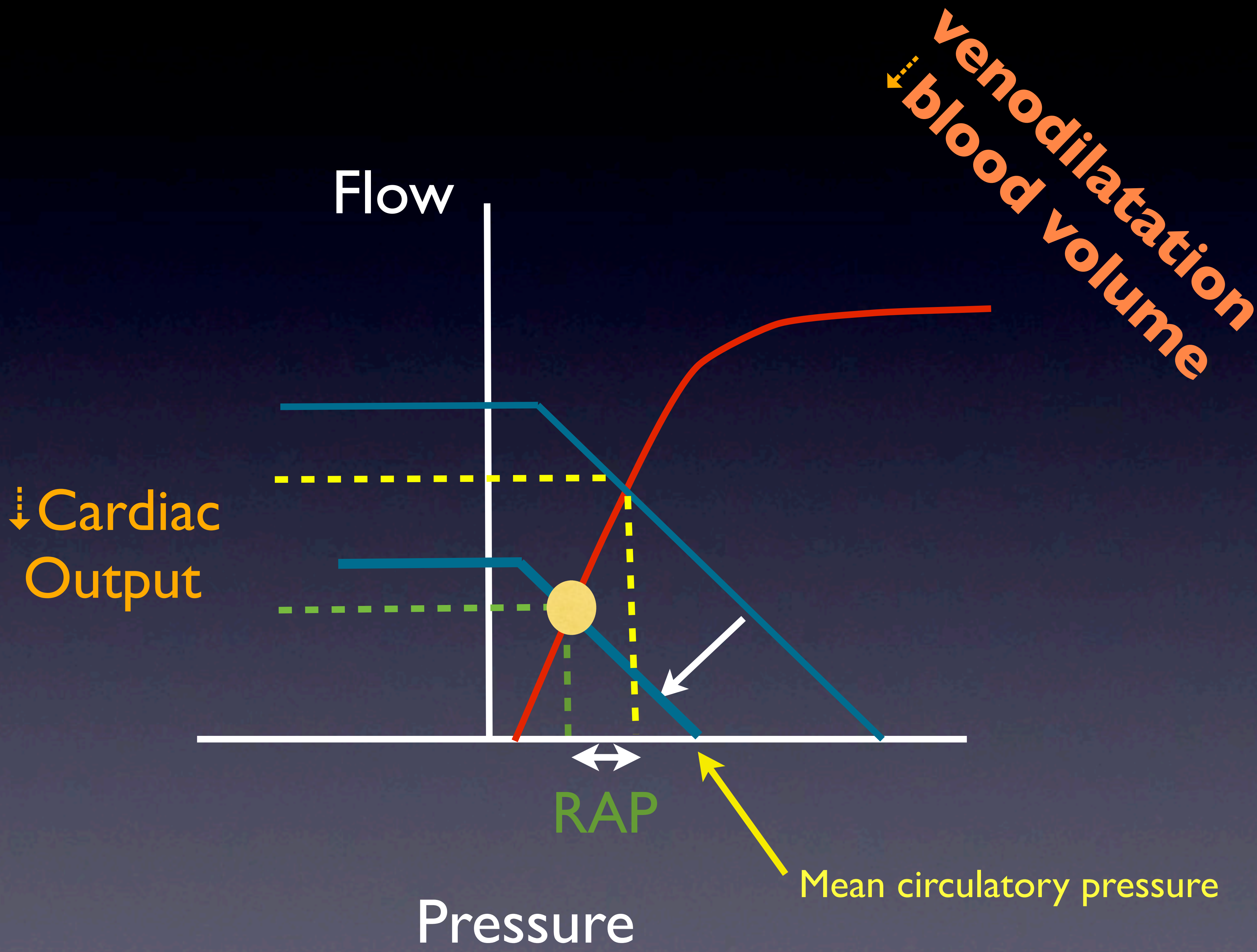
Venous return curve



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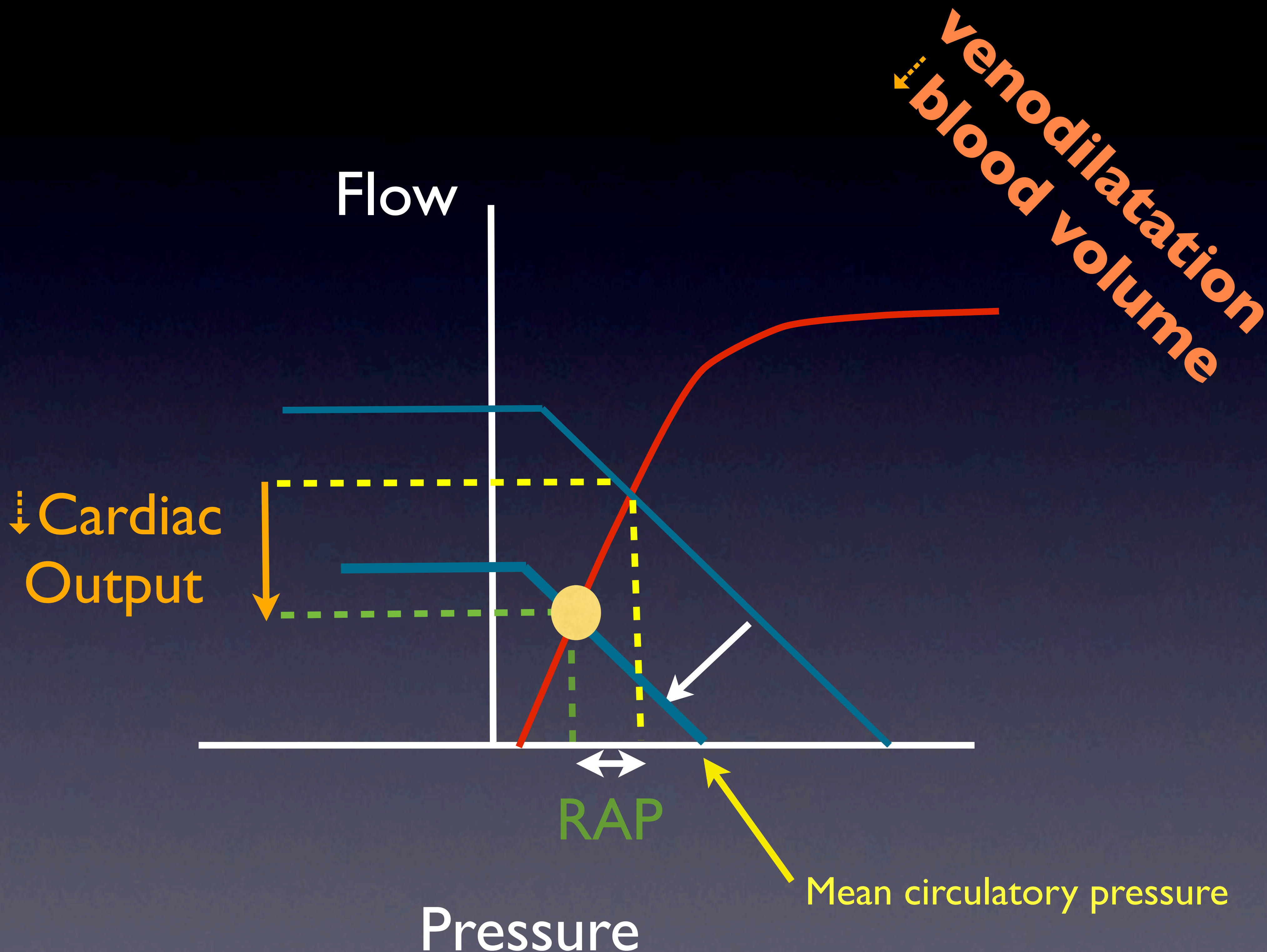
Venous return curve



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Resuscitation strategies

Resuscitation strategies

First **priority** is supporting cardiac output

with **<u>fluids</u>** - not anaemia

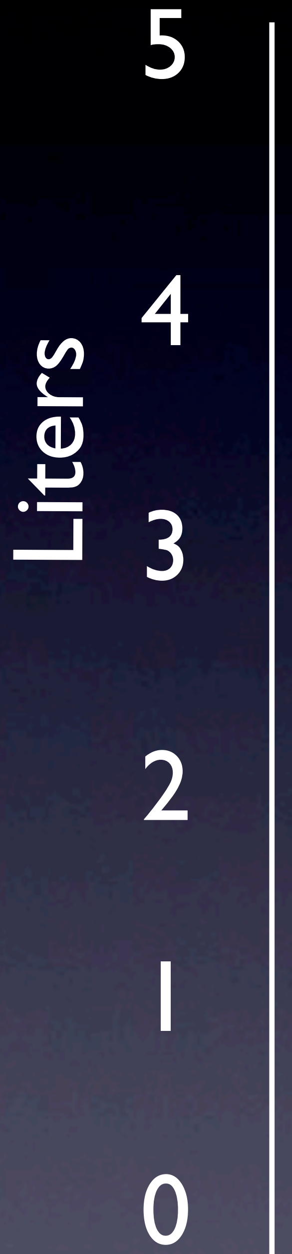
Resuscitation strategies

First **priority** is supporting cardiac output

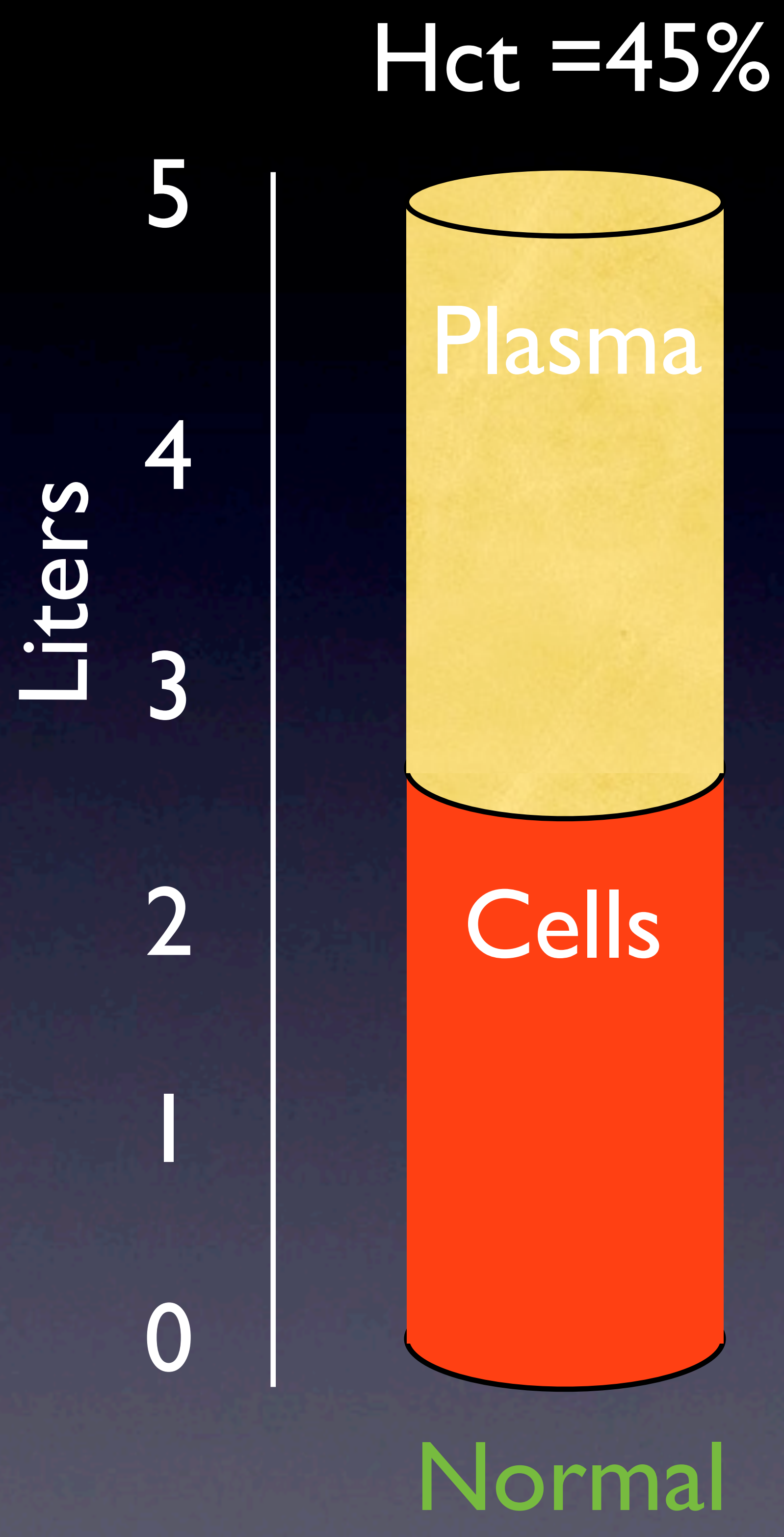
with **fluids** - not anaemia

Don't use Haematocrit to gauge bleeding

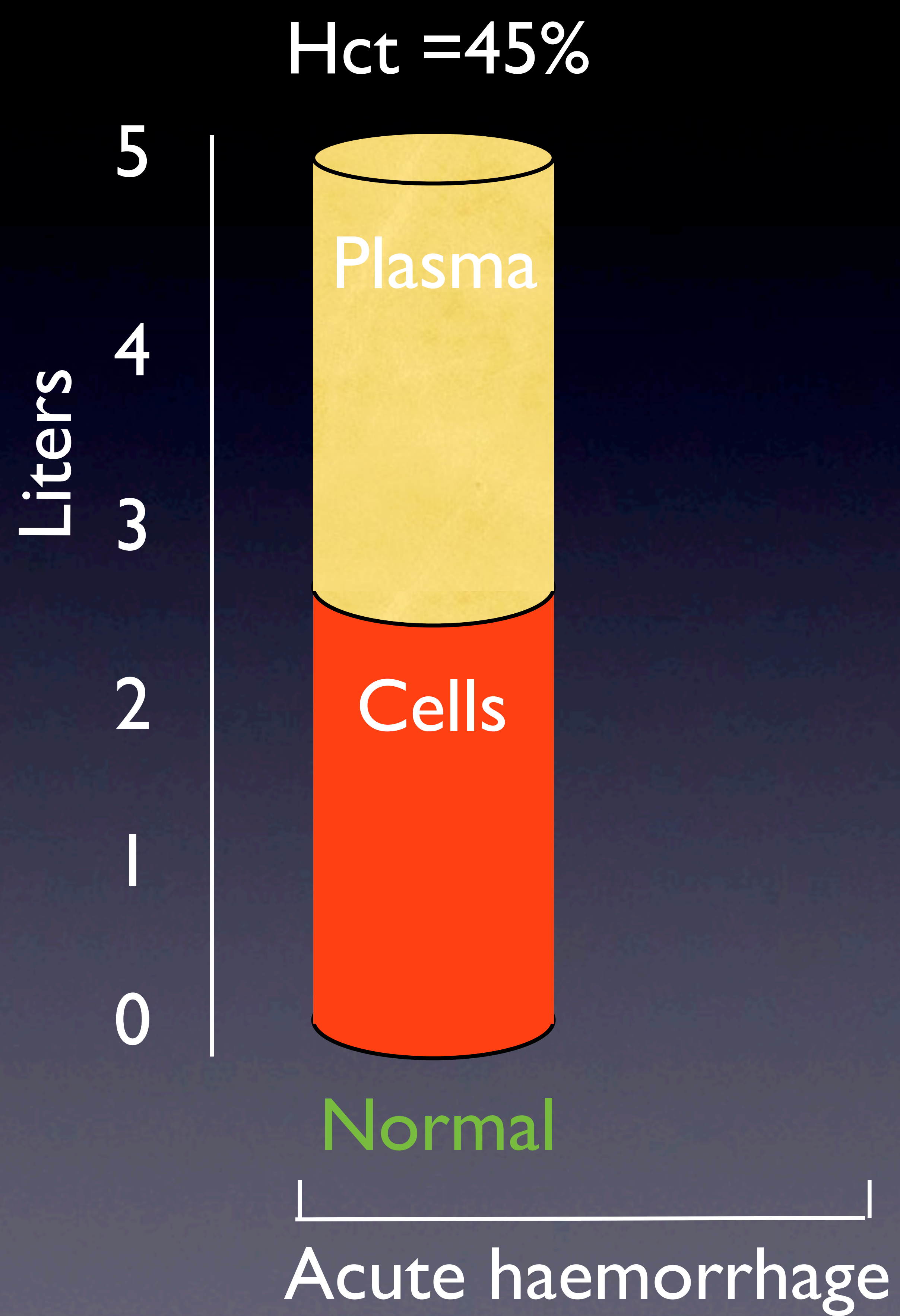
Hct as a marker of acute blood loss?



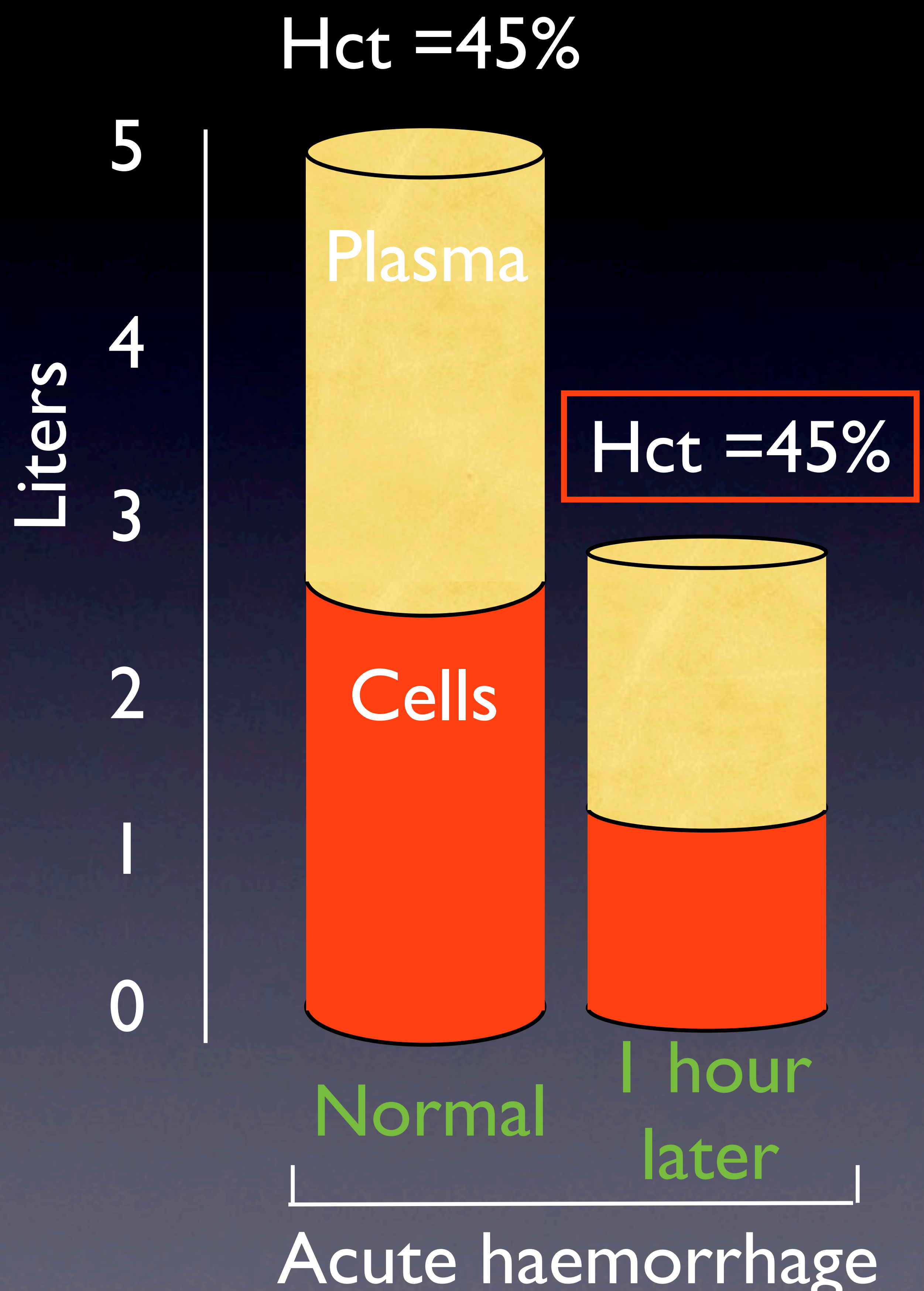
Hct as a marker of acute blood loss?



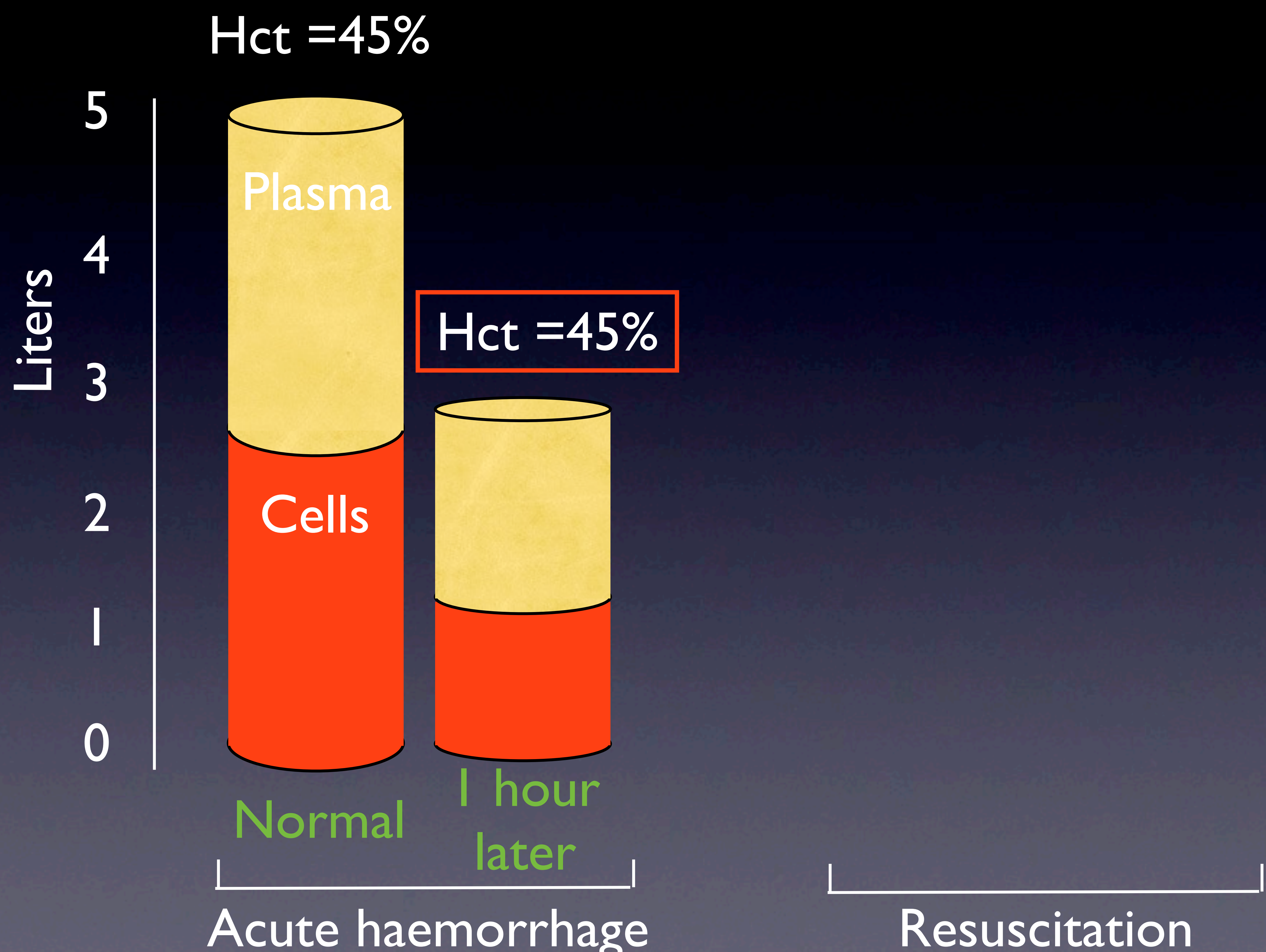
Hct as a marker of acute blood loss?



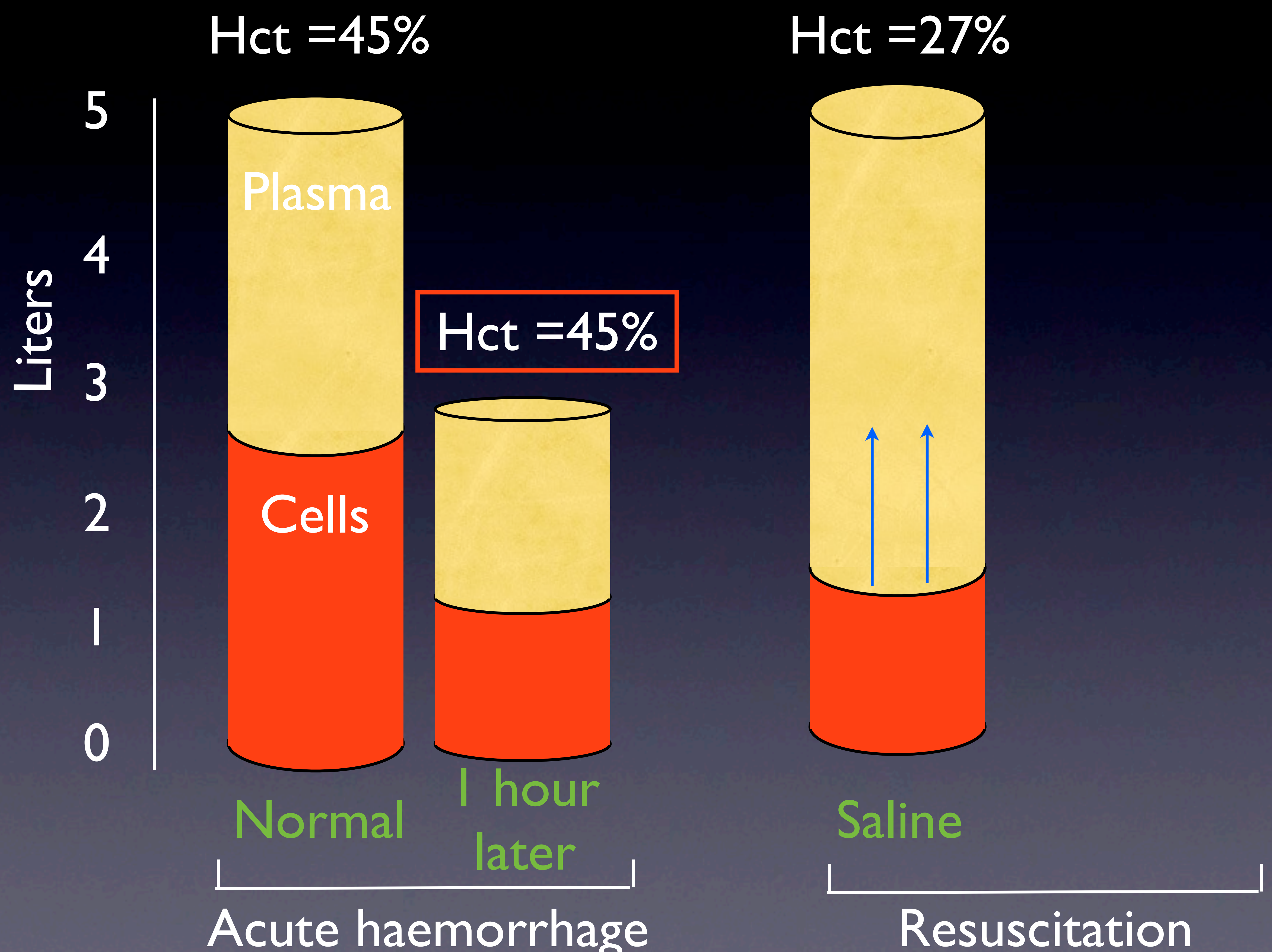
Hct as a marker of acute blood loss?



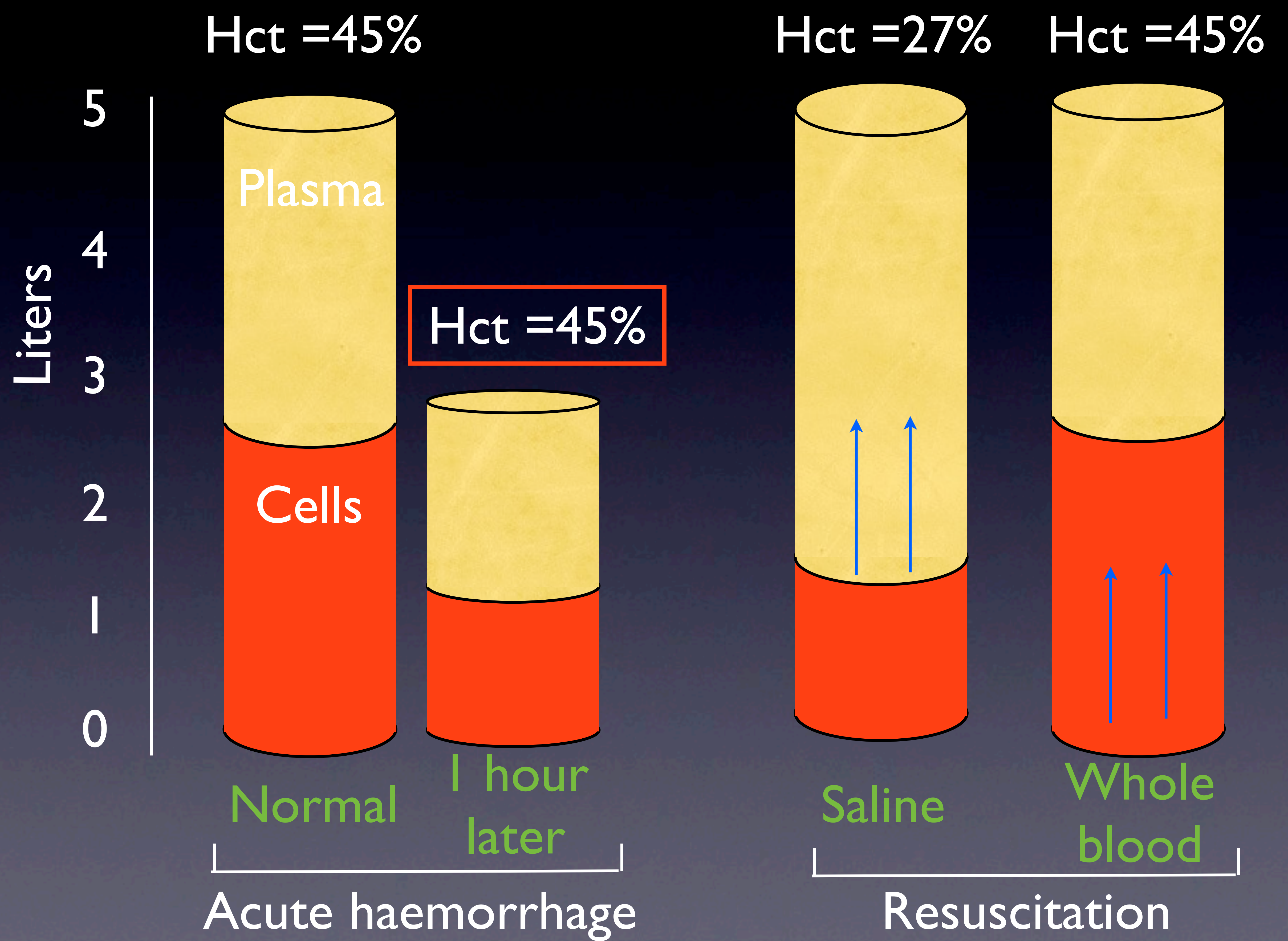
Hct as a marker of acute blood loss?



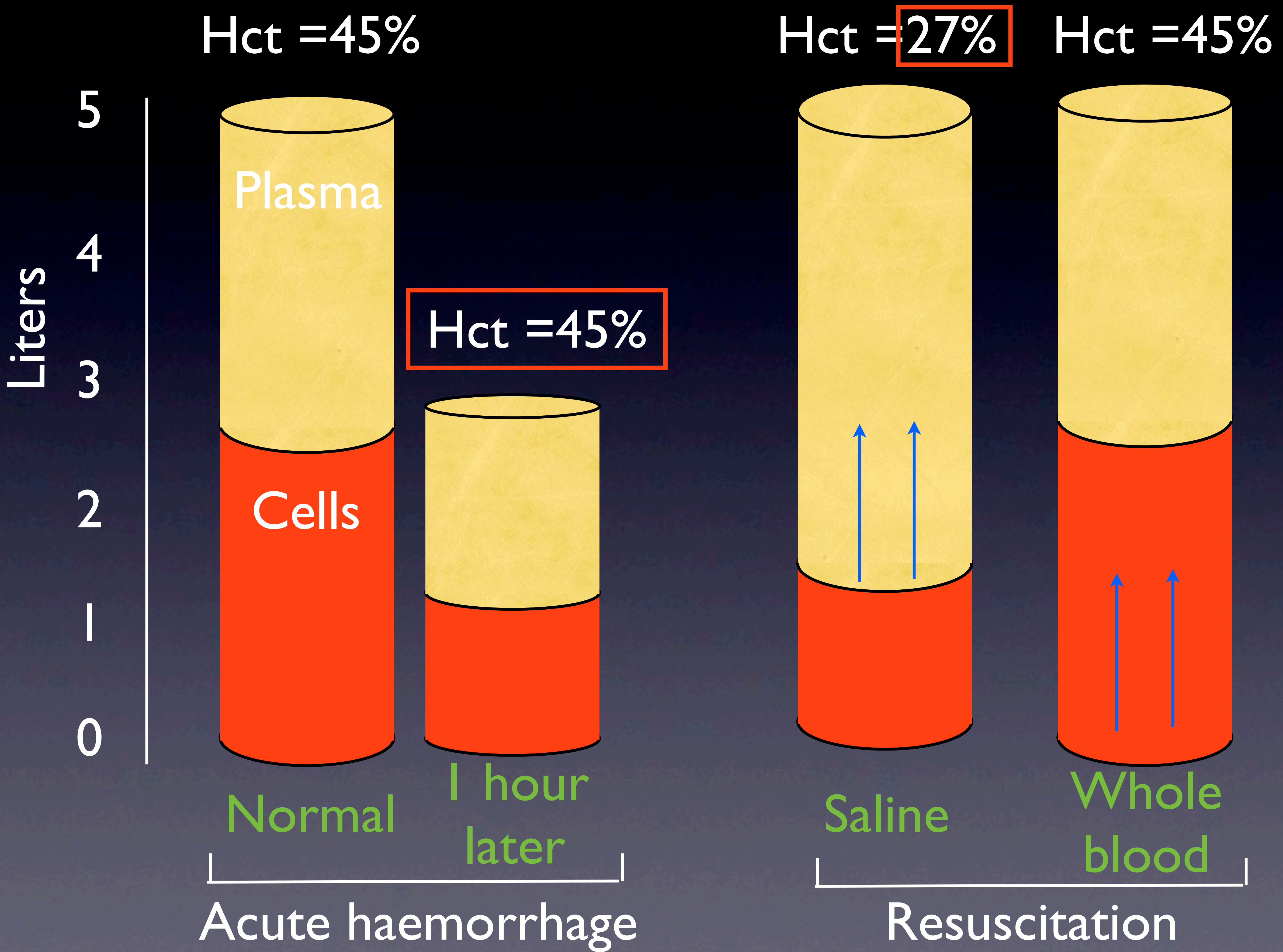
Hct as a marker of acute blood loss?



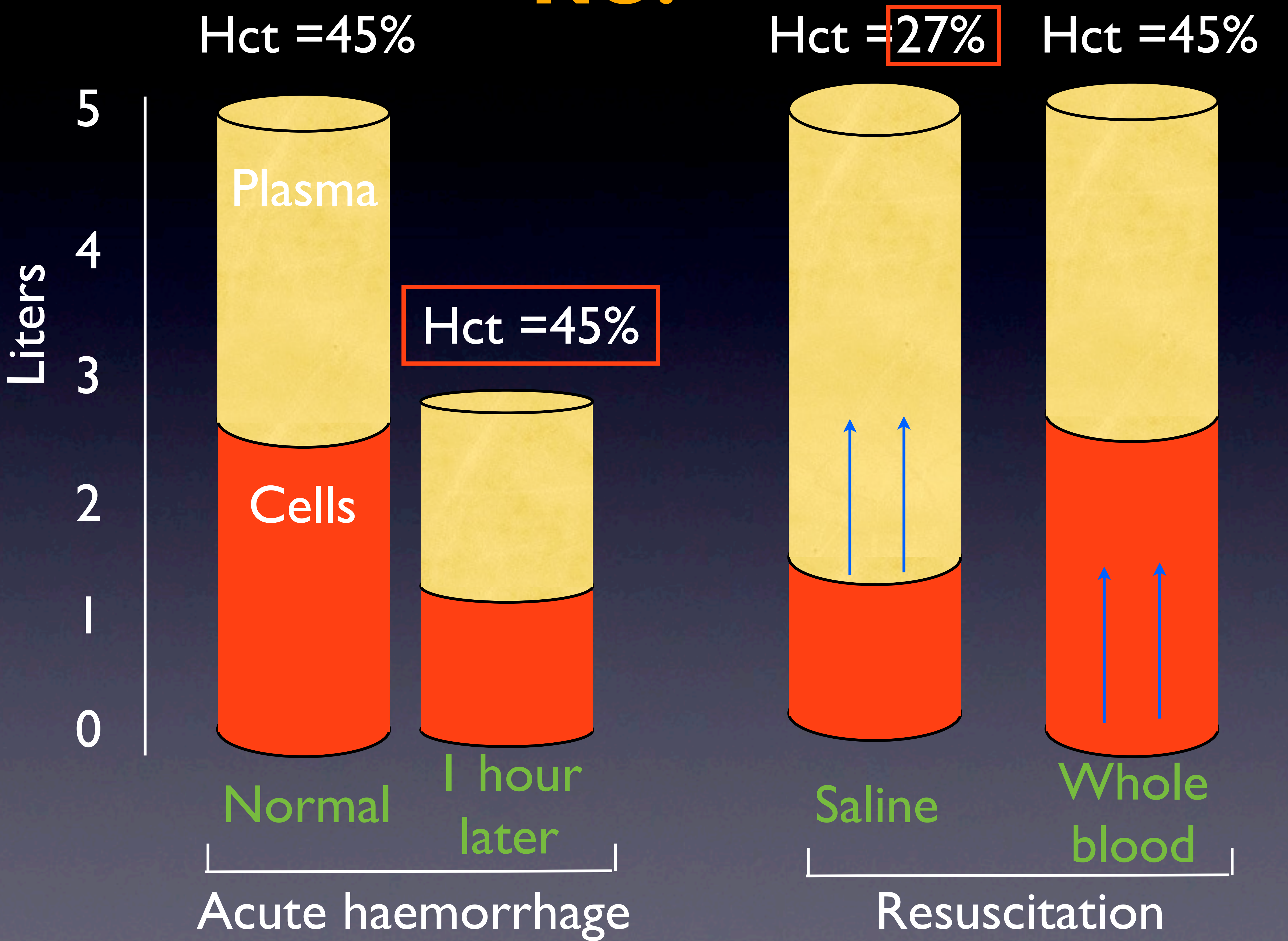
Hct as a marker of acute blood loss?



Hct as a marker of acute blood loss?



Hct as a marker of acute blood loss? **NO!**



Clinical Case

Clinical Case

24 yr old male stabbed in abdomen

Clinical Case

24 yr old male stabbed in abdomen

Arrives in A+E in shock

Clinical Case

24 yr old male stabbed in abdomen

Arrives in A+E in shock

Rushed to theatre for urgent laparotomy

Clinical Case

24 yr old male stabbed in abdomen

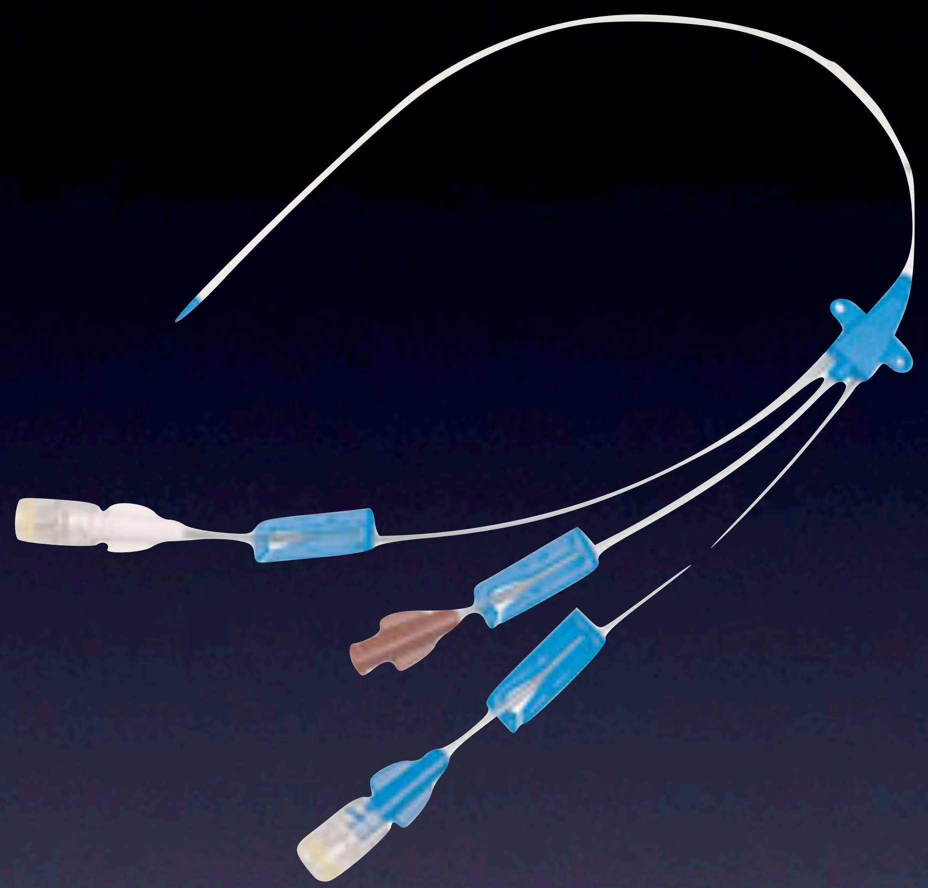
Arrives in A+E in shock

Rushed to theatre for urgent laparotomy

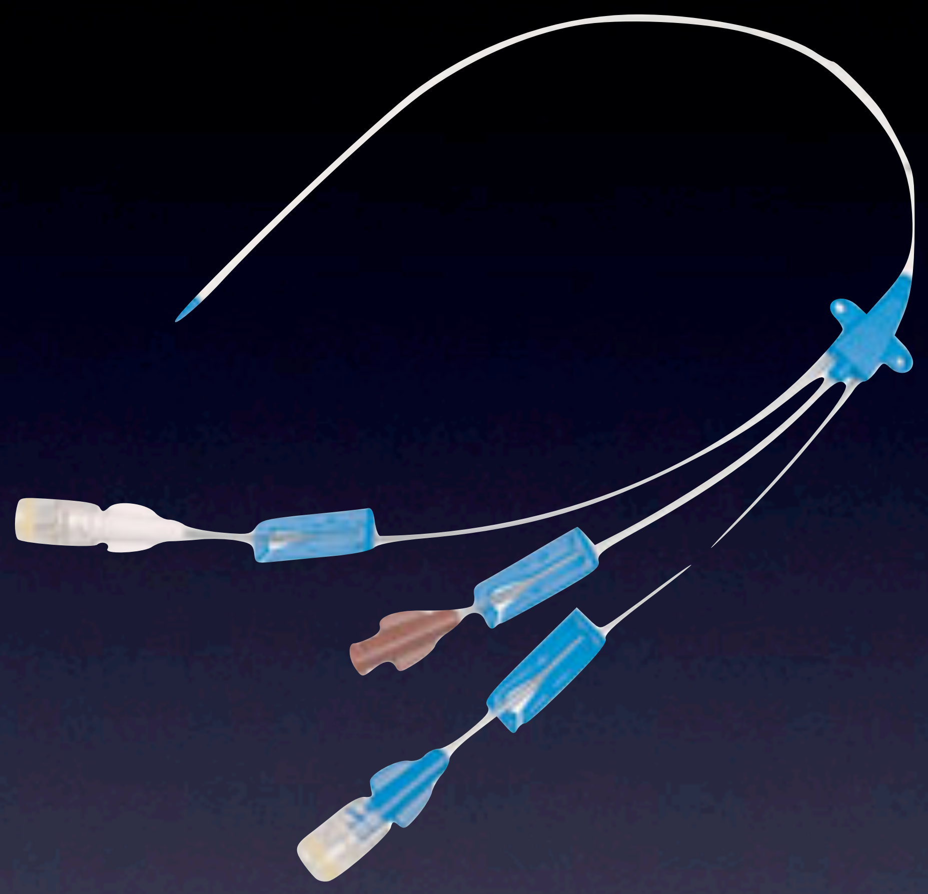
Do I need a central line ?

A central line for fluid therapy ?

A central line for fluid therapy ?

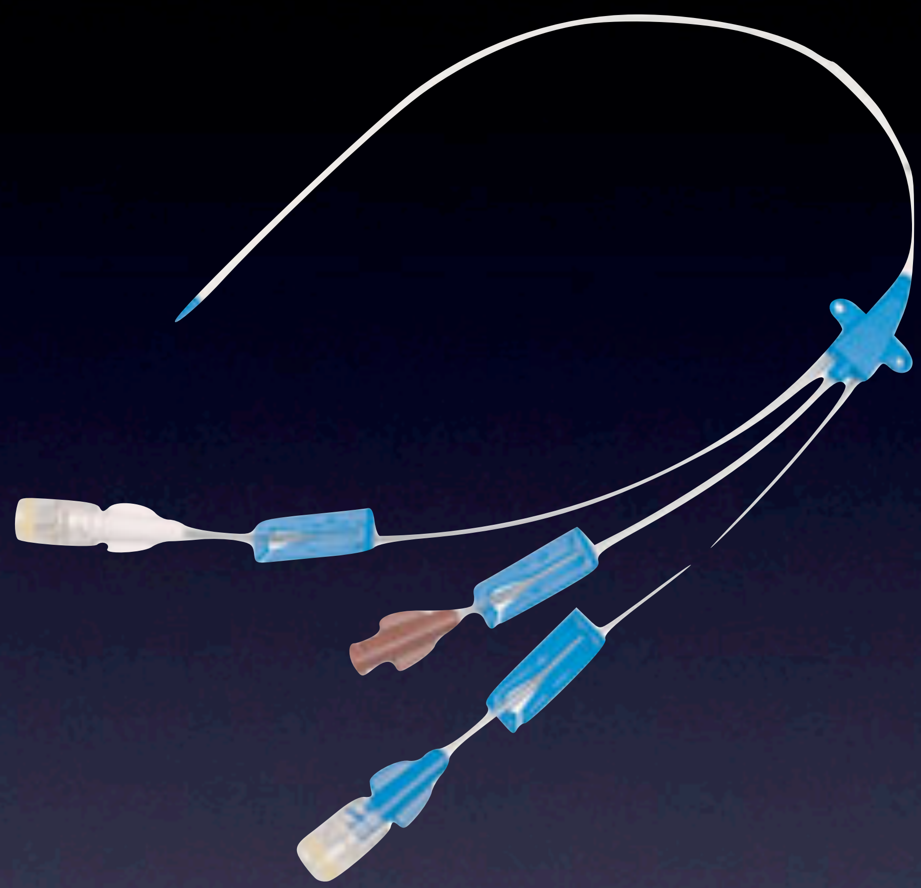


A central line for fluid therapy ?



Flow ~ **radius⁴** x pressure gradient / **length** x viscosity

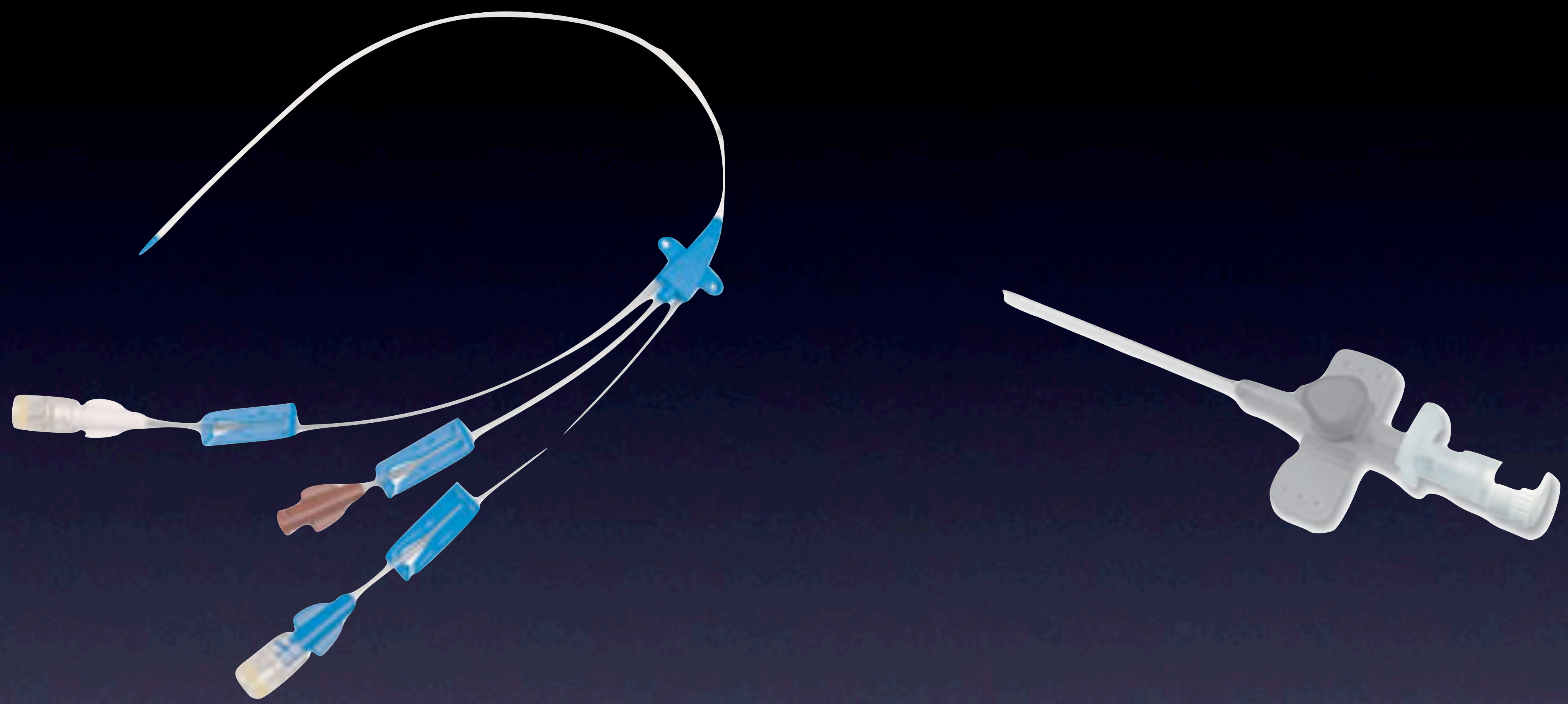
A central line for fluid therapy ?



Flow ~ **radius^4** x pressure gradient / **length** x viscosity

A 20 cm Central Line is **NOT** the best option to give fluid rapidly !

A central line for fluid therapy ?



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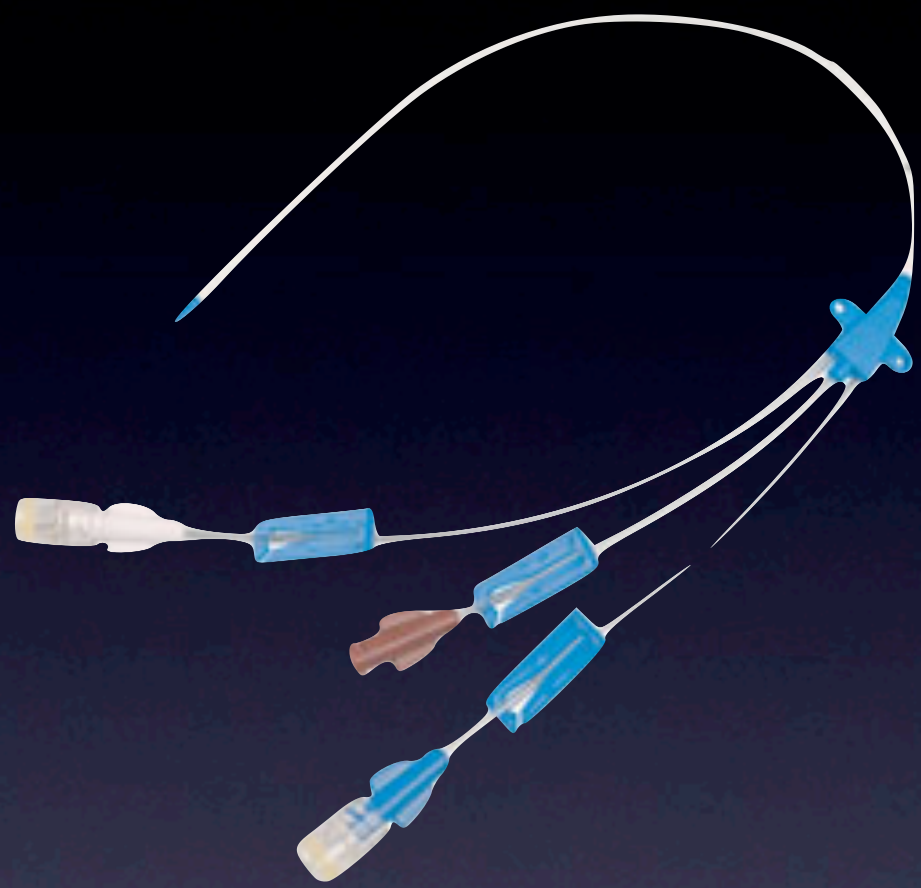
A central line for fluid therapy ?



Short and **Fat** is best!

Flow ~ **radius^4** x pressure gradient / **length** x viscosity

A 20 cm Central Line is **NOT** the best option to give fluid rapidly !

Clinical Case

Clinical Case

42 yr old male admitted to A+E

Clinical Case

42 yr old male admitted to A+E

Known alcoholic with endoscopically proven, bleeding posterior duodenal ulcer

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42 yr old male admitted to A+E

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Likely to have aspirated on intubation

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Taken to theatre for laparotomy

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O2 saturation is 80% on 100% 02

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Hct on Hemacue 18 %

Clinical Case

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Likely to have aspirated on intubation

Taken to theatre for laparotomy

O2 saturation is 80% on 100% 02

Hct on Hemacue 18 %

Blood on the way !

Clinical Case

With regards to O2 delivery, what do I worry about most:

Clinical Case

With regards to O2 delivery, what do I worry about most:

Hct or O2 Saturation ?

Clinical Case

With regards to O2 delivery, what do I worry about most:

Hct or O2 Saturation ?

Do I use PEEP to get increase pO2 ?

Clinical Case

With regards to O2 delivery, what do I worry about most:

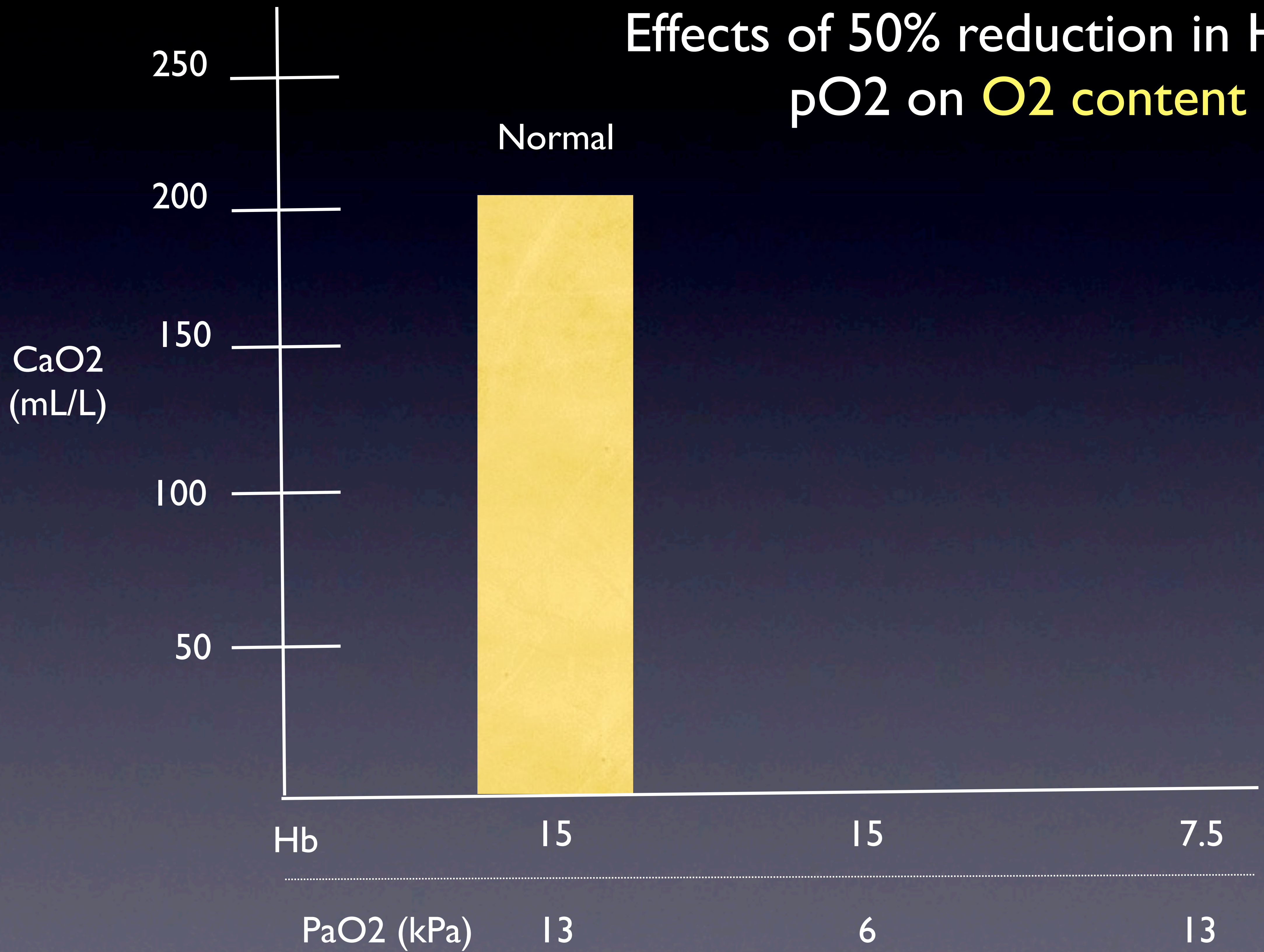
Hct or O2 Saturation ?

Do I use PEEP to get increase pO2 ?

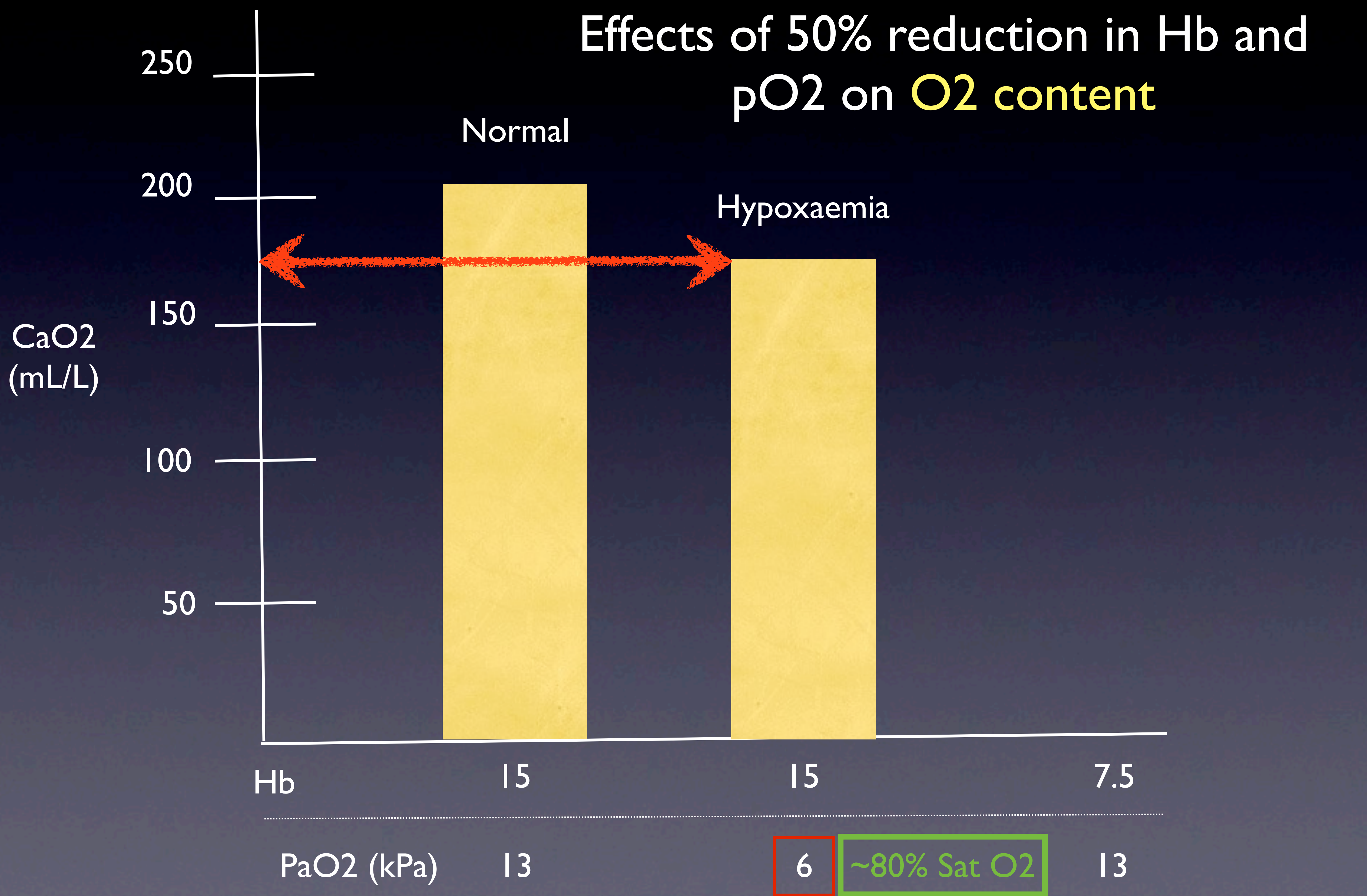
What might that do to O2 delivery?

Hct or O2 Saturation ?

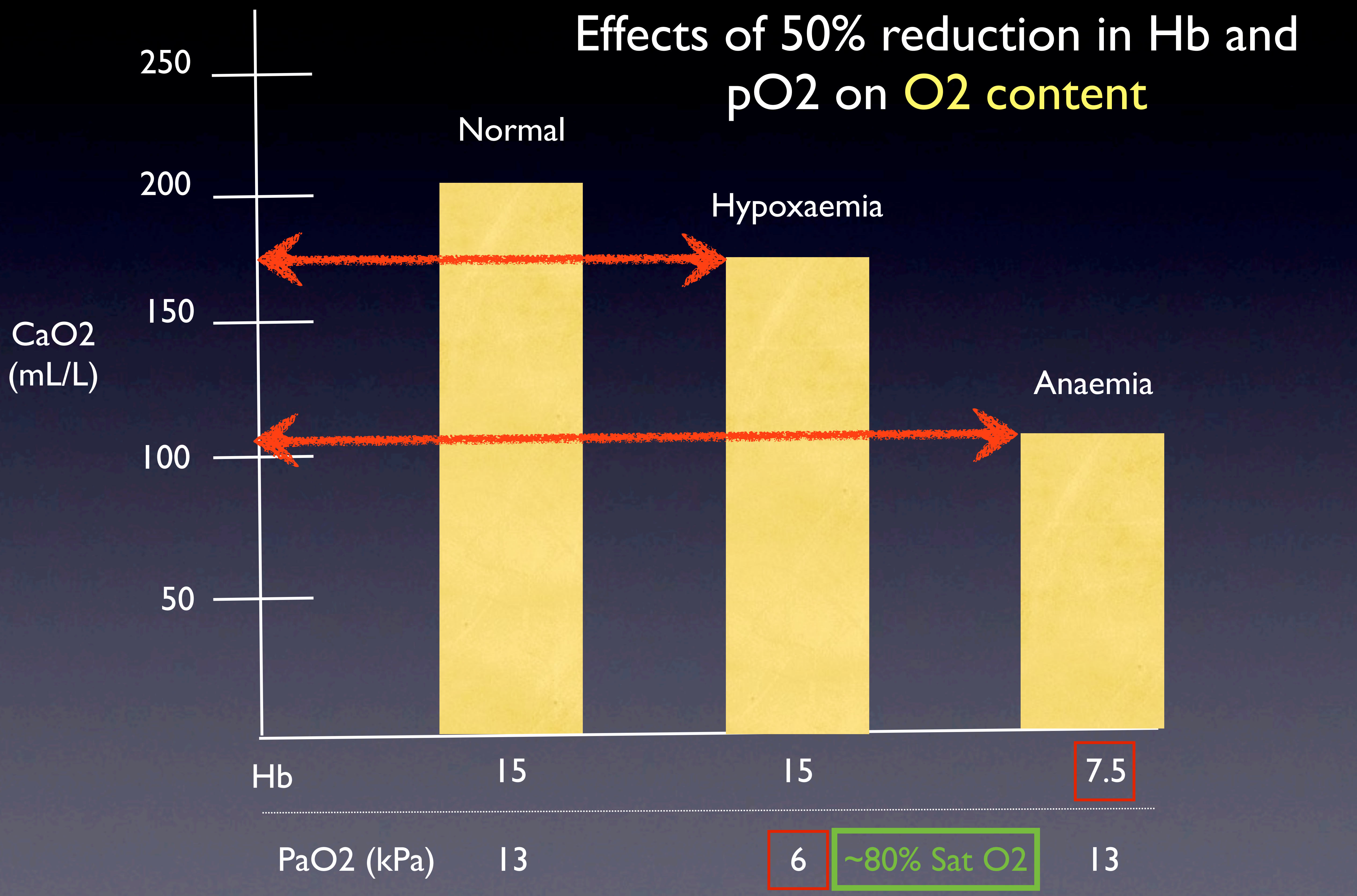
Effects of 50% reduction in Hb and pO2 on O2 content



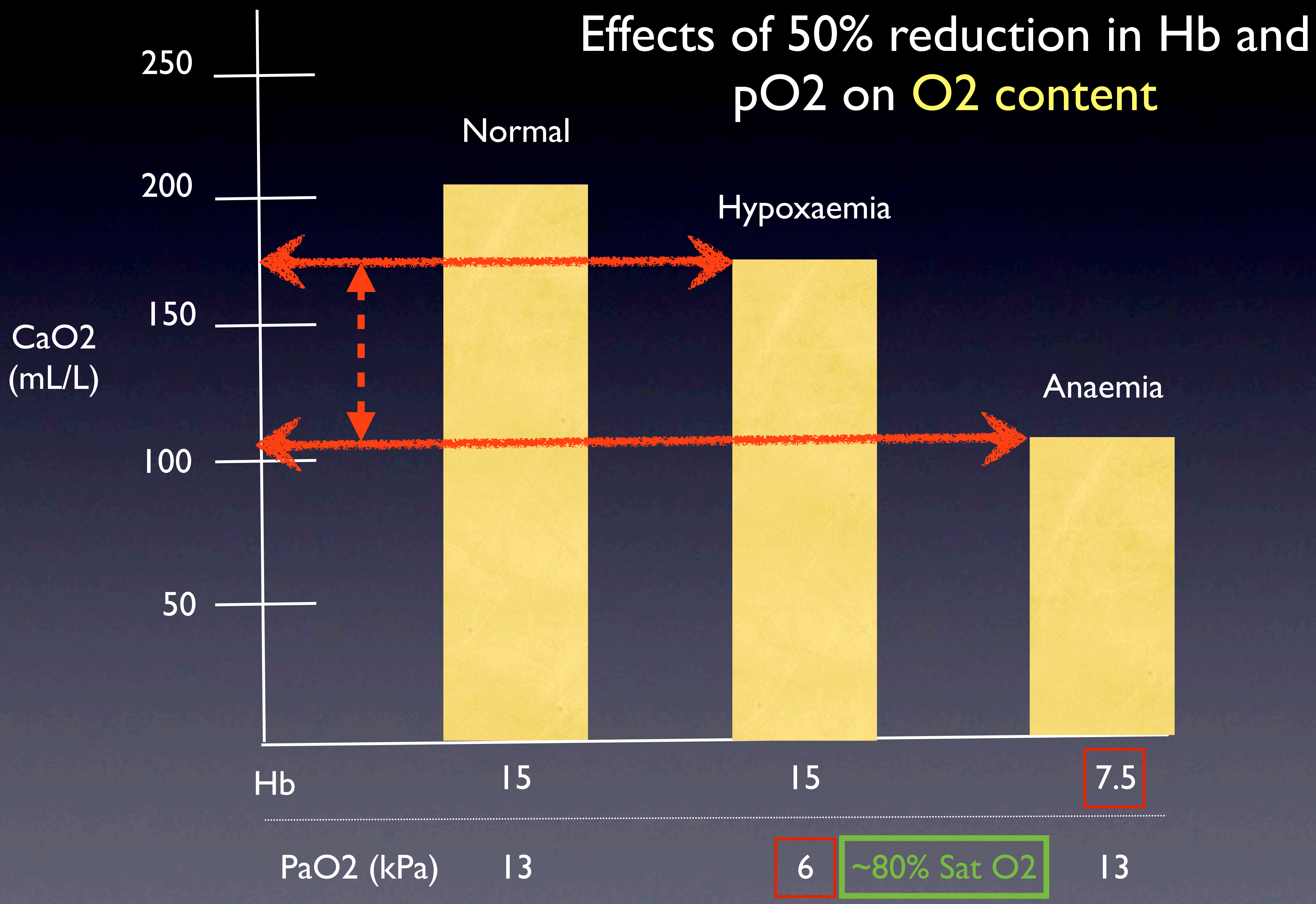
Hct or O2 Saturation ?



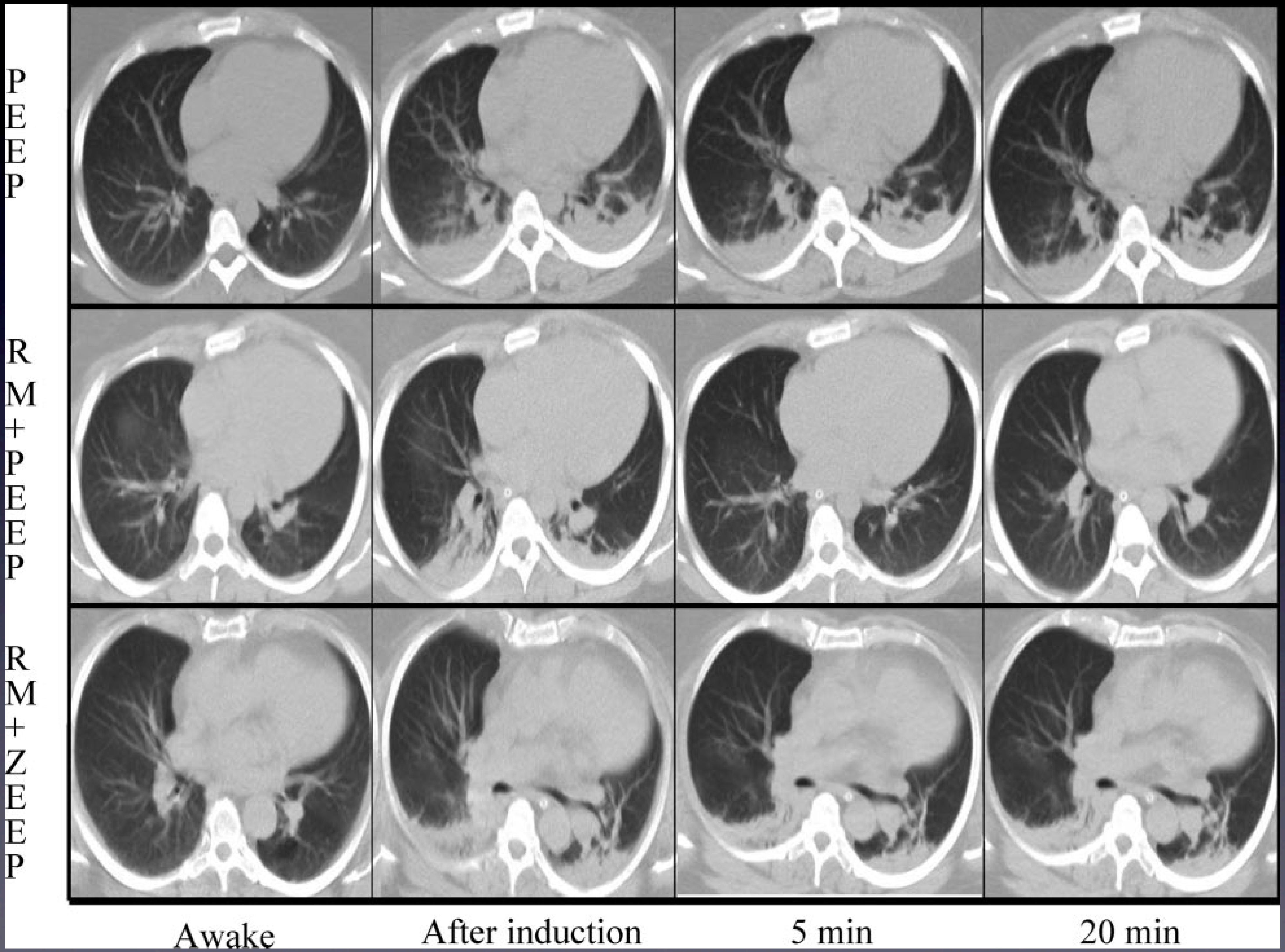
Hct or O2 Saturation ?



Hct or O2 Saturation ?



Recruitment maneuver and PEEP



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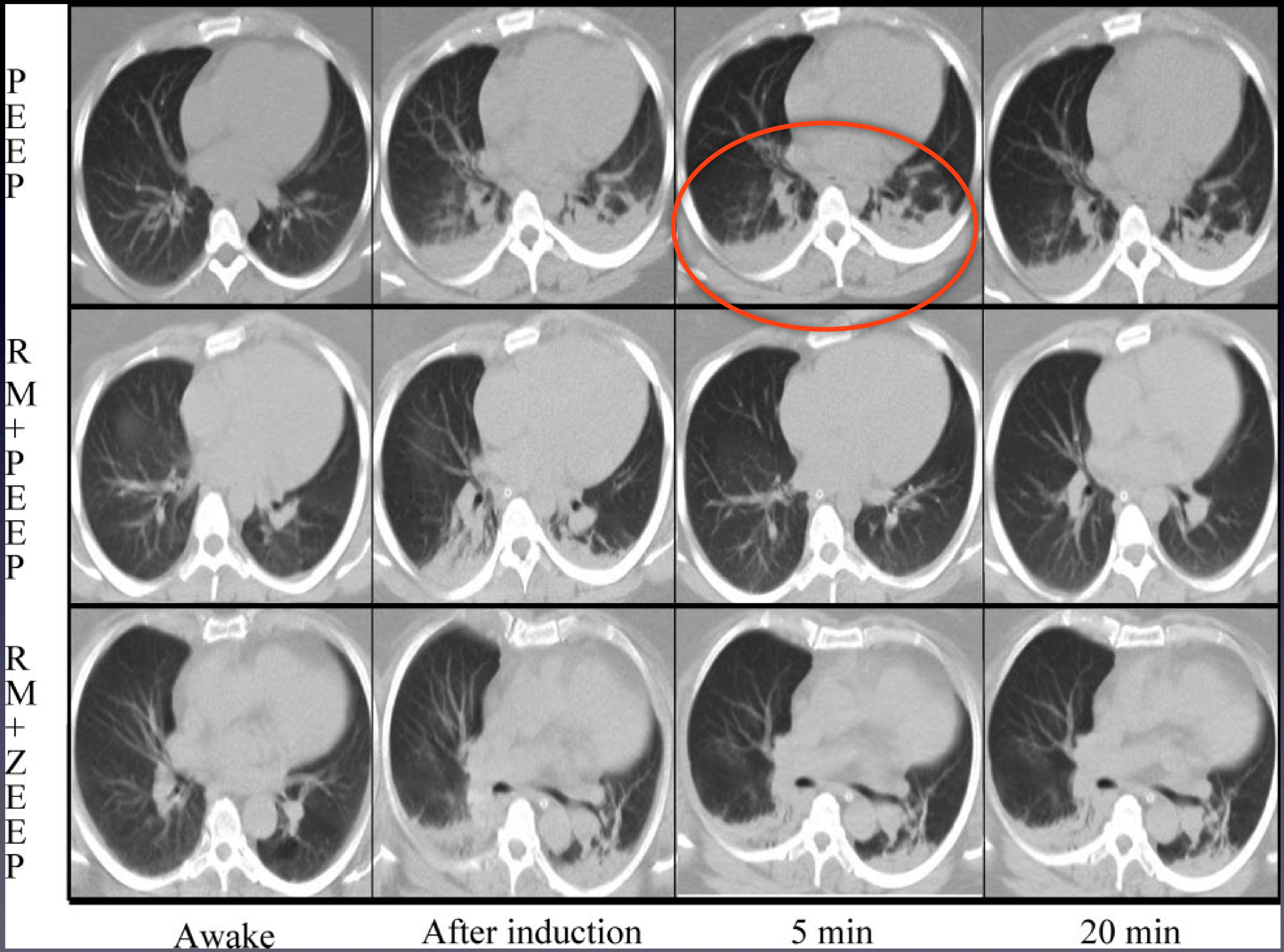

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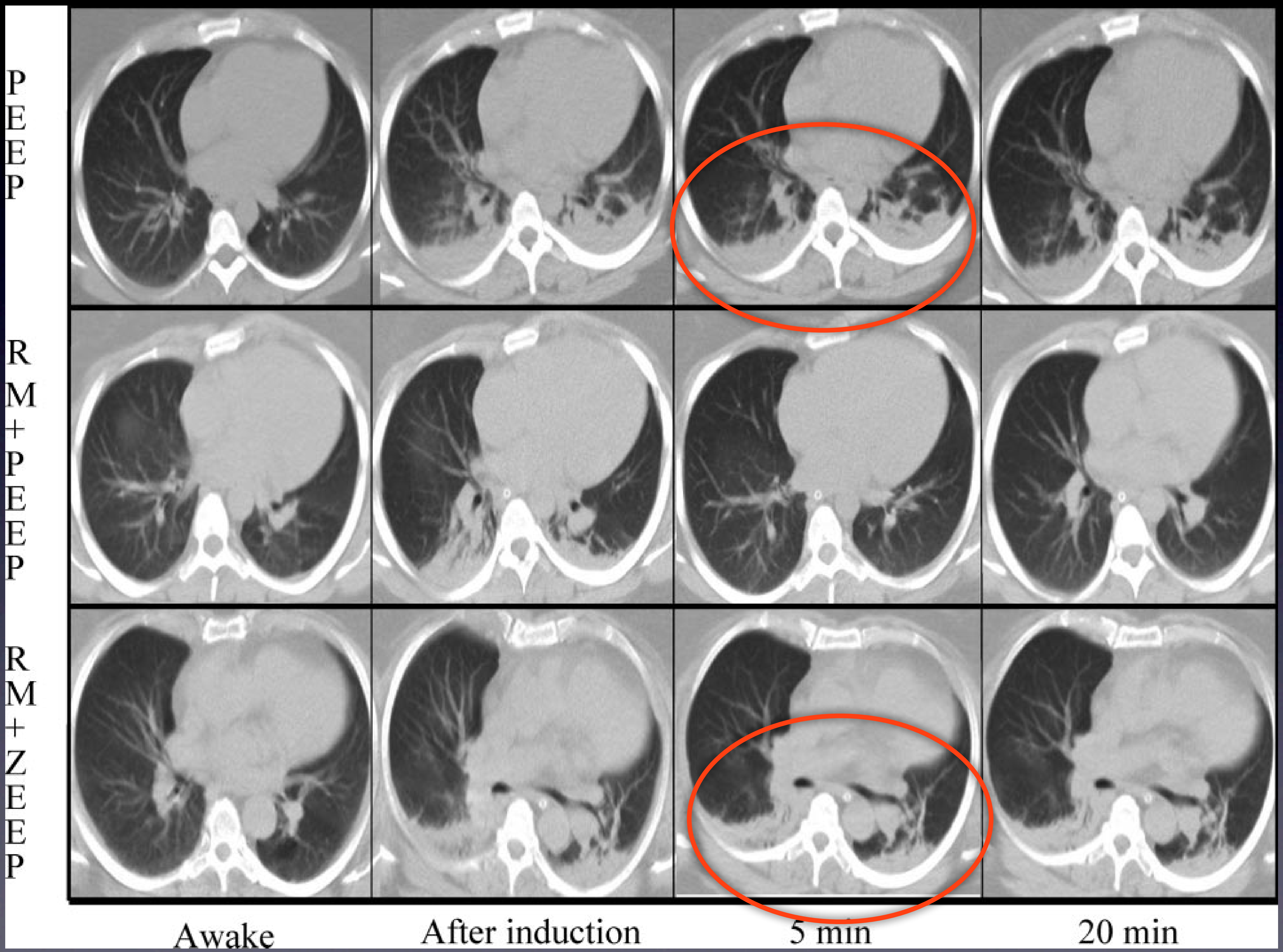

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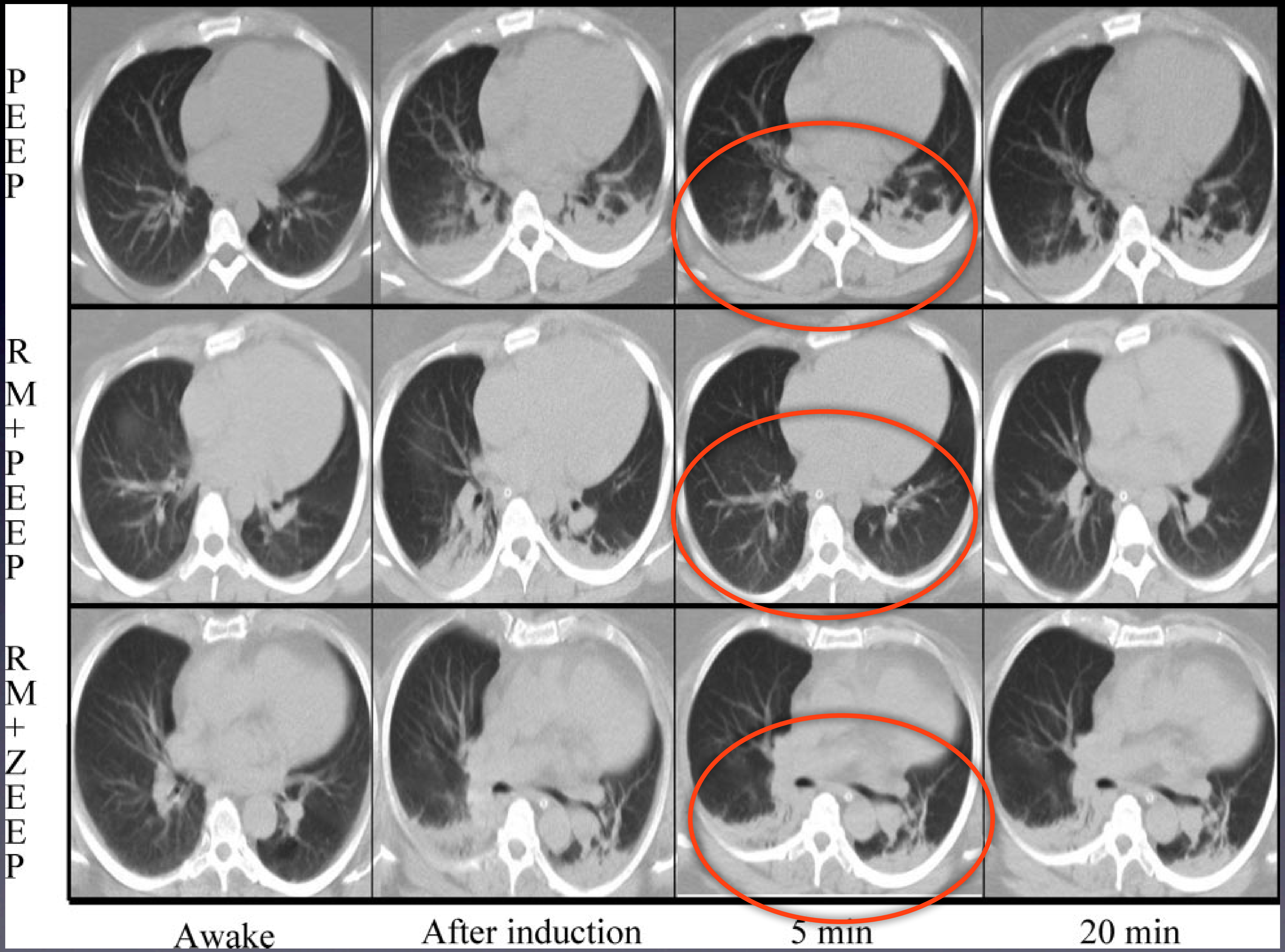

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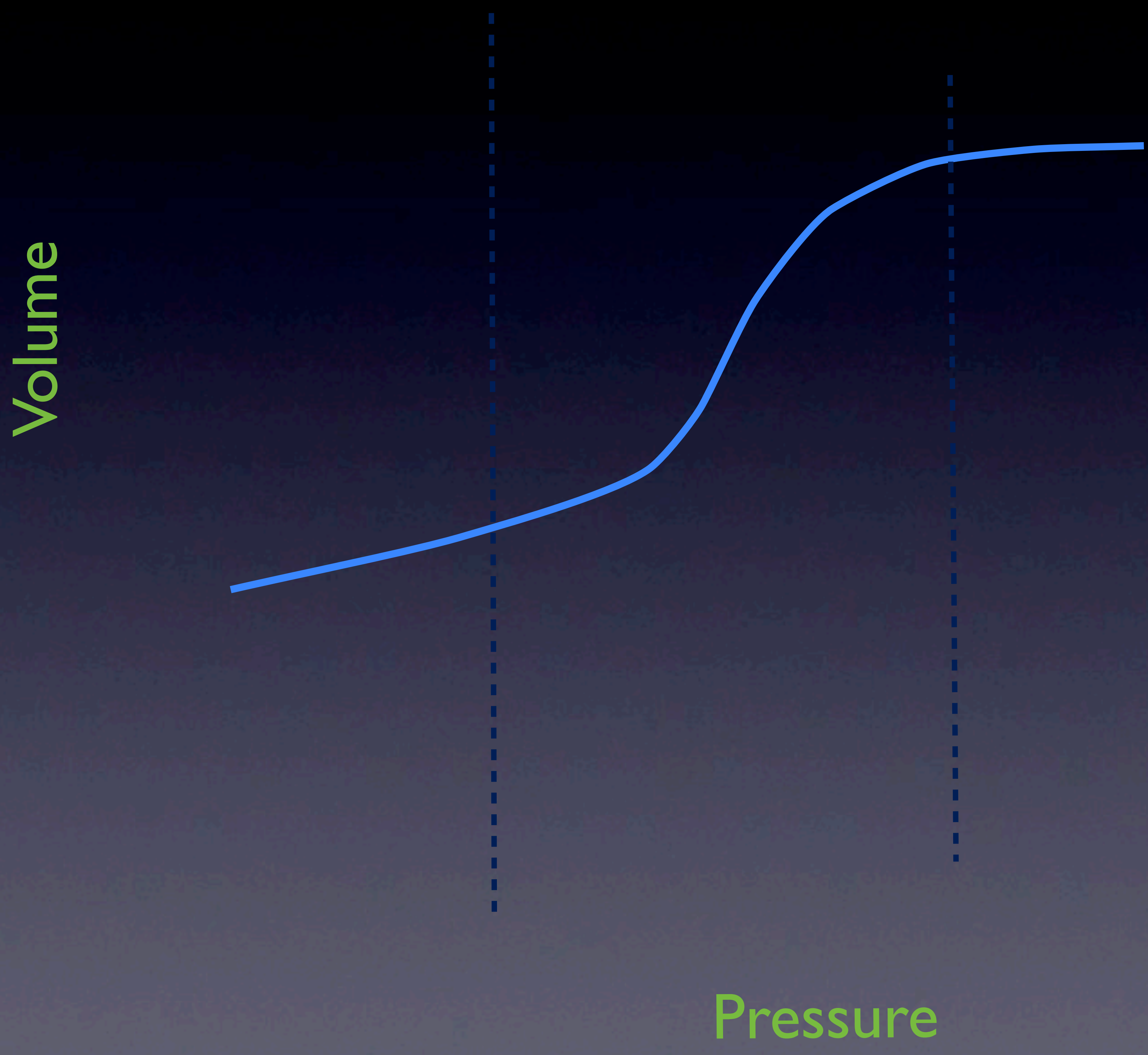

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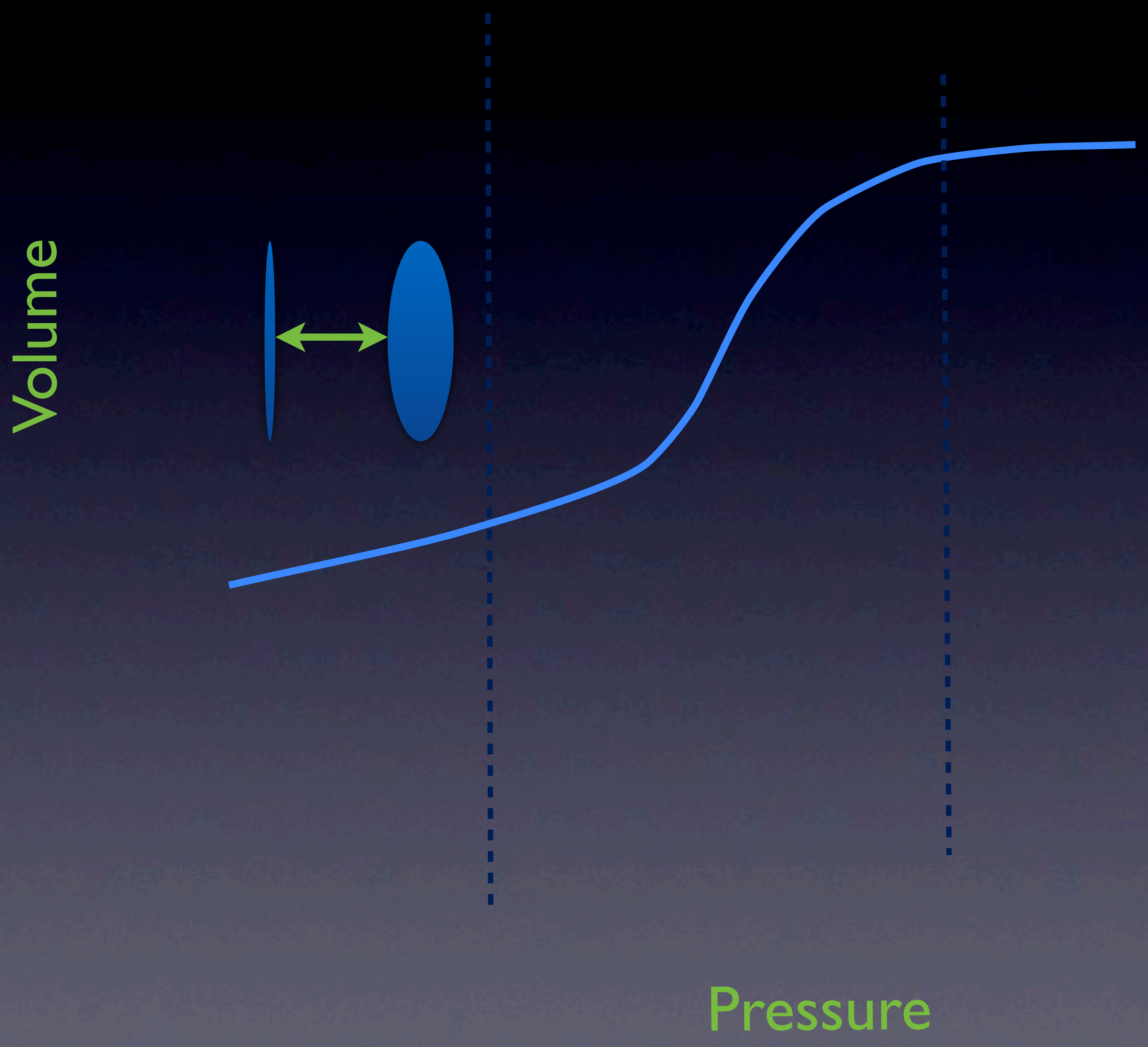

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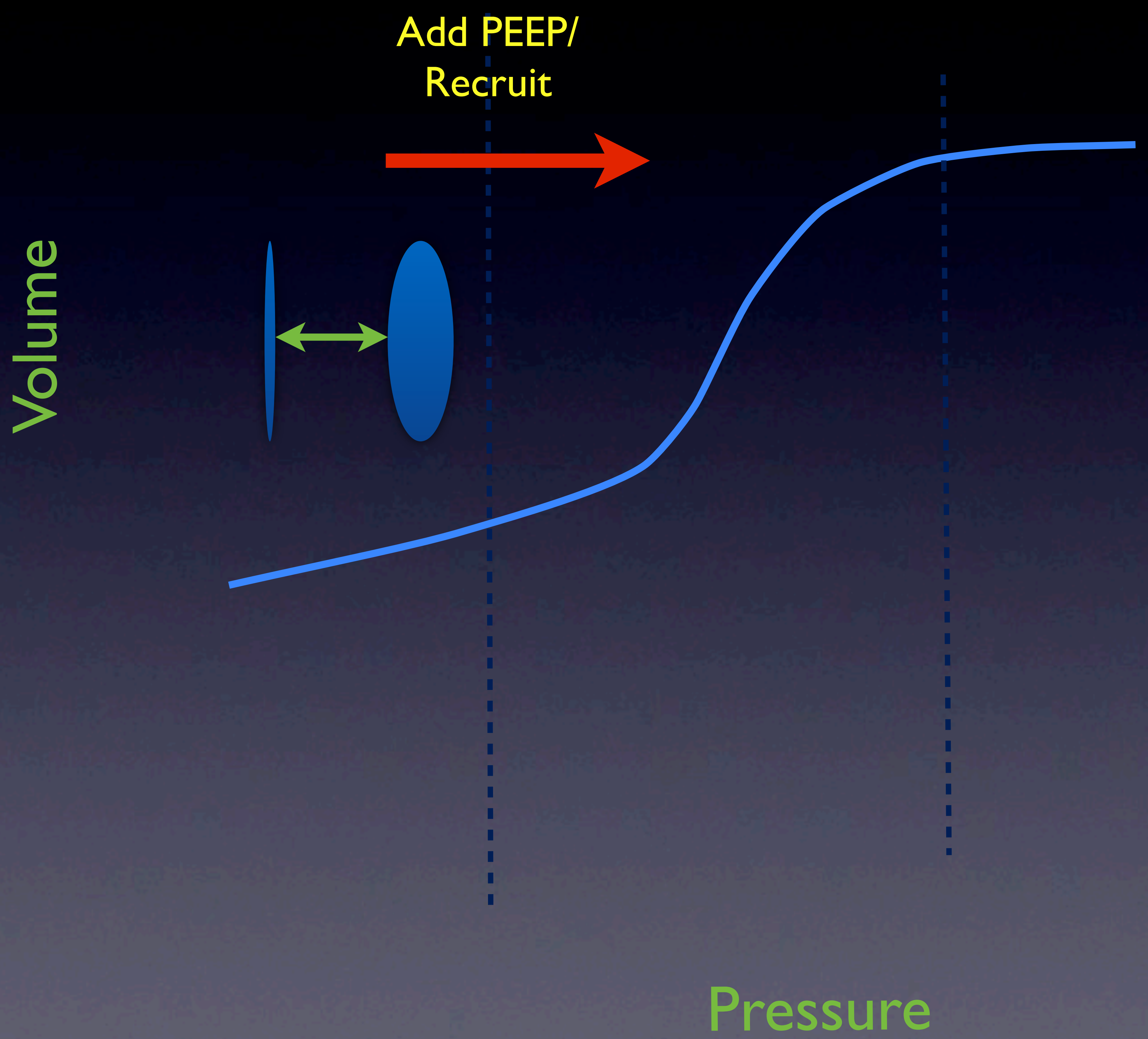

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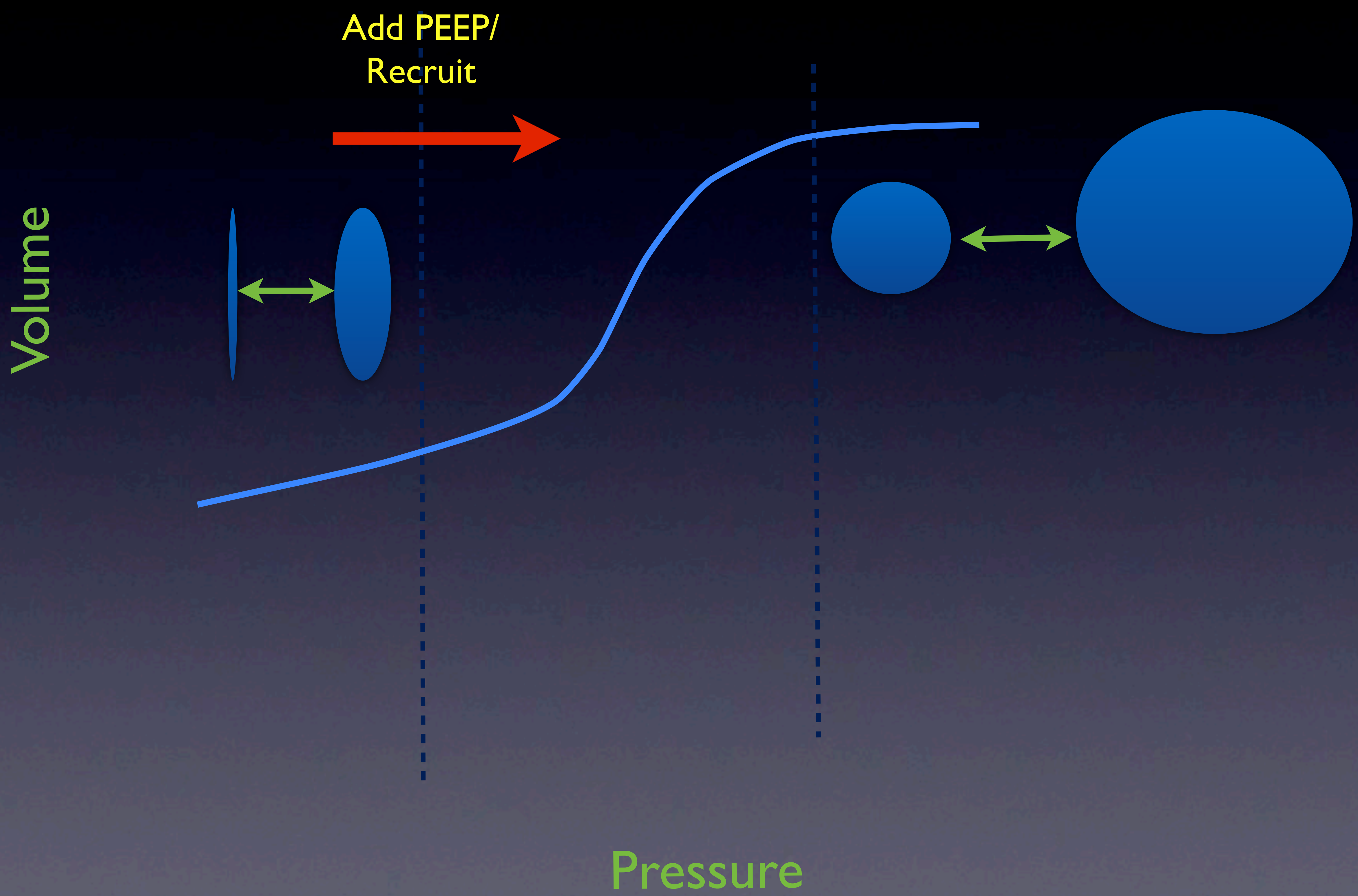

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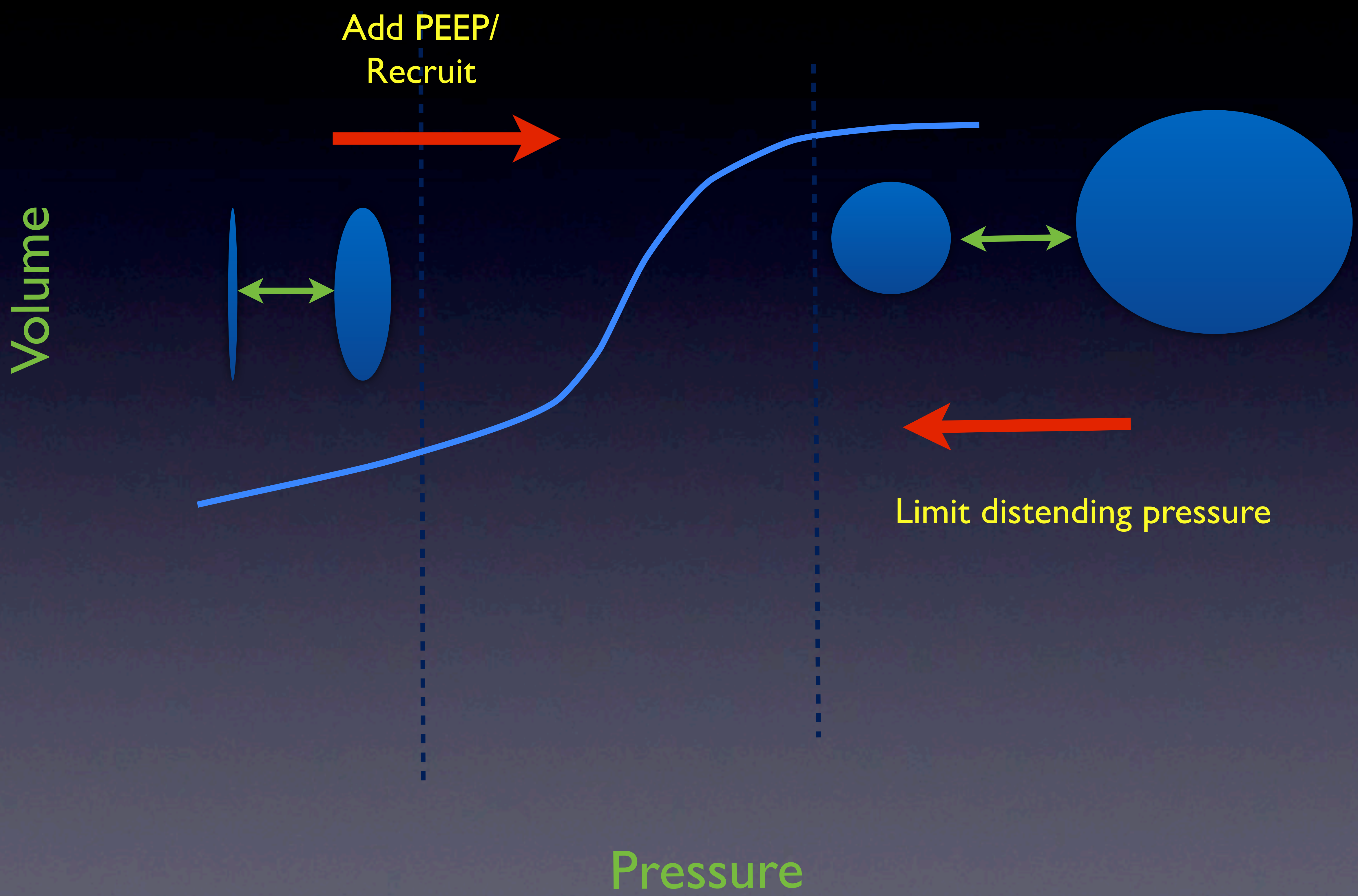

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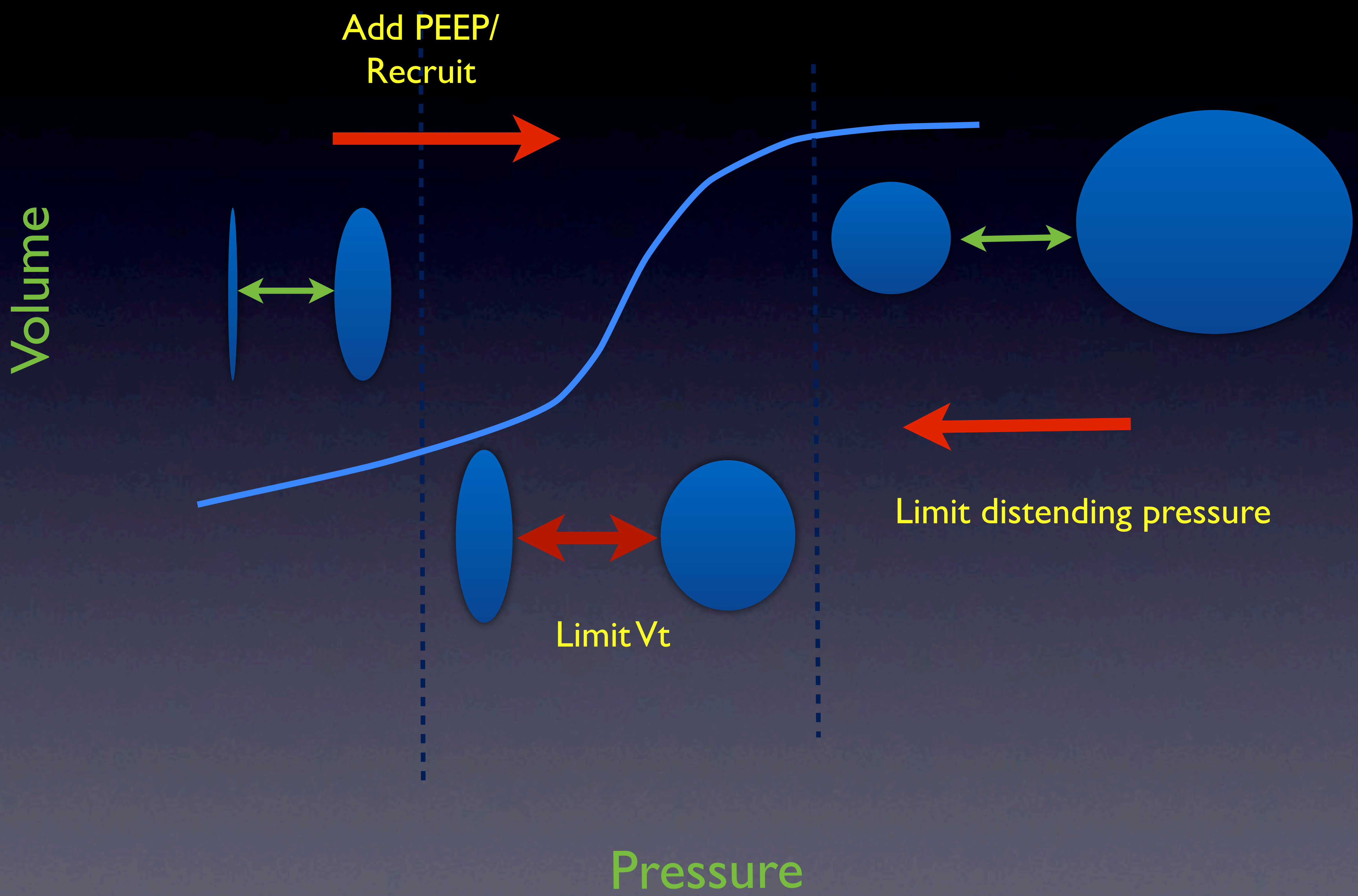

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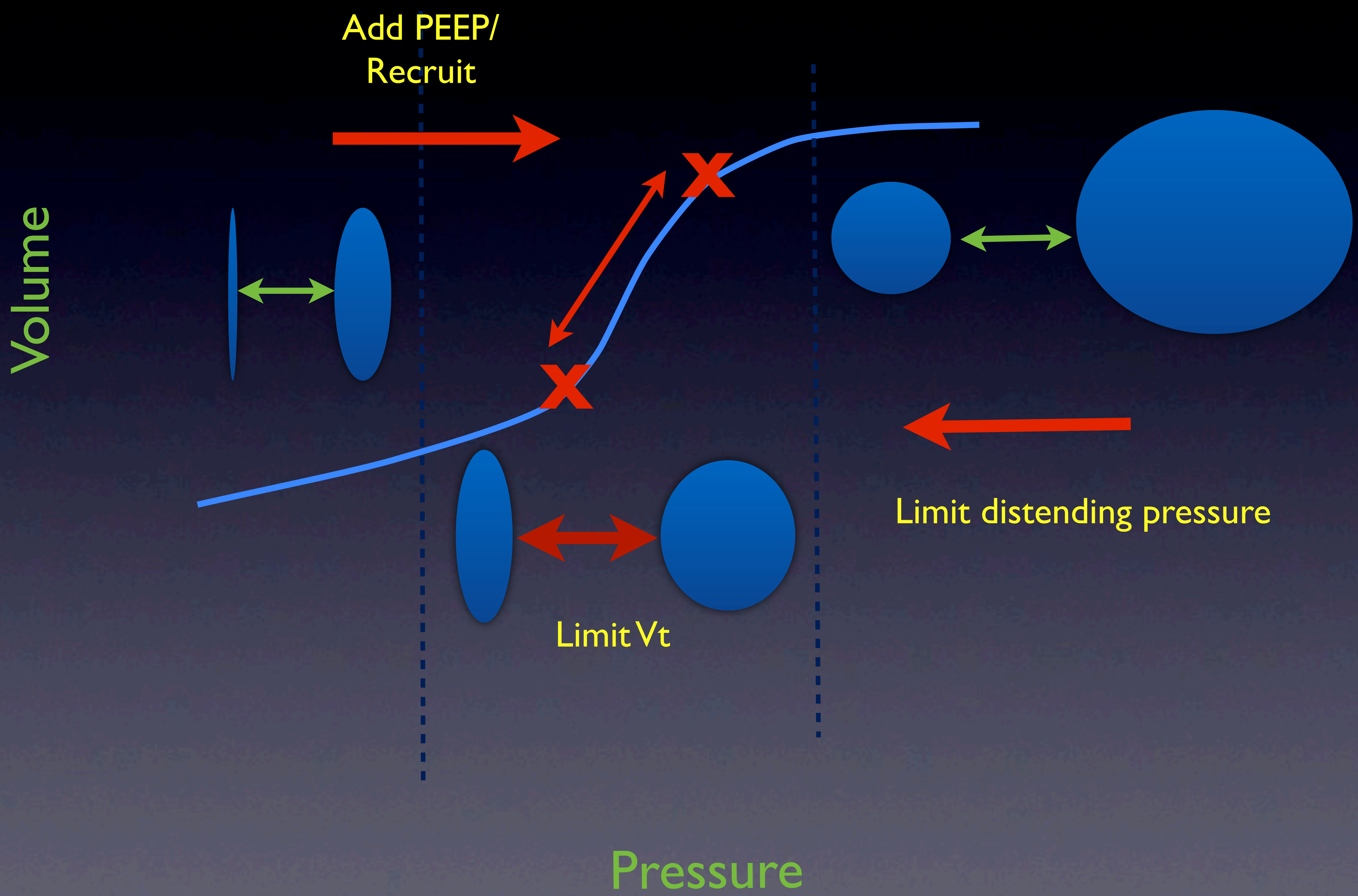
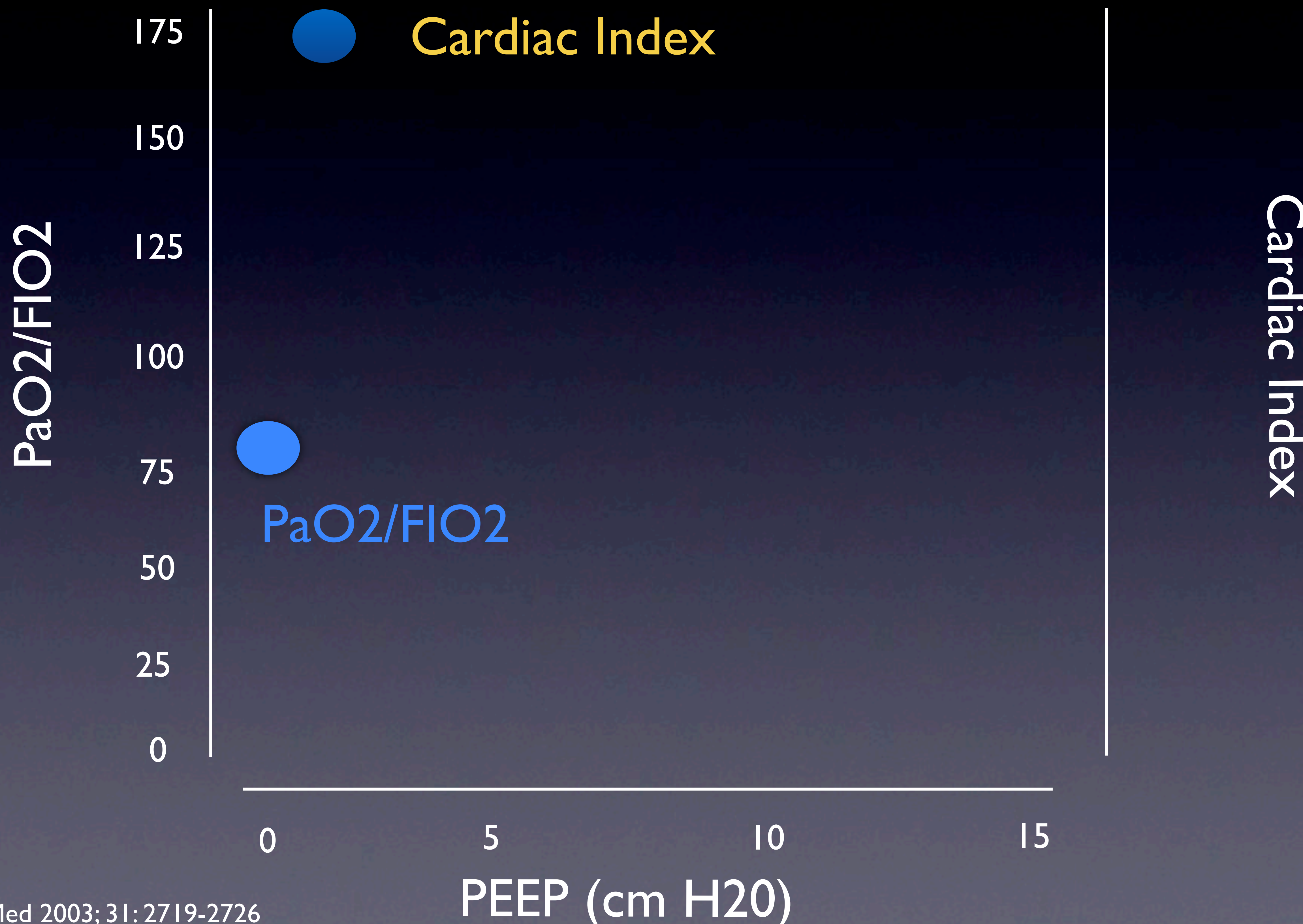


Effect of PEEP on lung efficiency vs. cardiac output



Crit Care Med 2003; 31: 2719-2726

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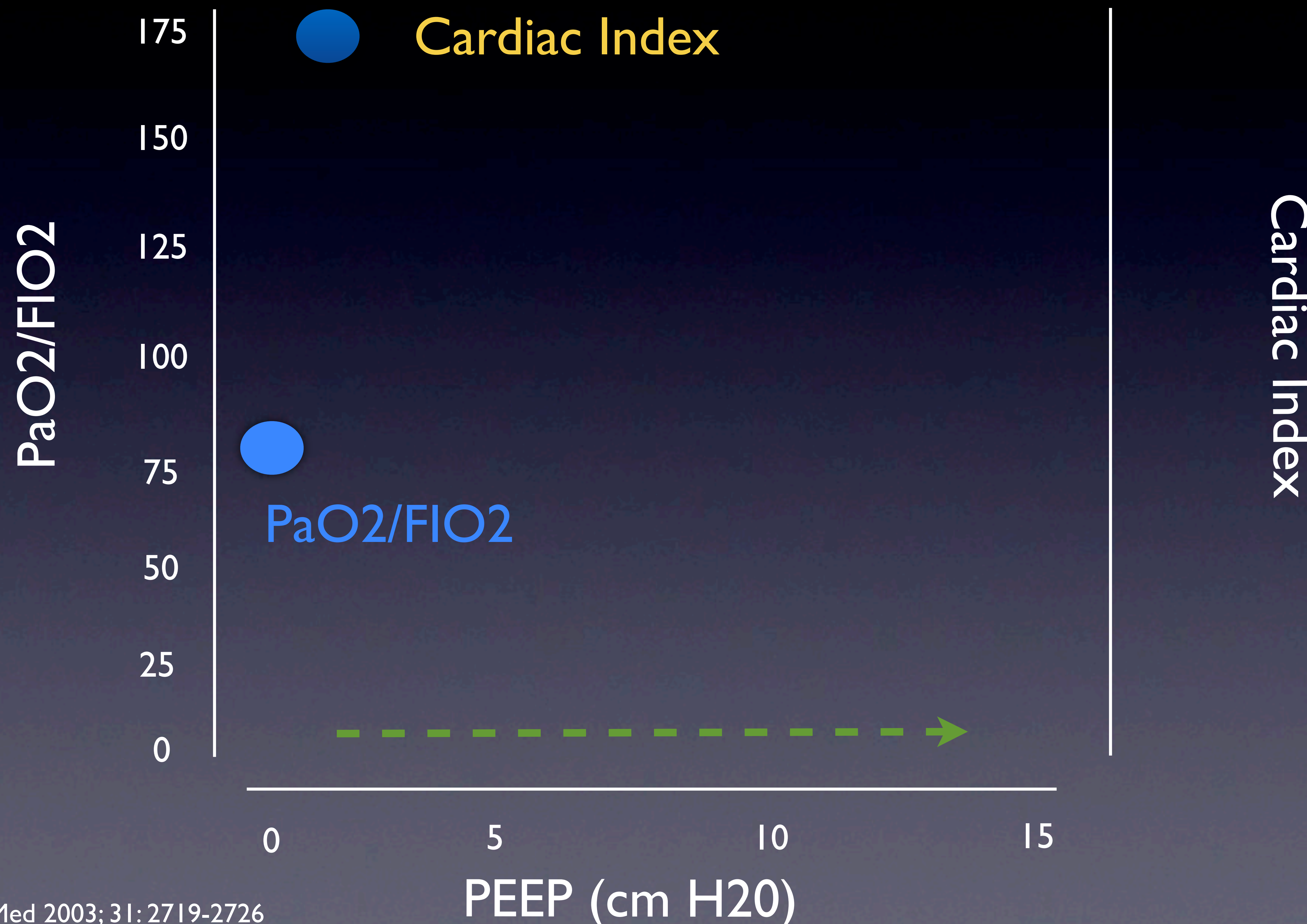

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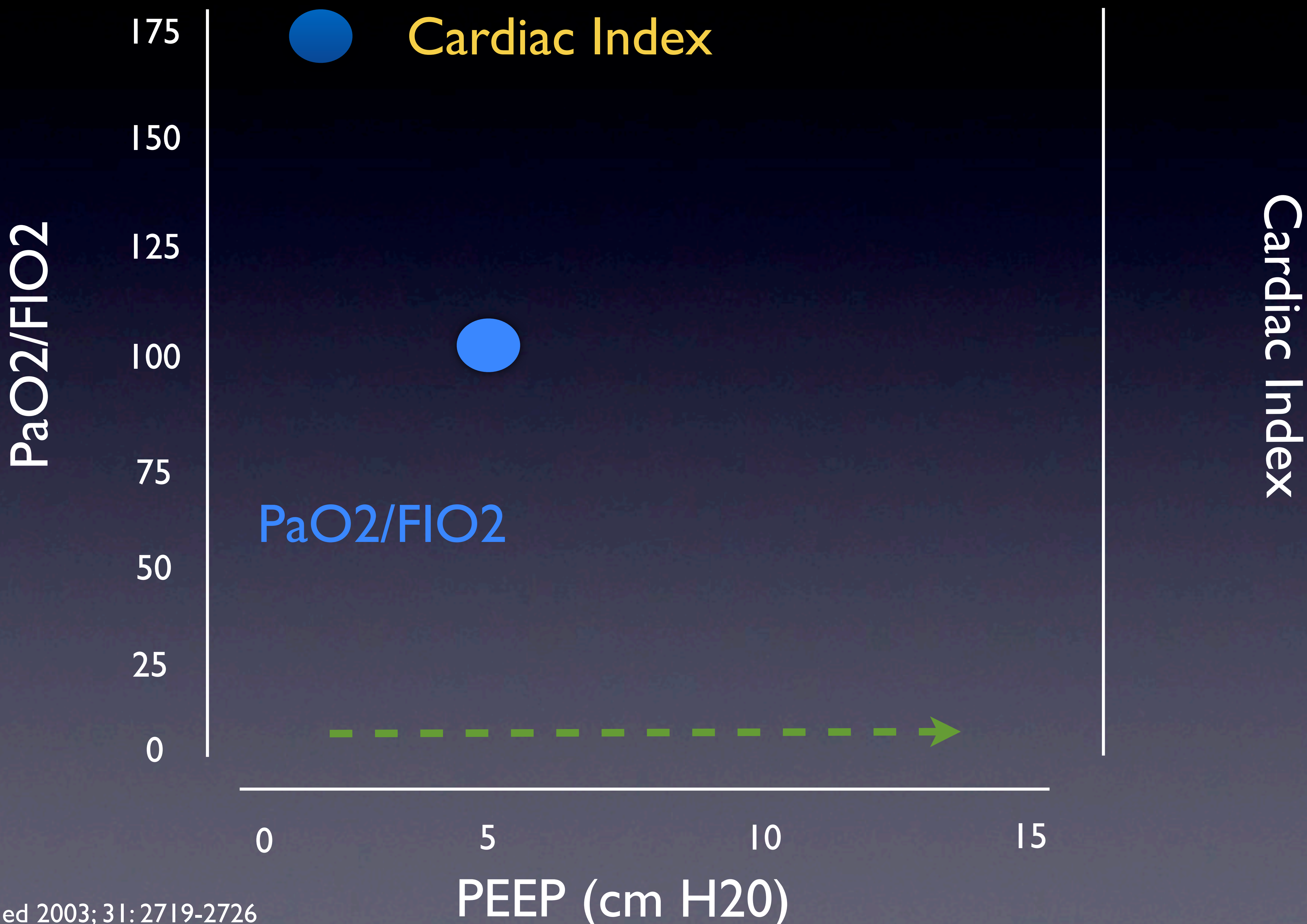

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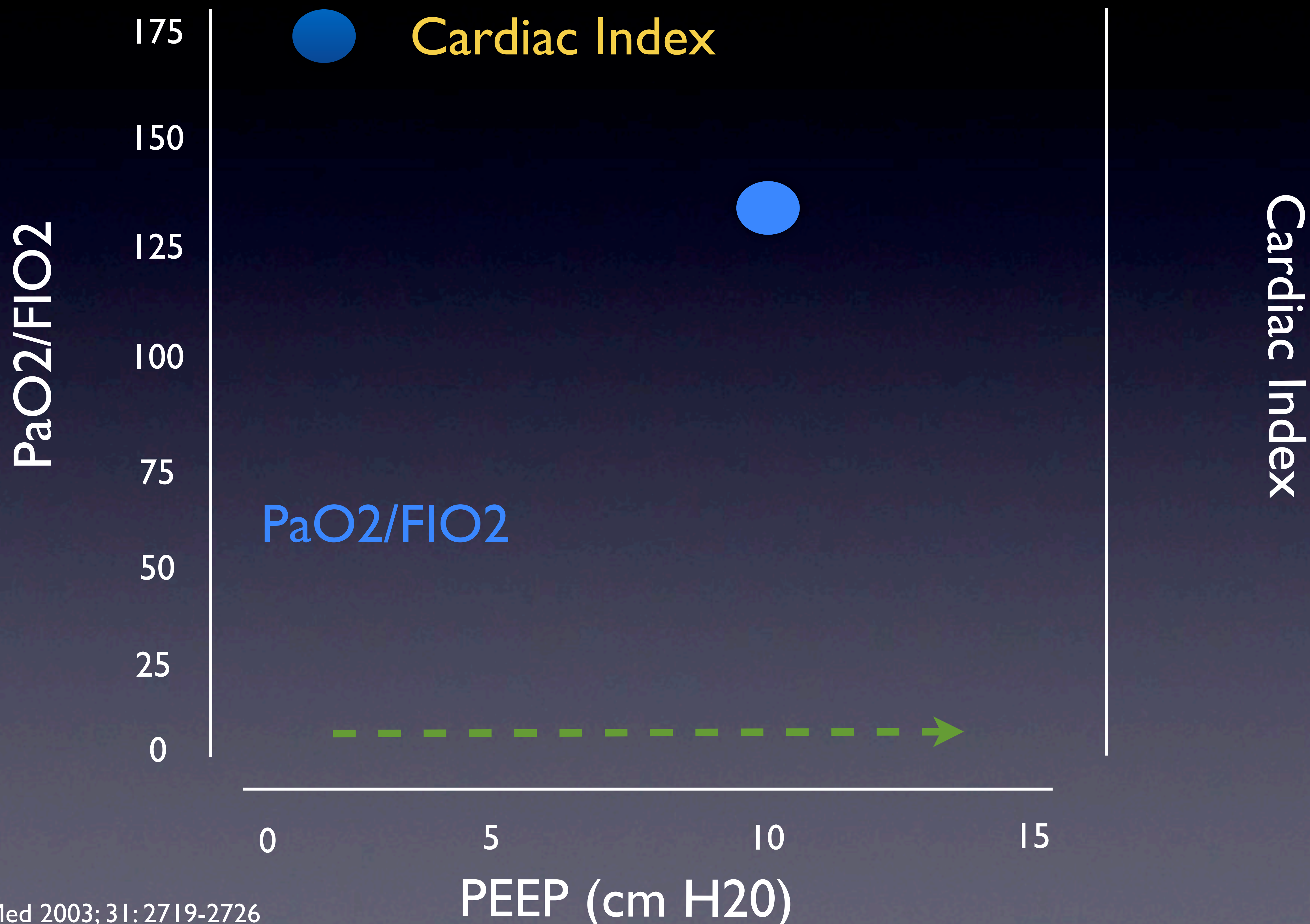

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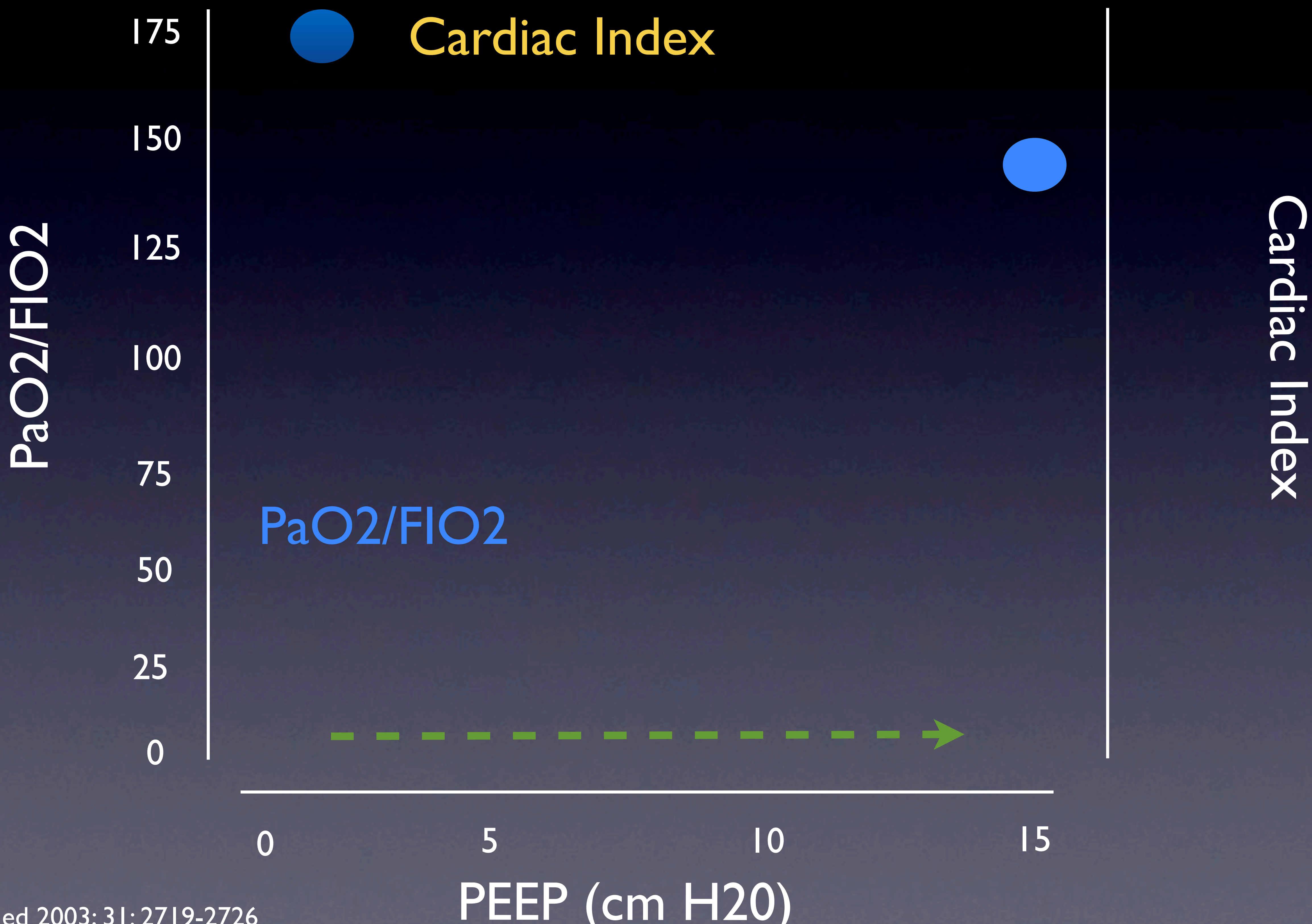

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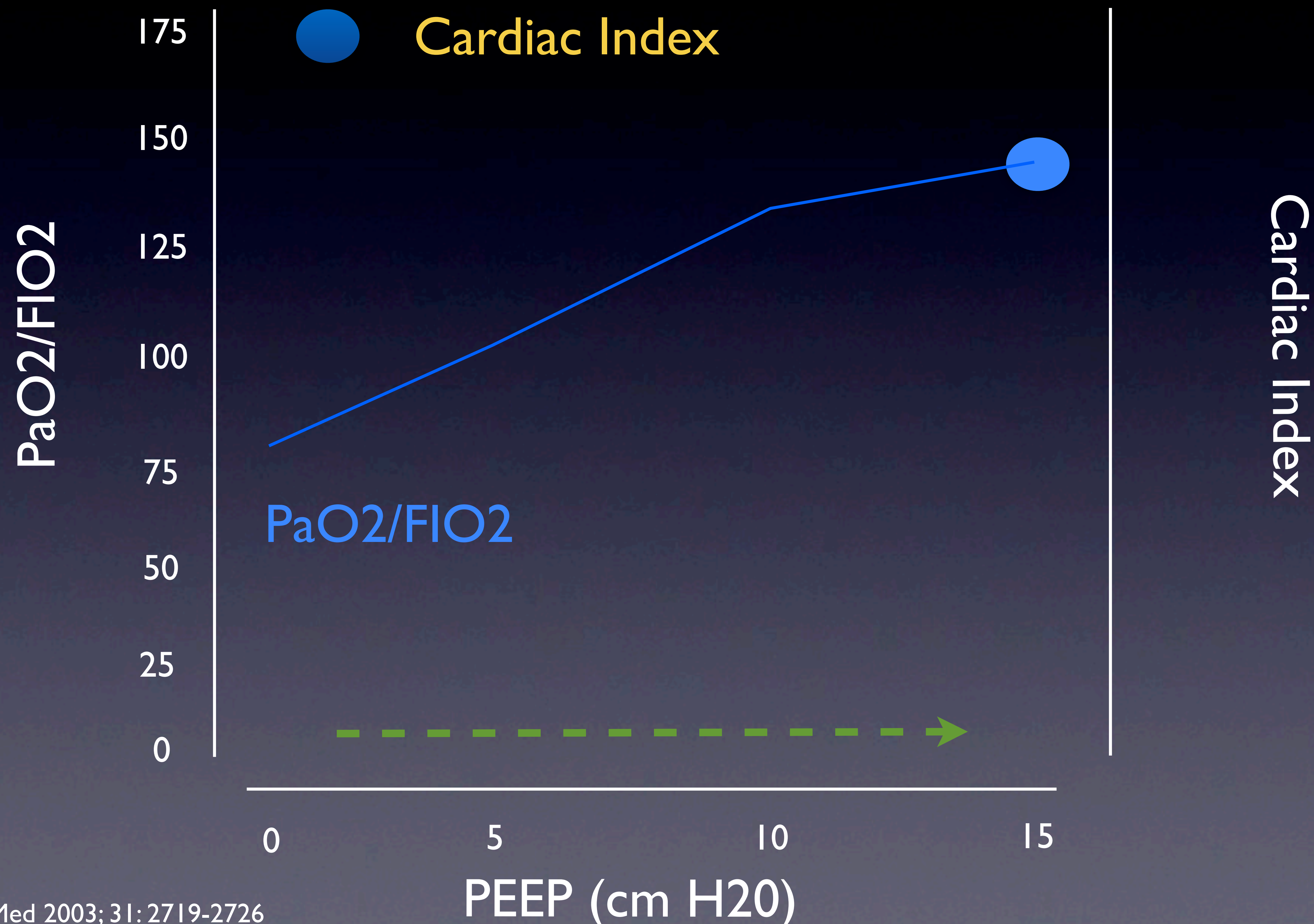

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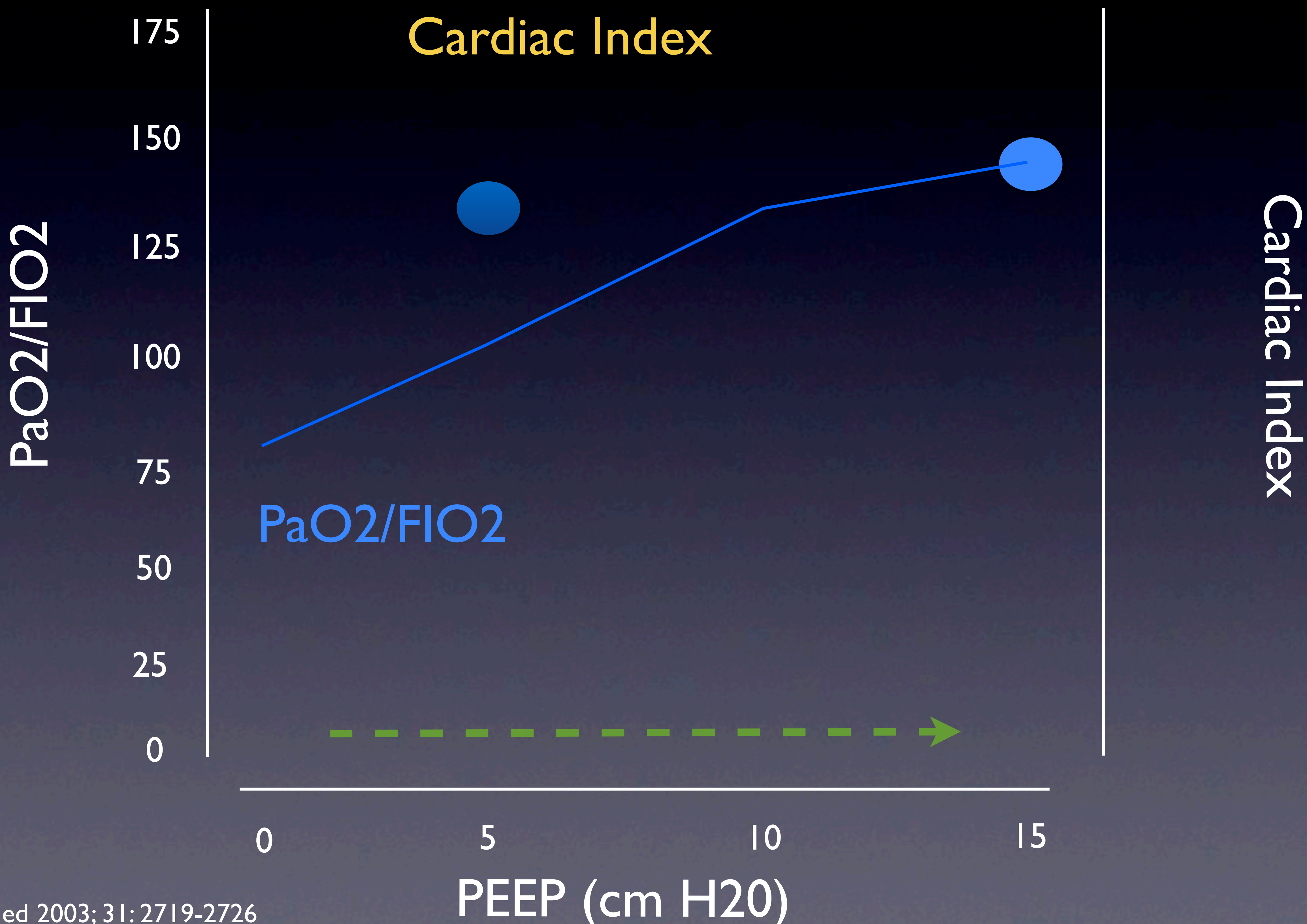

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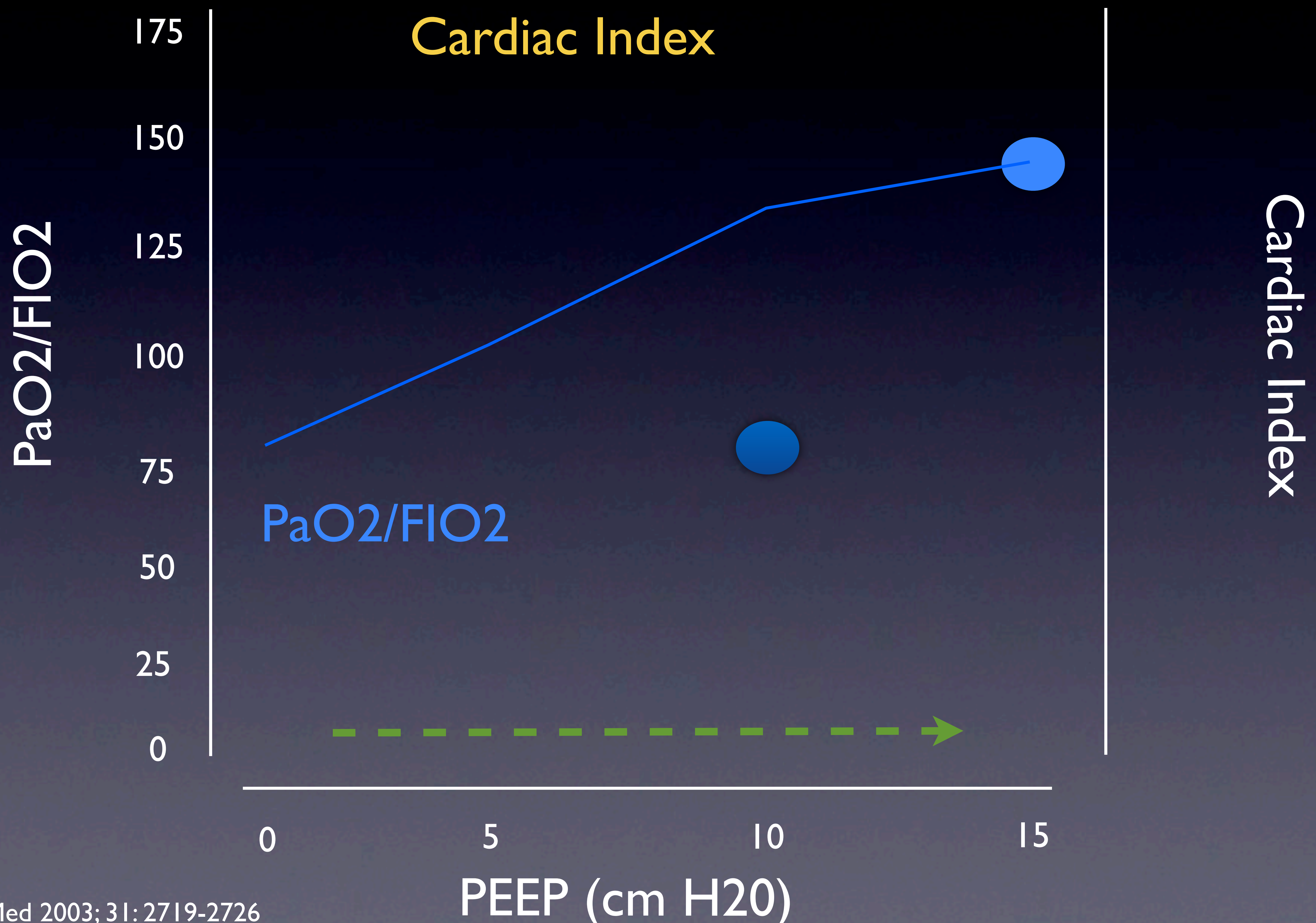

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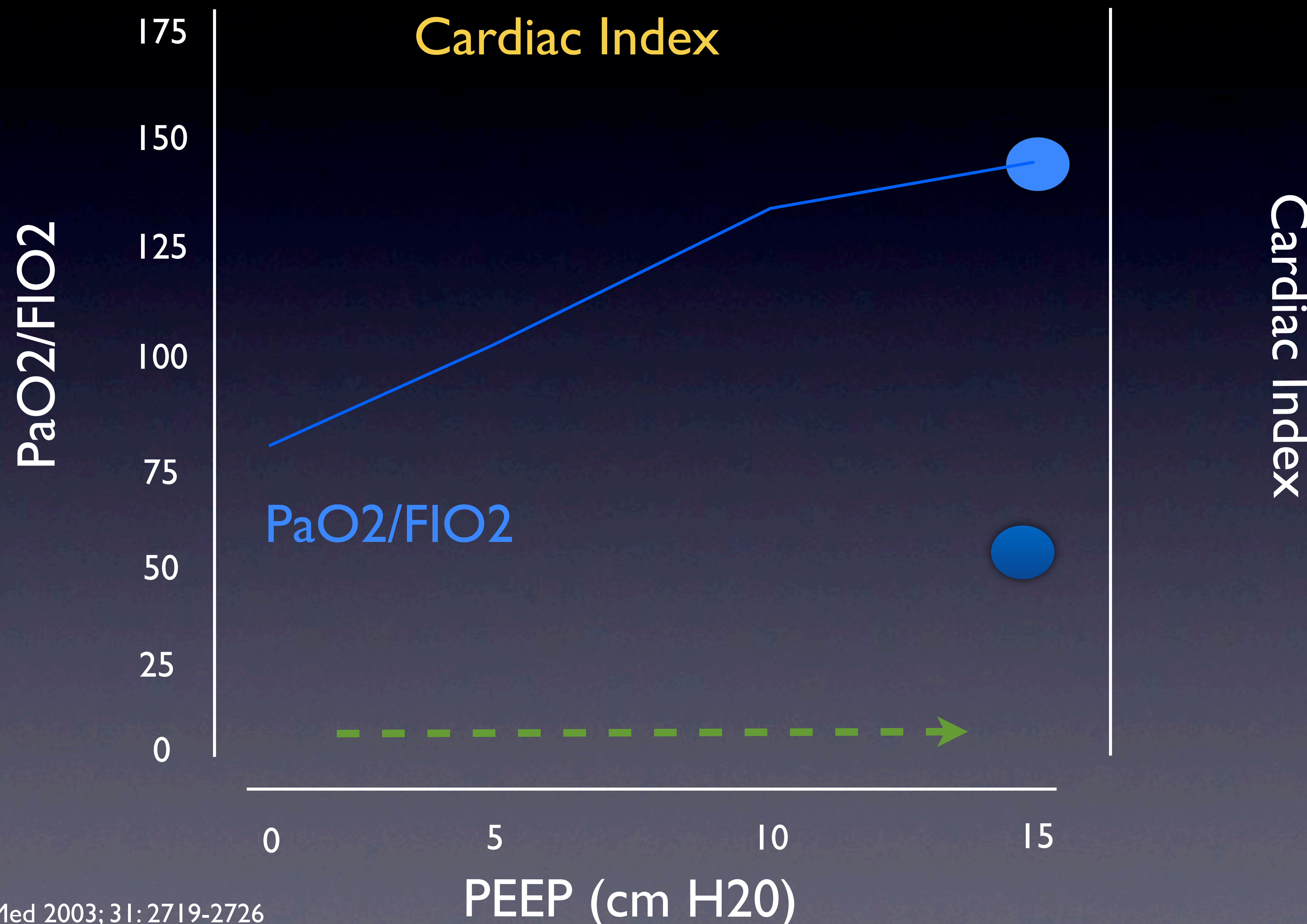

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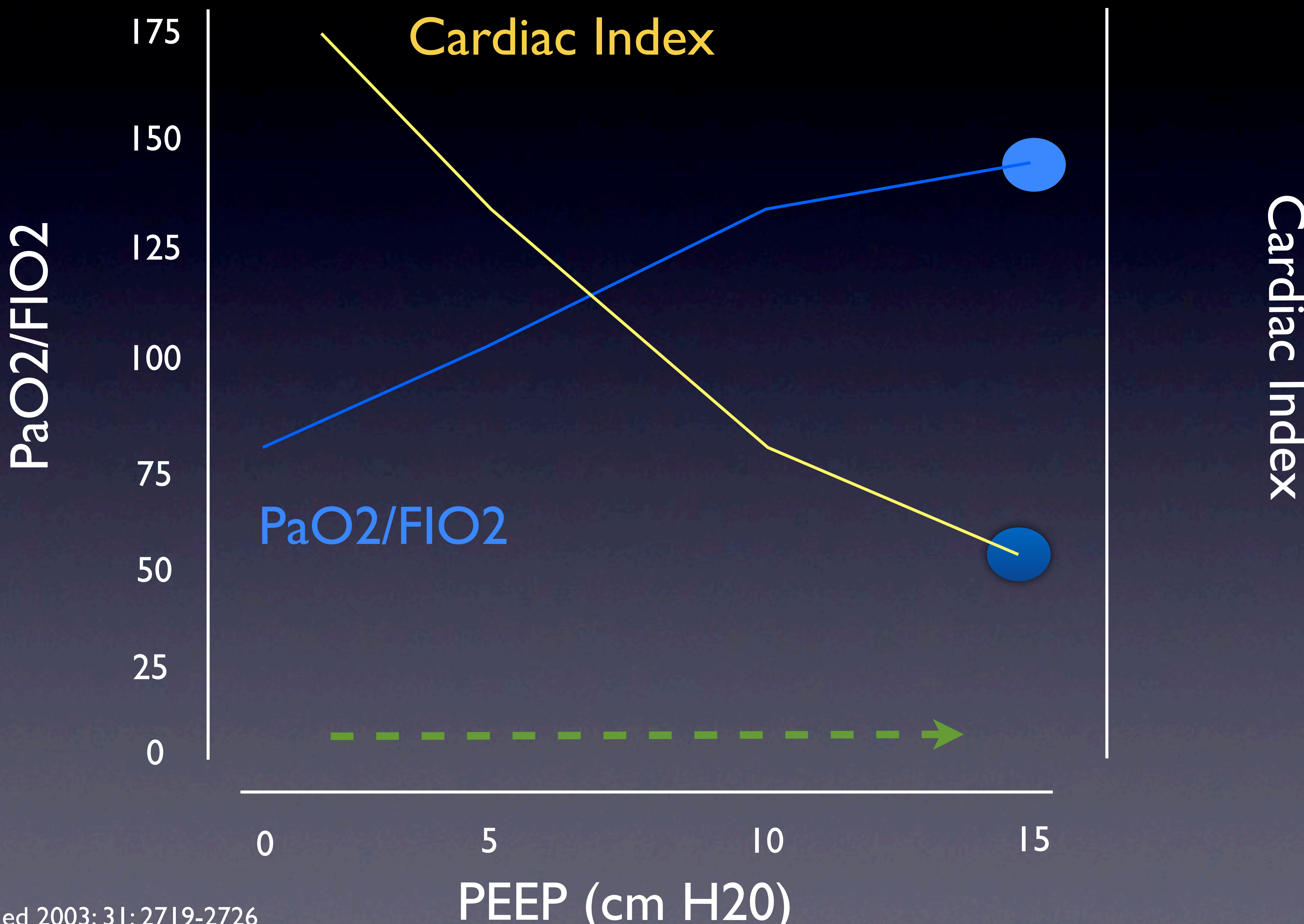

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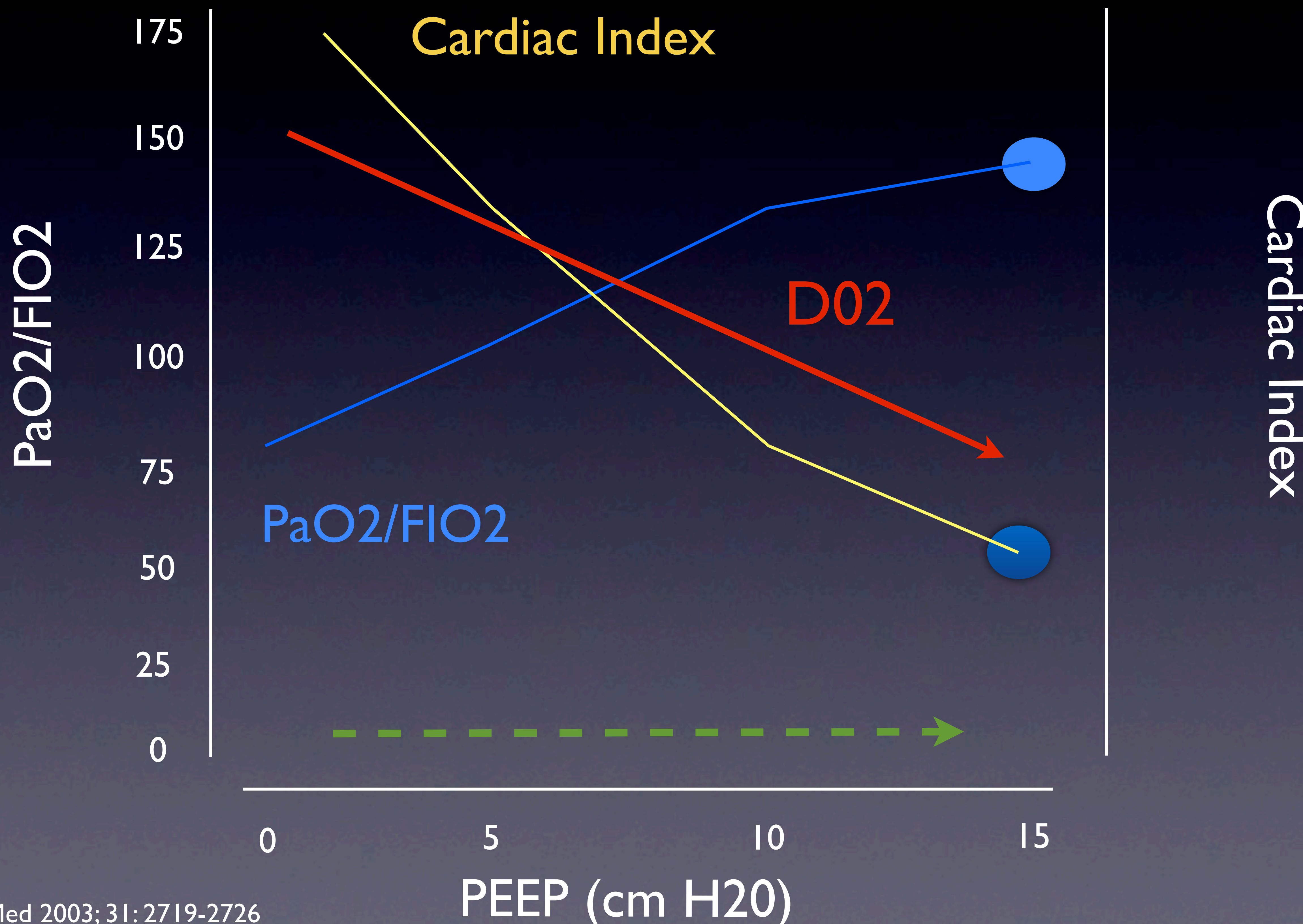

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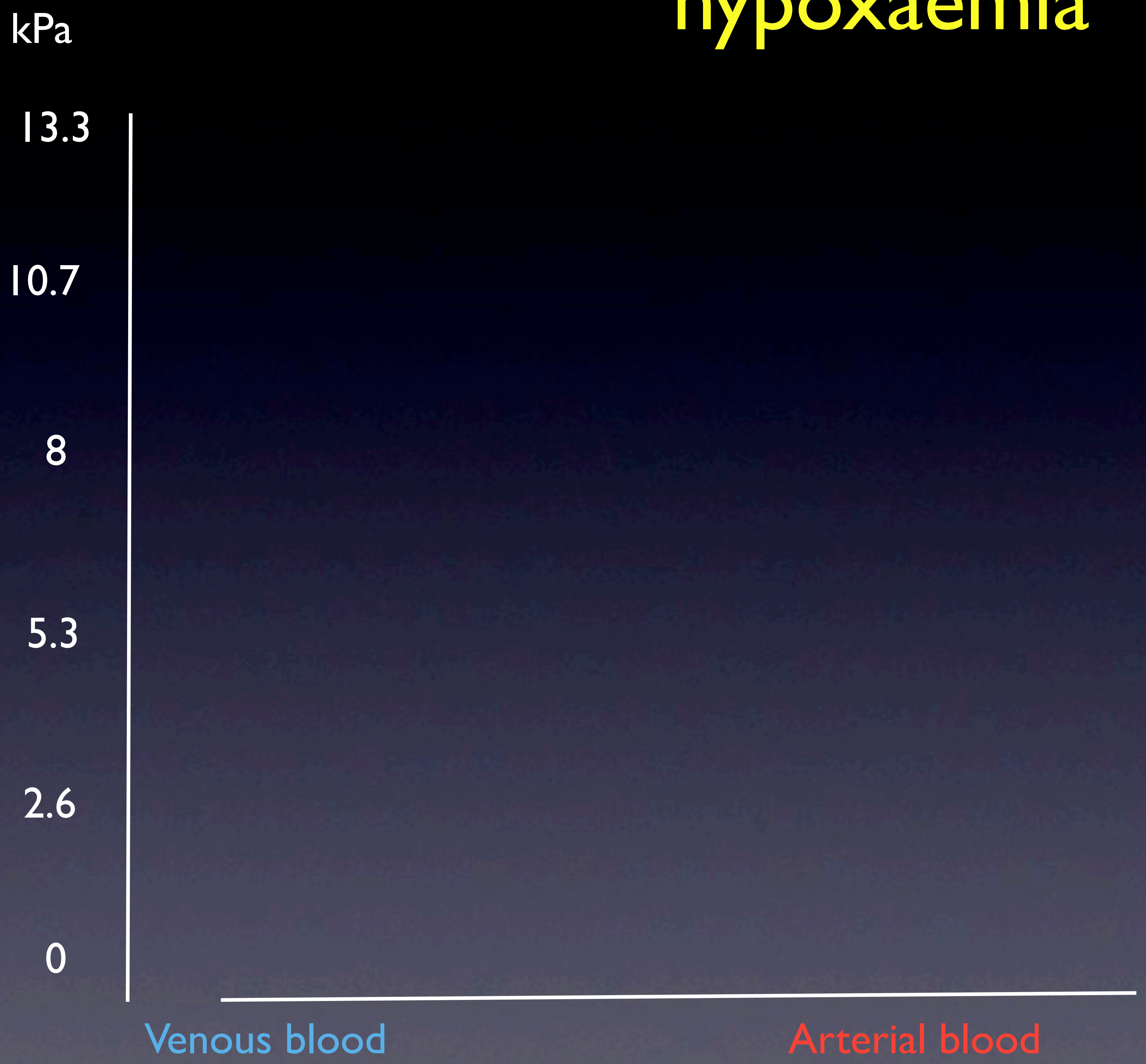
Why a low cardiac output can accentuate hypoxaemia



Influence of a V/Q abnormality on the transition from arterial to venous P02 + the added effect of a low mixed venous p02.

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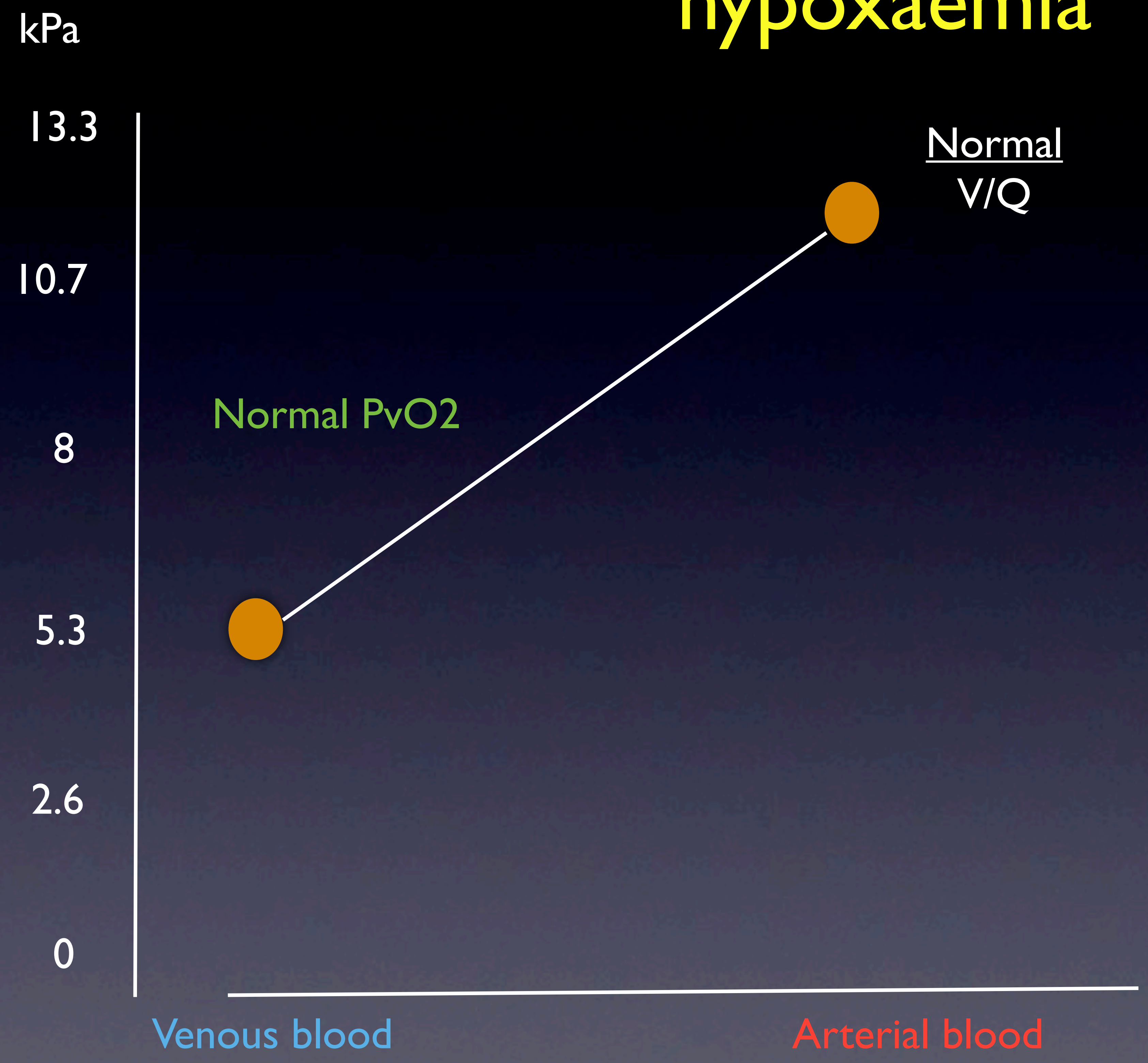

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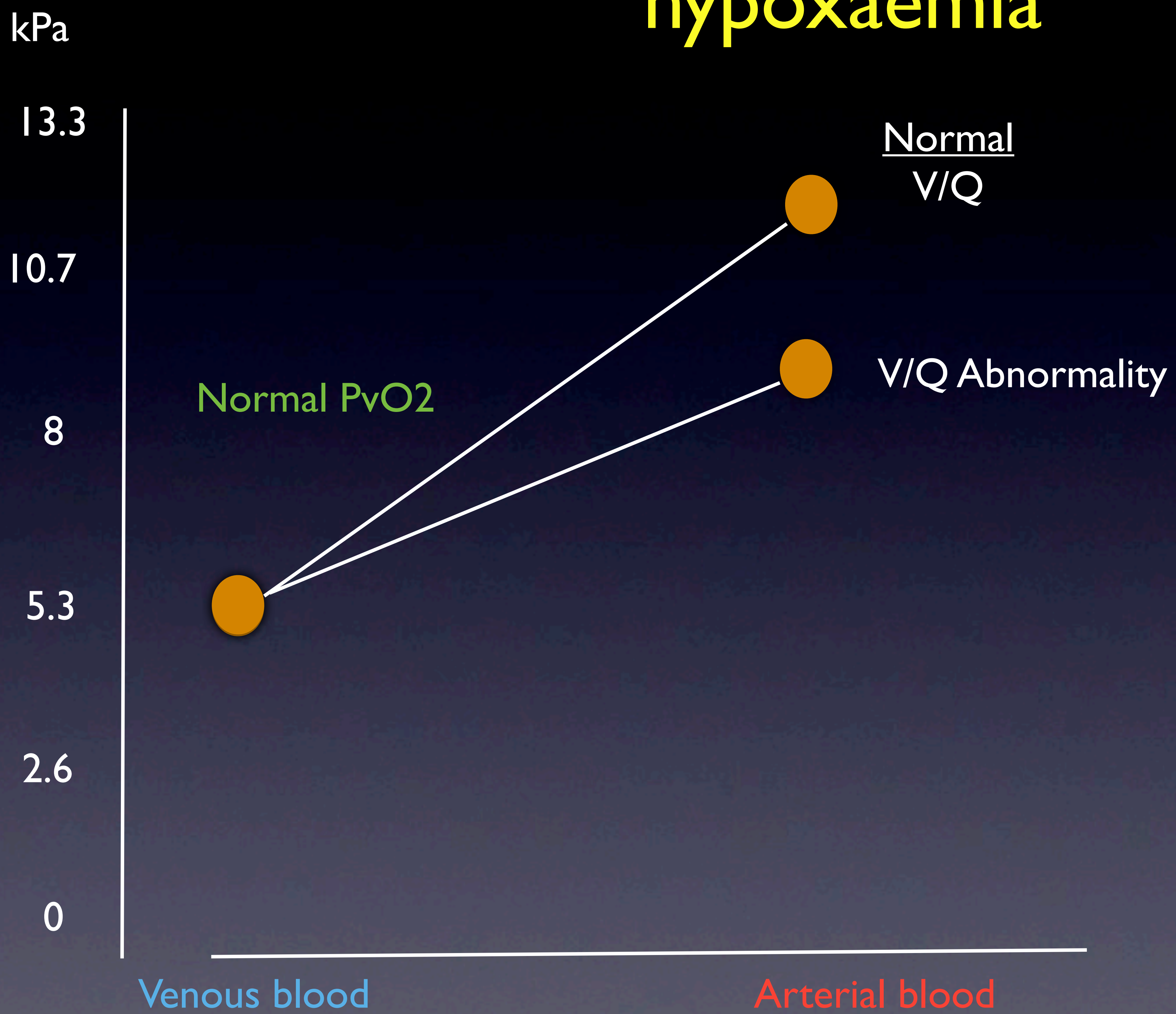

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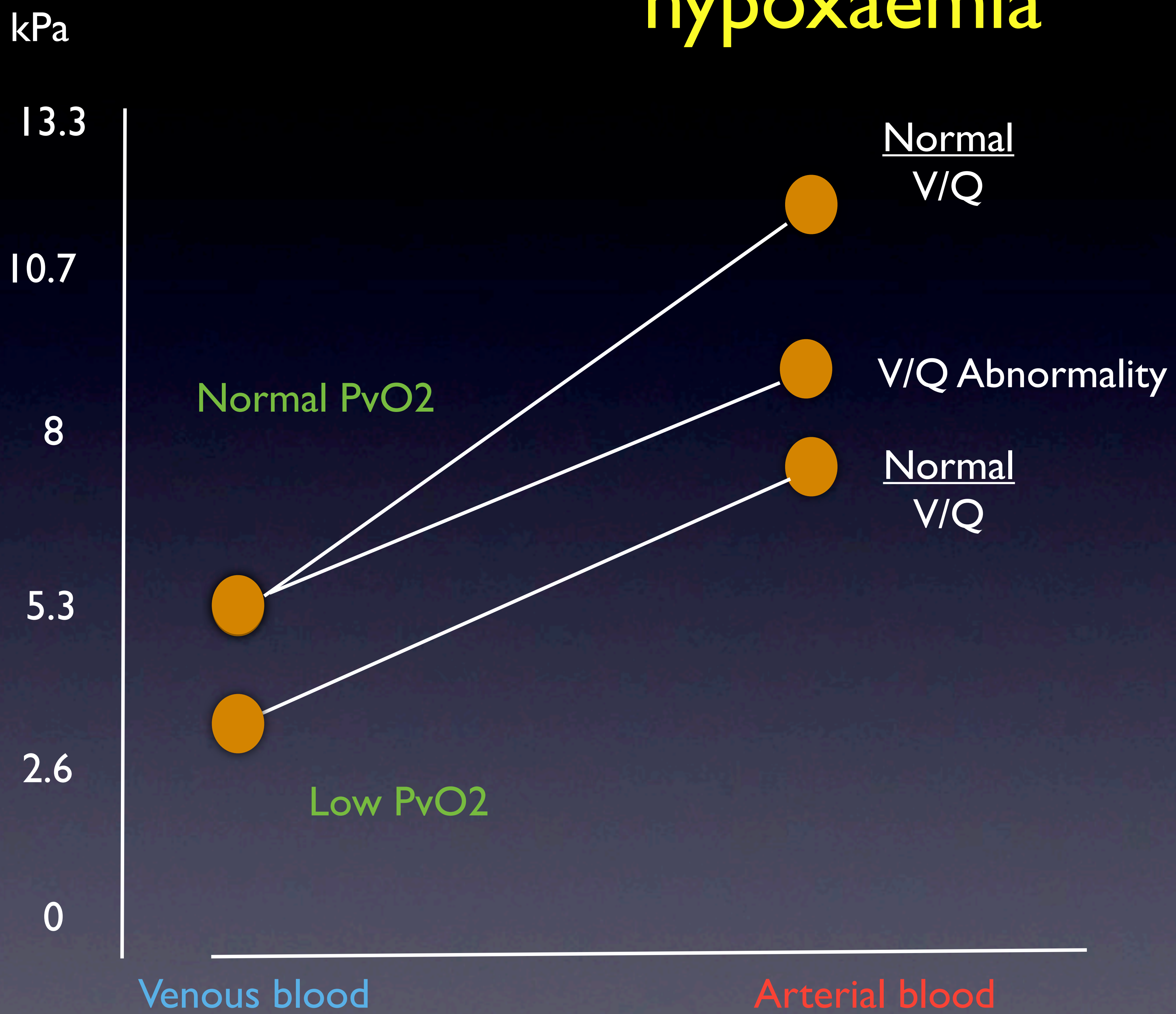

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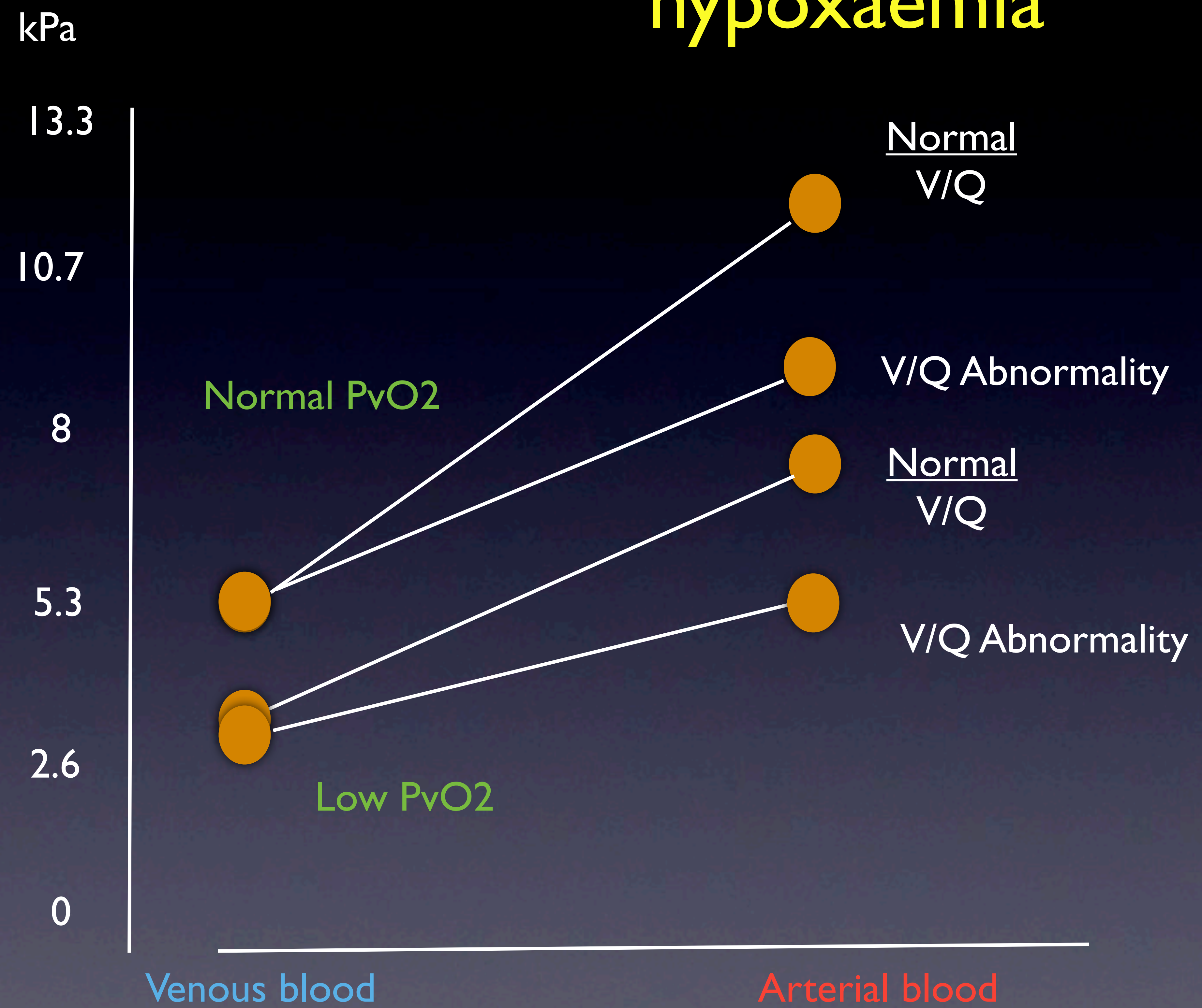

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What must we watch out for?

Negative pressure pulmonary oedema

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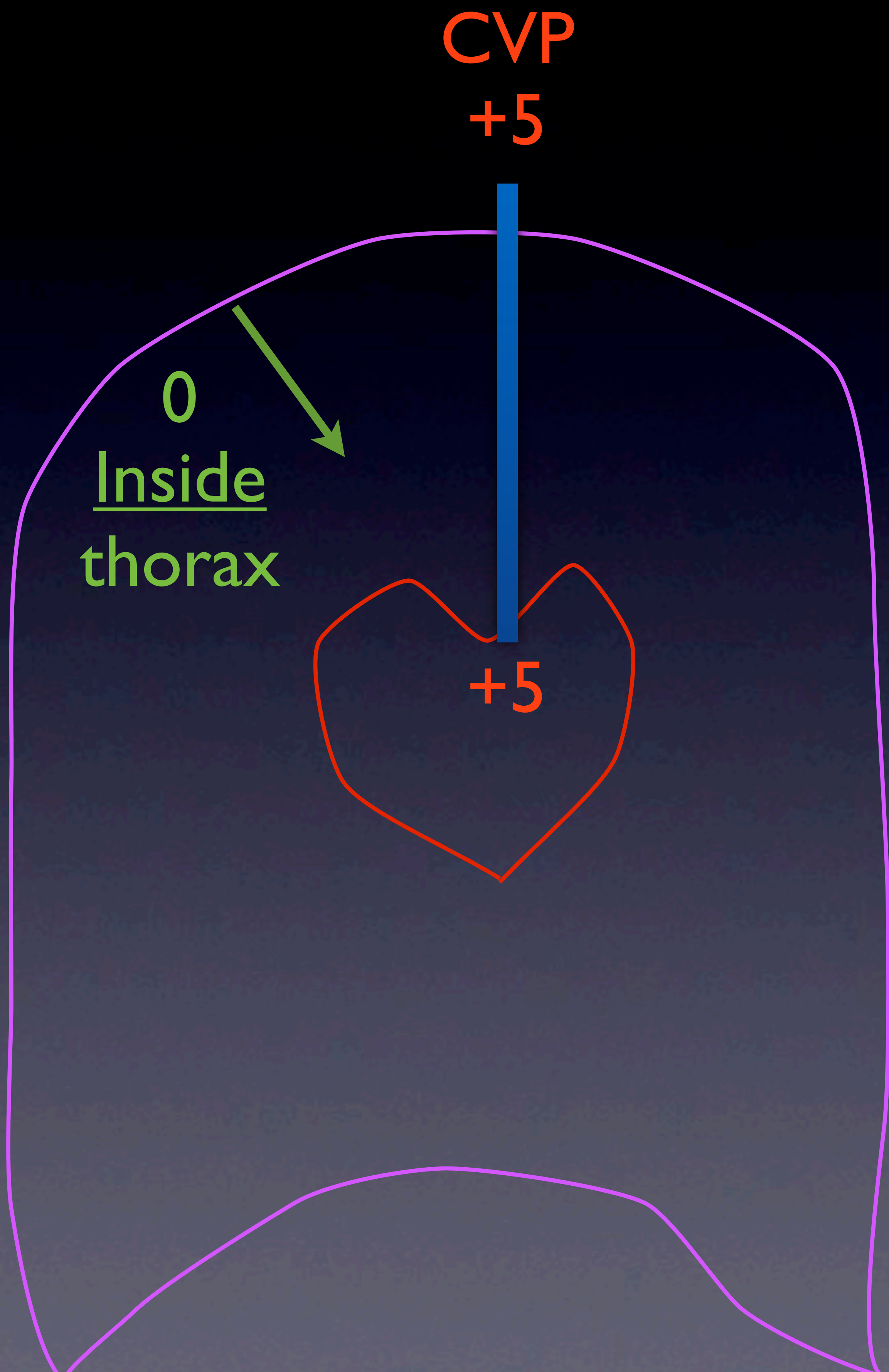

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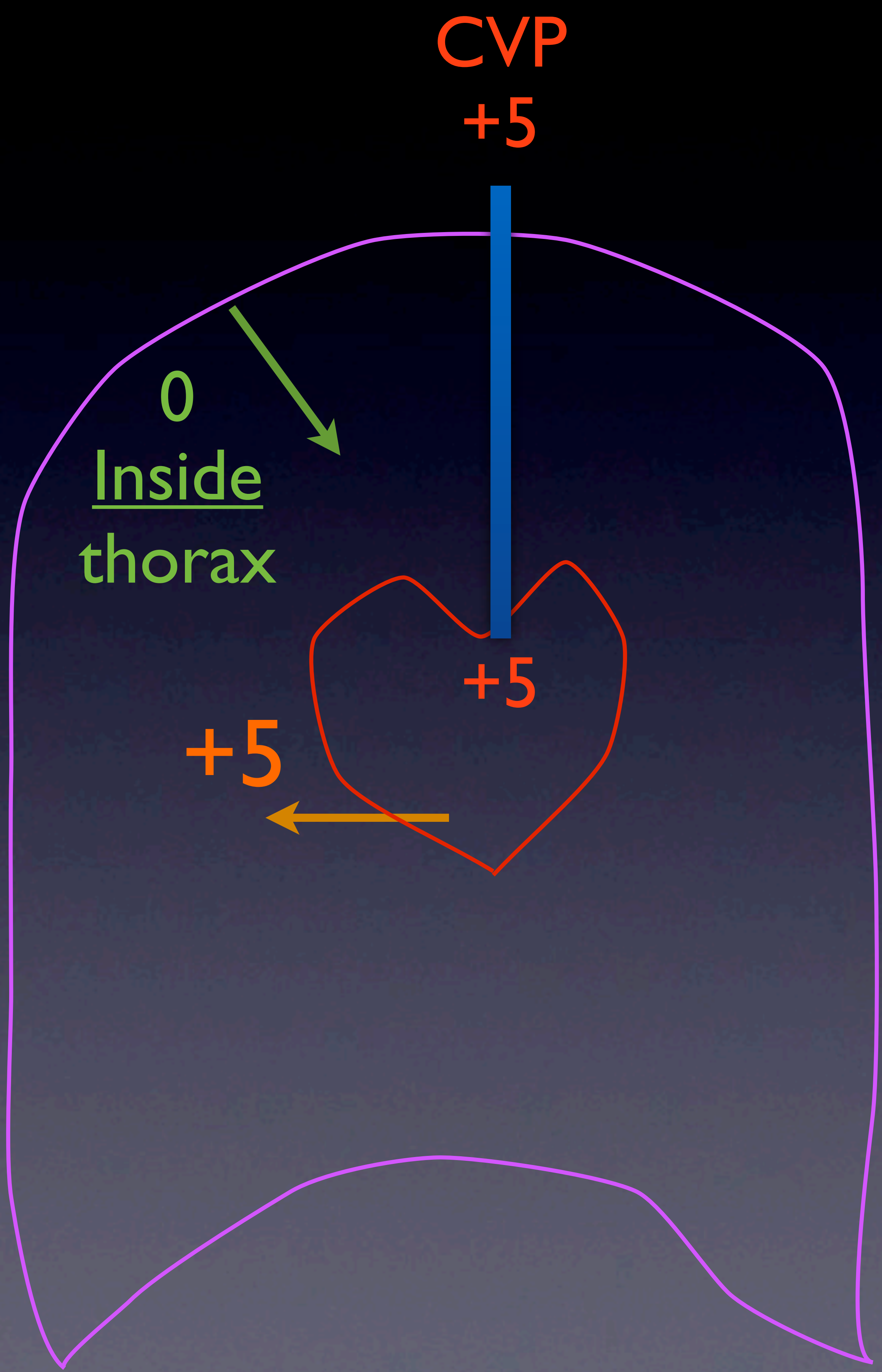

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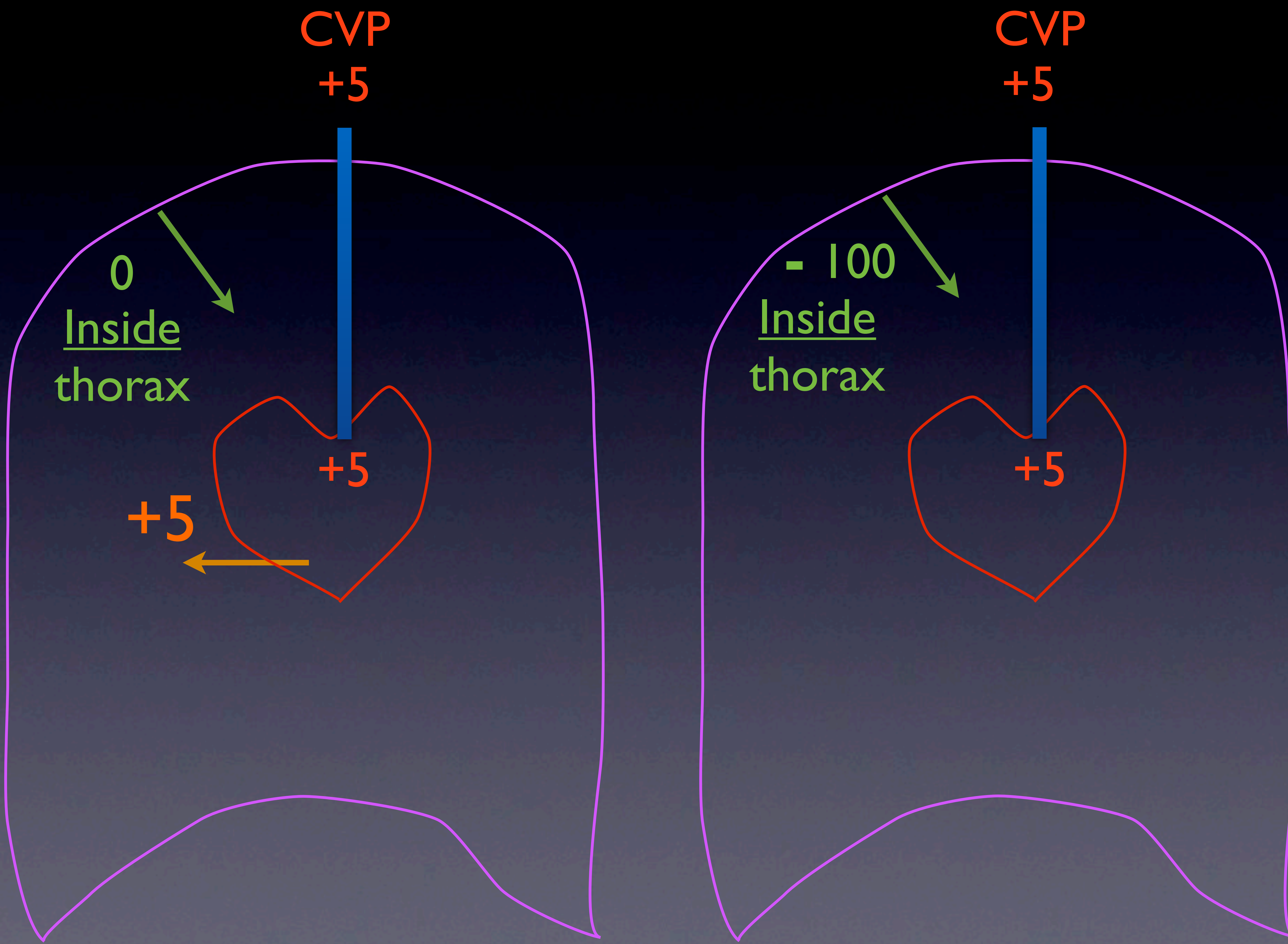

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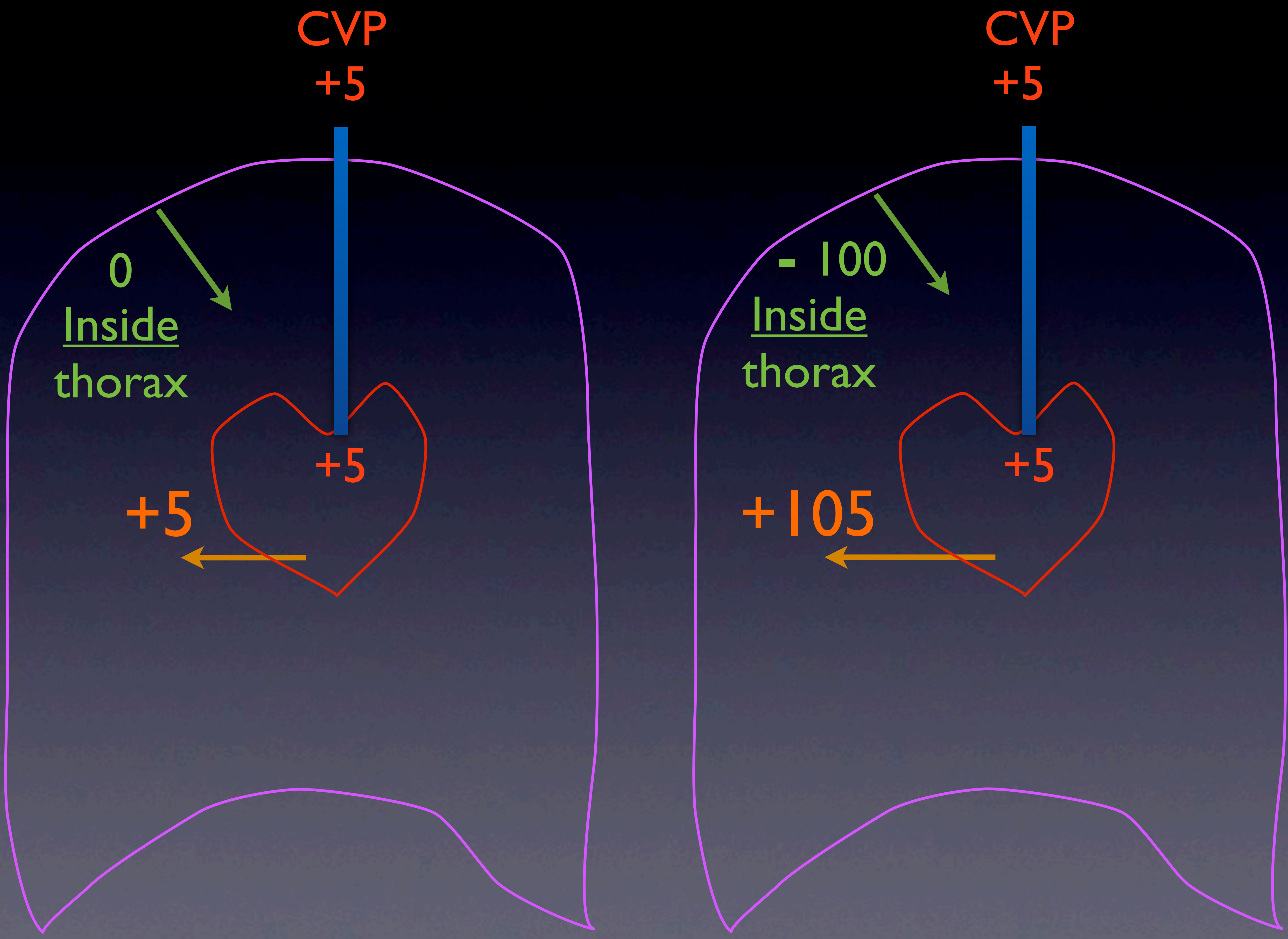


Illustration of transmural pressure

807 m

Illustration of transmural pressure

1424 m

Negative pressure pulmonary oedema

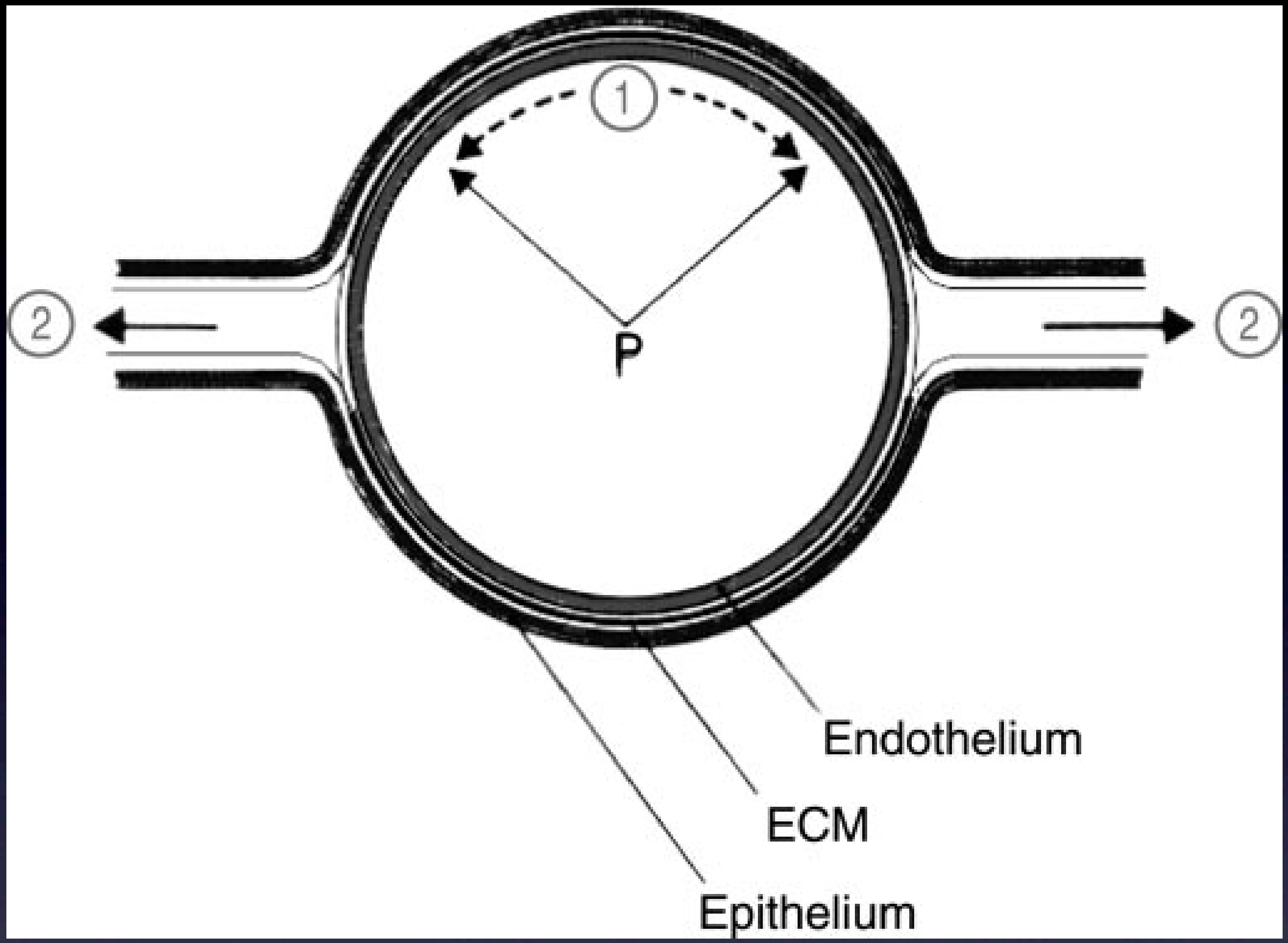
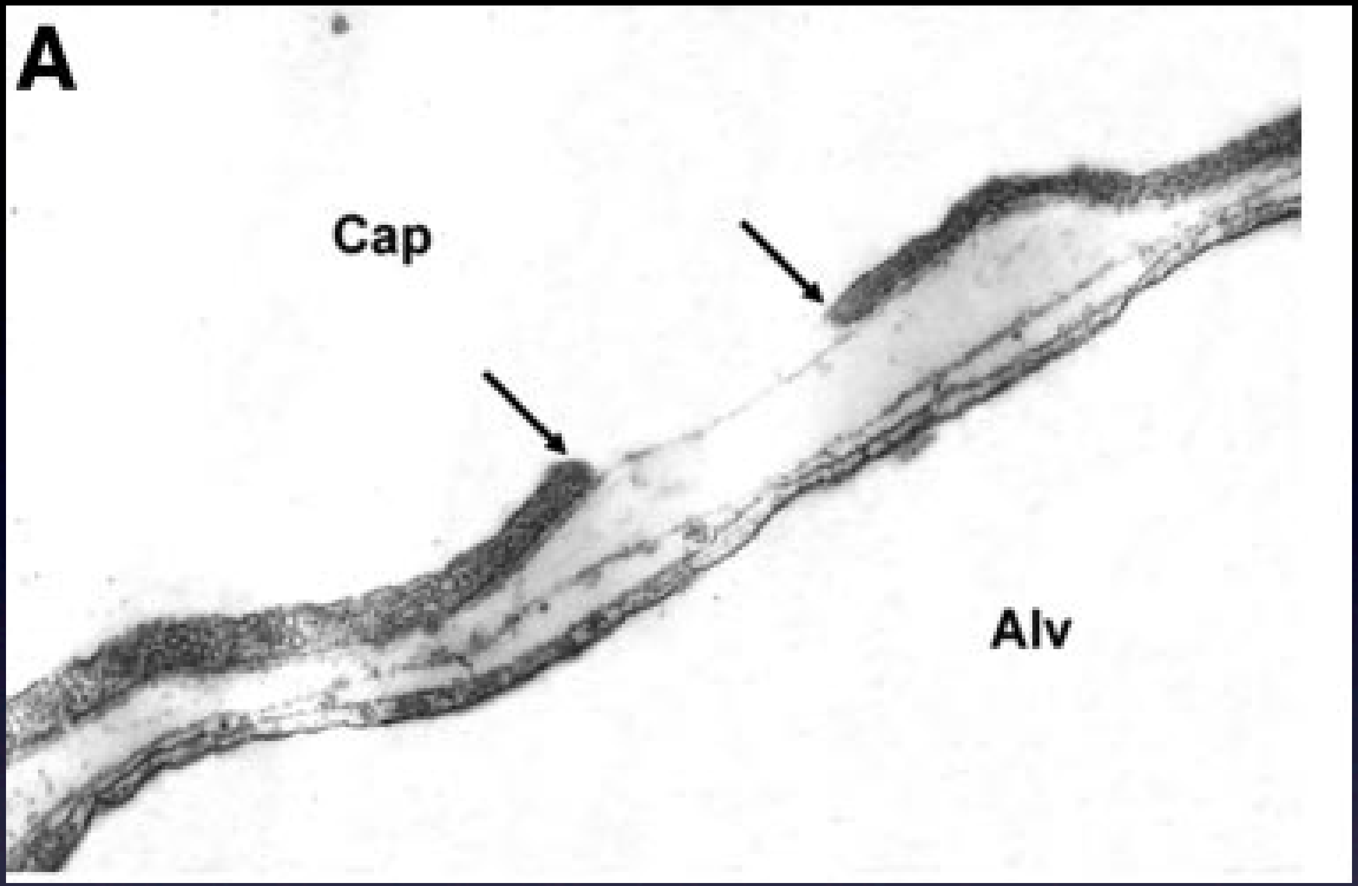


FIG. 18. Diagram showing two mechanisms that can cause an increased stress in the blood-gas barrier. *1*, Hoop or circumferential stress caused by the capillary transmural pressure; *2*, results from linear tension in the alveolar wall which increases as the lung is inflated. P, capillary hydrostatic pressure. [Modified from West et al. (253).]



Physiol Rev • VOL 85 • JULY 2005 • www.prv.org

To recap

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Remember, when things get wild, think :

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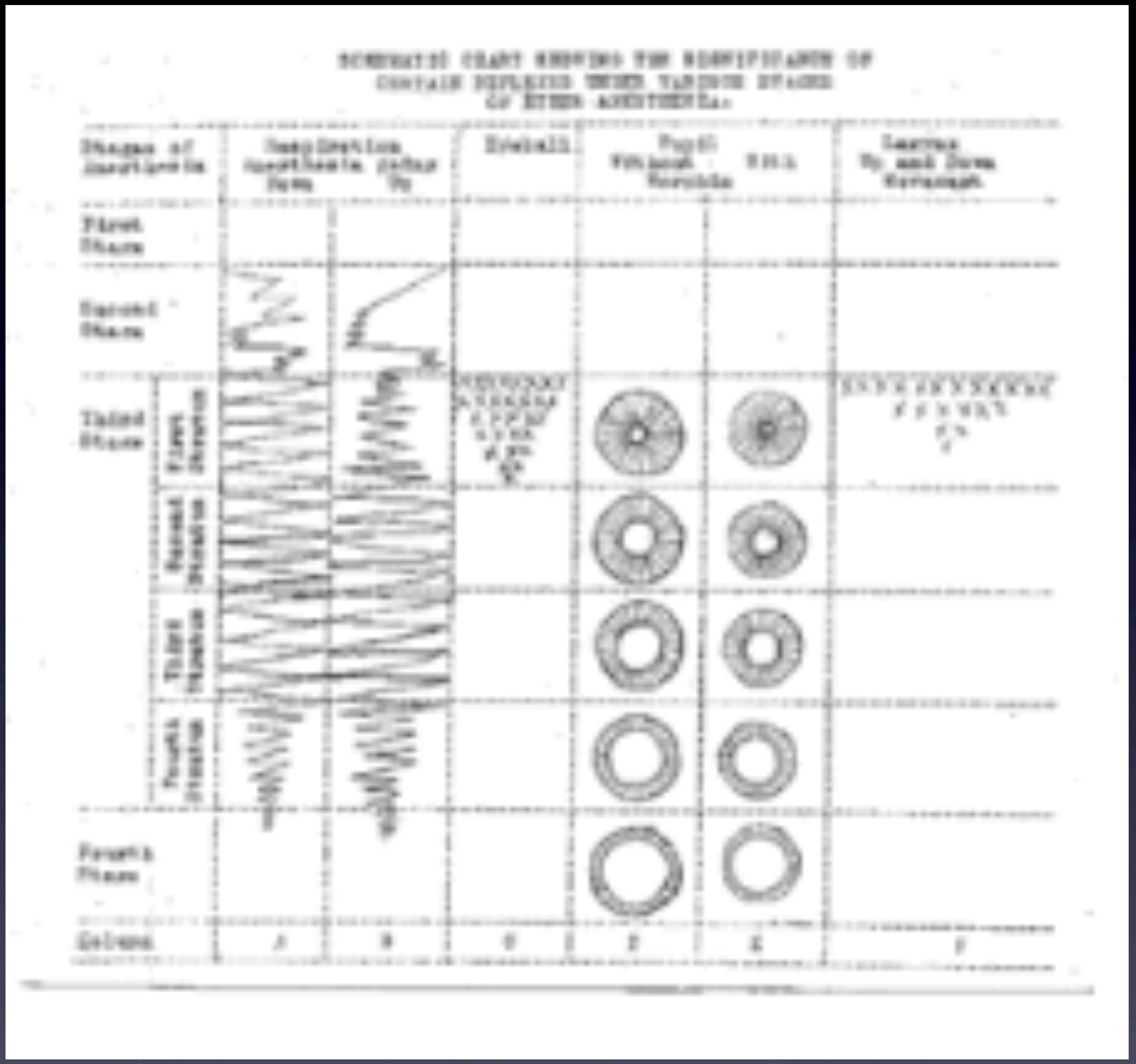
Cardiac output x Hb x % Sat O2

Arthur Guedel



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Does instant access to compiled information undermine clinical cognition?

Prof Jerome Kassirer
Stanford University School of Medicine

The Lancet 2010; 376: 1510-11

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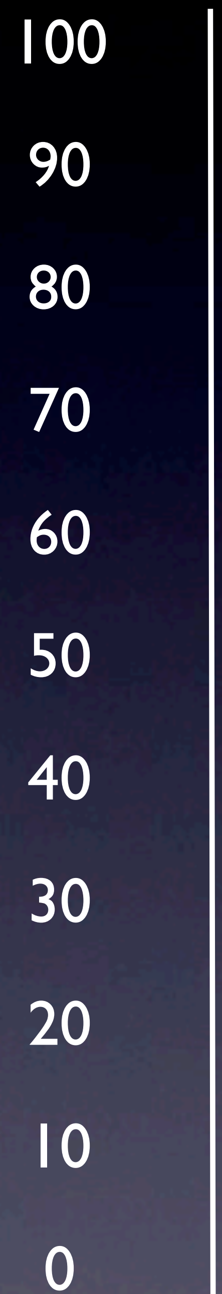
"As teachers, we are not blameless if the next generation is short-changed."

Performance of CRNAs vs Anesthesiologists in a simulation-based skills assessment



Anesthesia Analgesia Vol. 108, No. 1, January 2009

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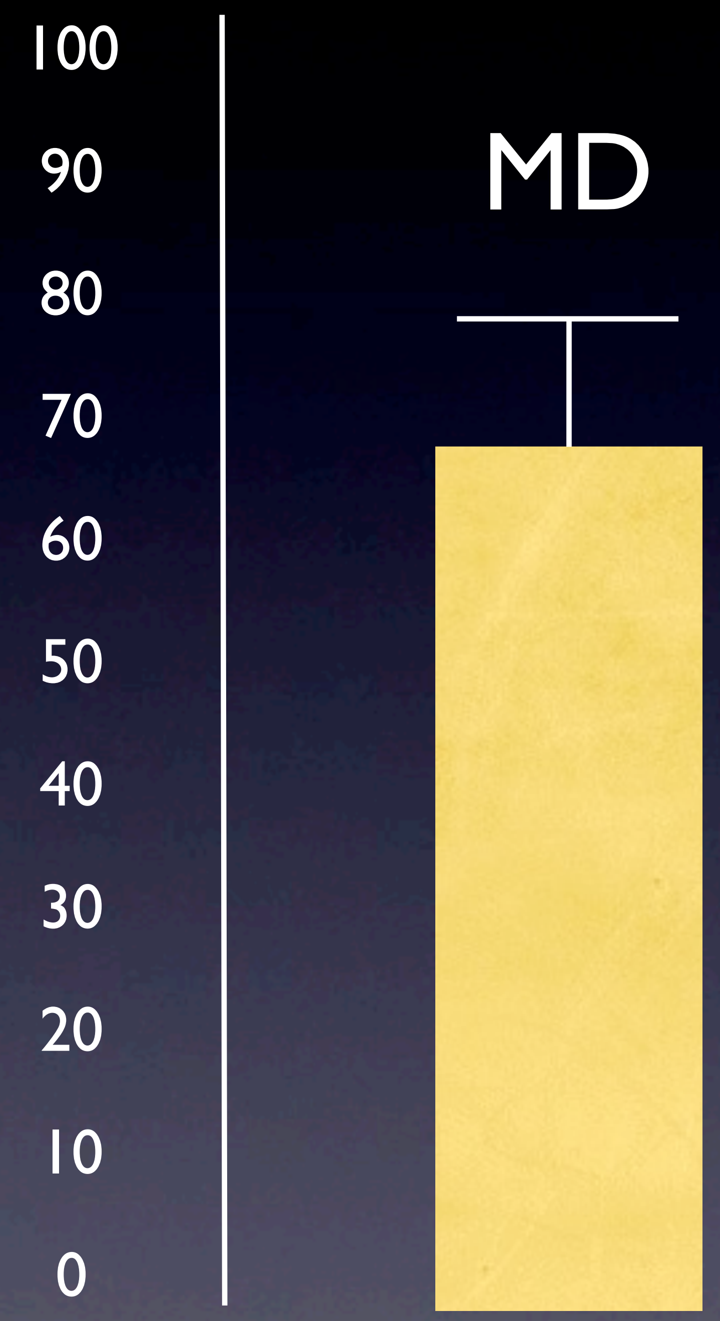

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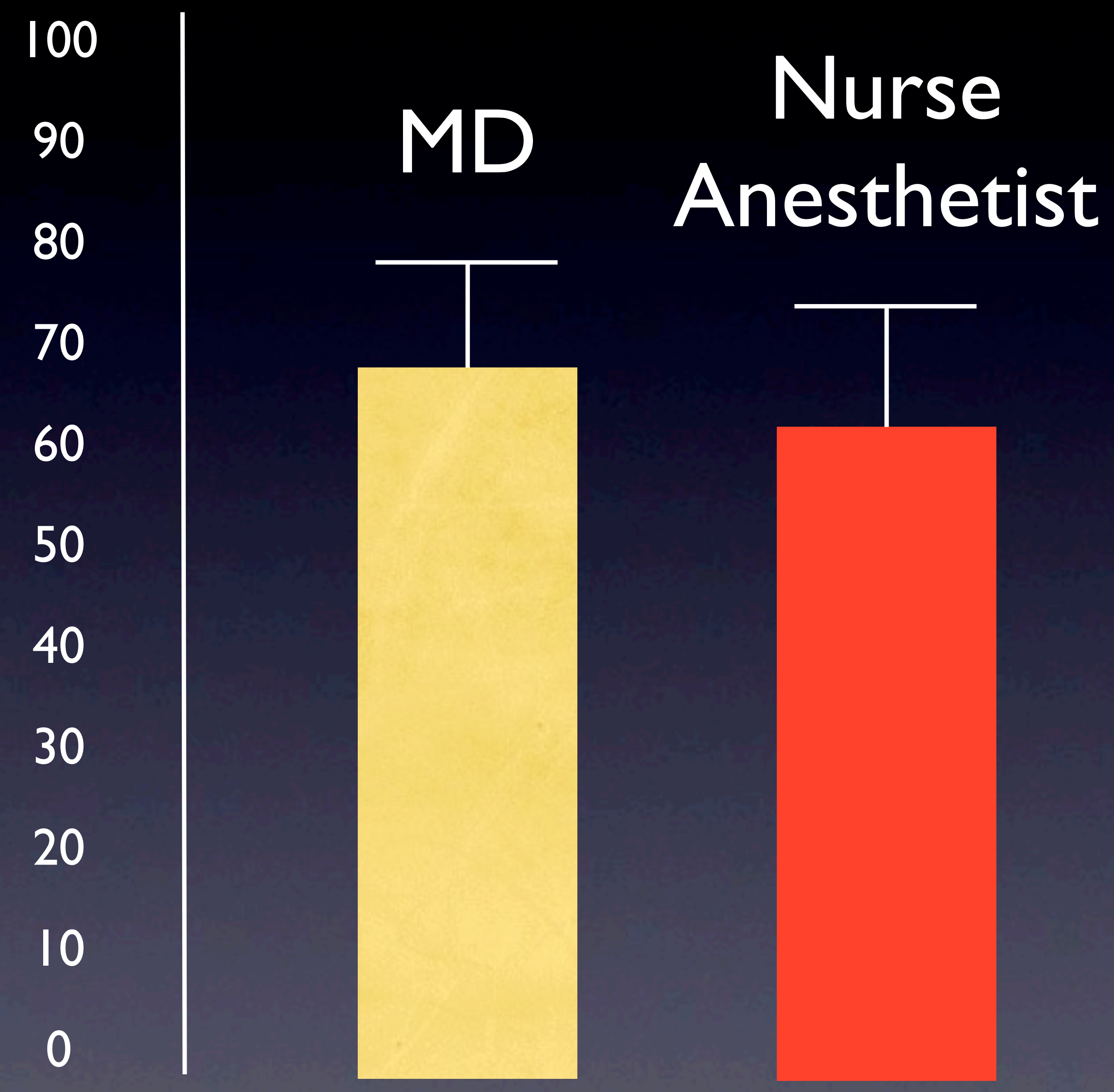

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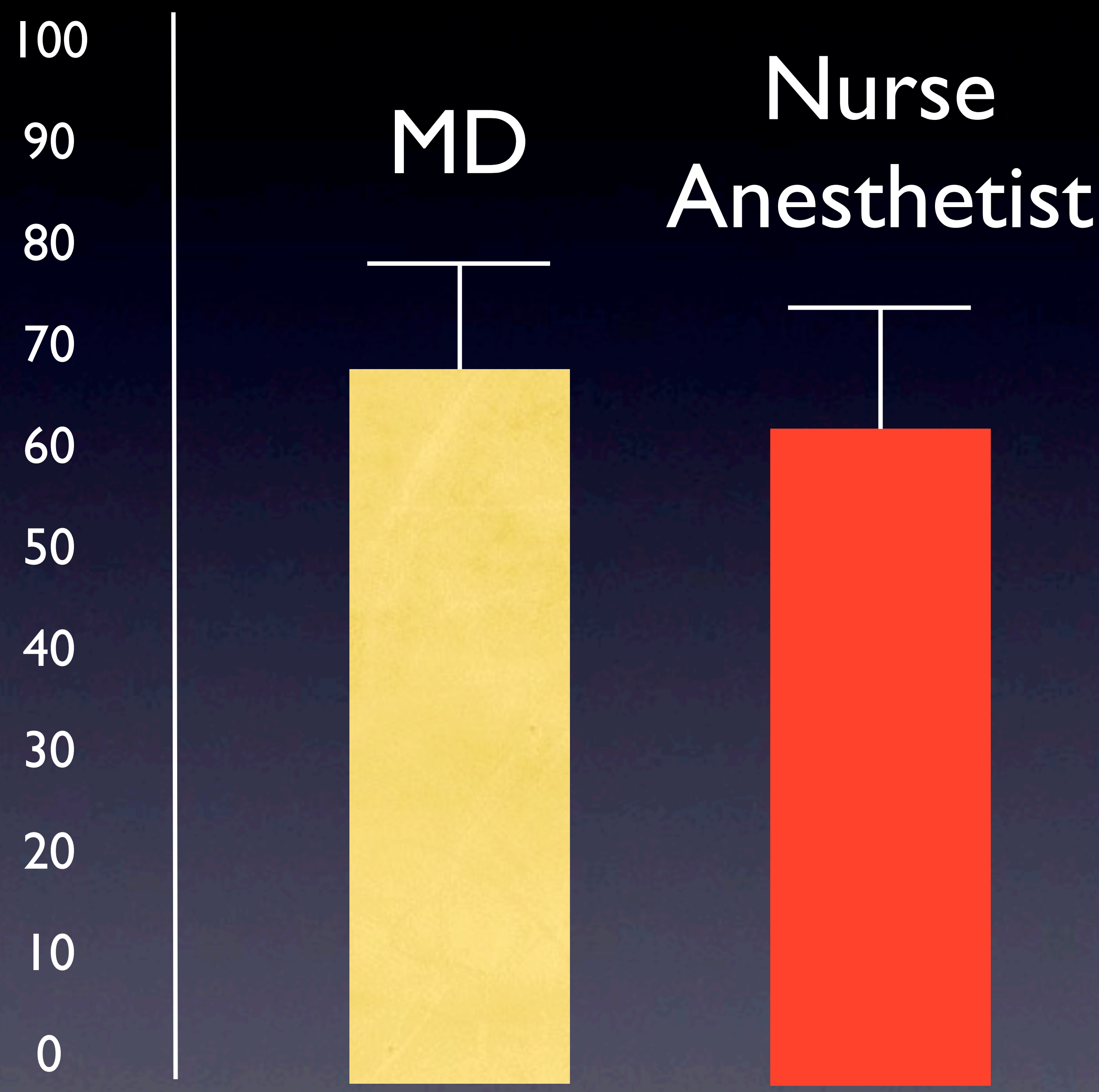

"..the overall difference...was small in magnitude"

Anesthesia Analgesia Vol. 108, No. 1, January 2009

February 14, 2011, 9:30 PM

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The New York Times

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