Principles and Management of Acute Postoperative Hemodynamics

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Primary Function of Circulatory System

To deliver sufficient oxygen to the organs & tissues to meet their metabolic demands

WHY???

OXYGEN = ENERGY = WORK

Shock

Inadequate delivery of oxygen to the organs & tissues to meet their metabolic demands

i.e.

CIRCULATORY FAILURE

Classification of Shock

Hypovolemic

Cardiogenic

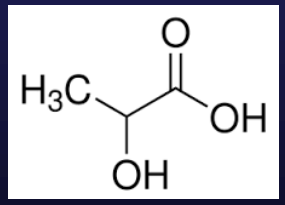
Distributive

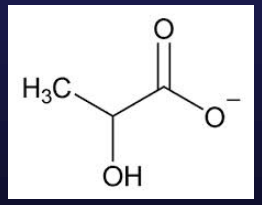
Neurogenic

Anaerobic Metabolism

Glucose/FFA + oxygen → ATP + H_2O + CO_2

Glucose/FFA + ~~oxygen~~ → Lactic Acid + ATP





Lactic Acid + HCO_3^- → Lactate + H_2O + CO_2

Consequences of Prolonged Anaerobic Metabolism

Decreased HCO_3^-

Decreased pH

Increased lactate

Increased base deficit (BX more neg)

Ultimately end organ dysfunction

Base Excess

Amount of acid required to restore 1L of blood to normal pH at a normal pCO2

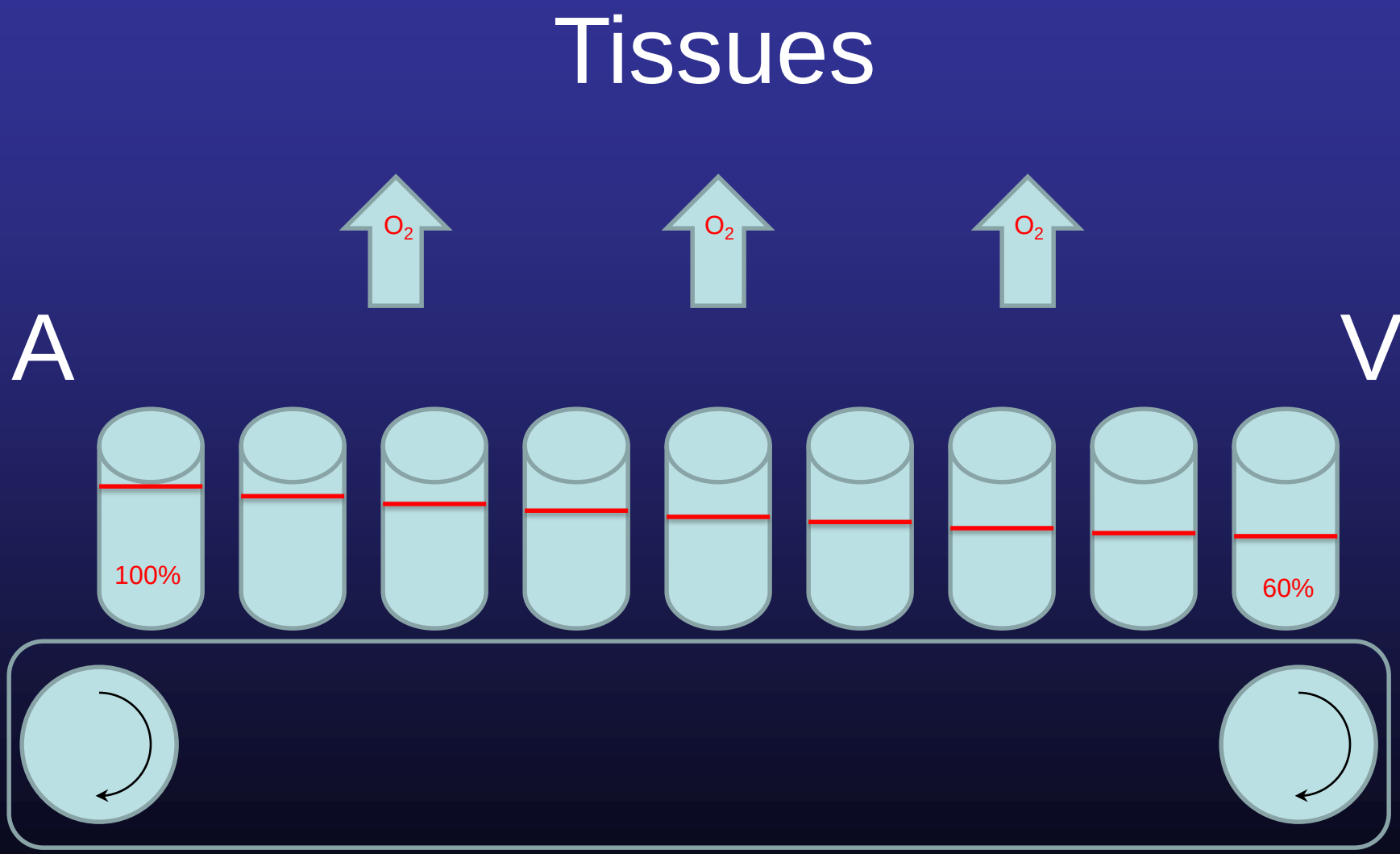
B.E. = 0.93 (HCO_3^- - 24.4 + 14.8(pH - 7.4))

REFLECTS METABOLIC COMPONENT

ie blah, blah, blah

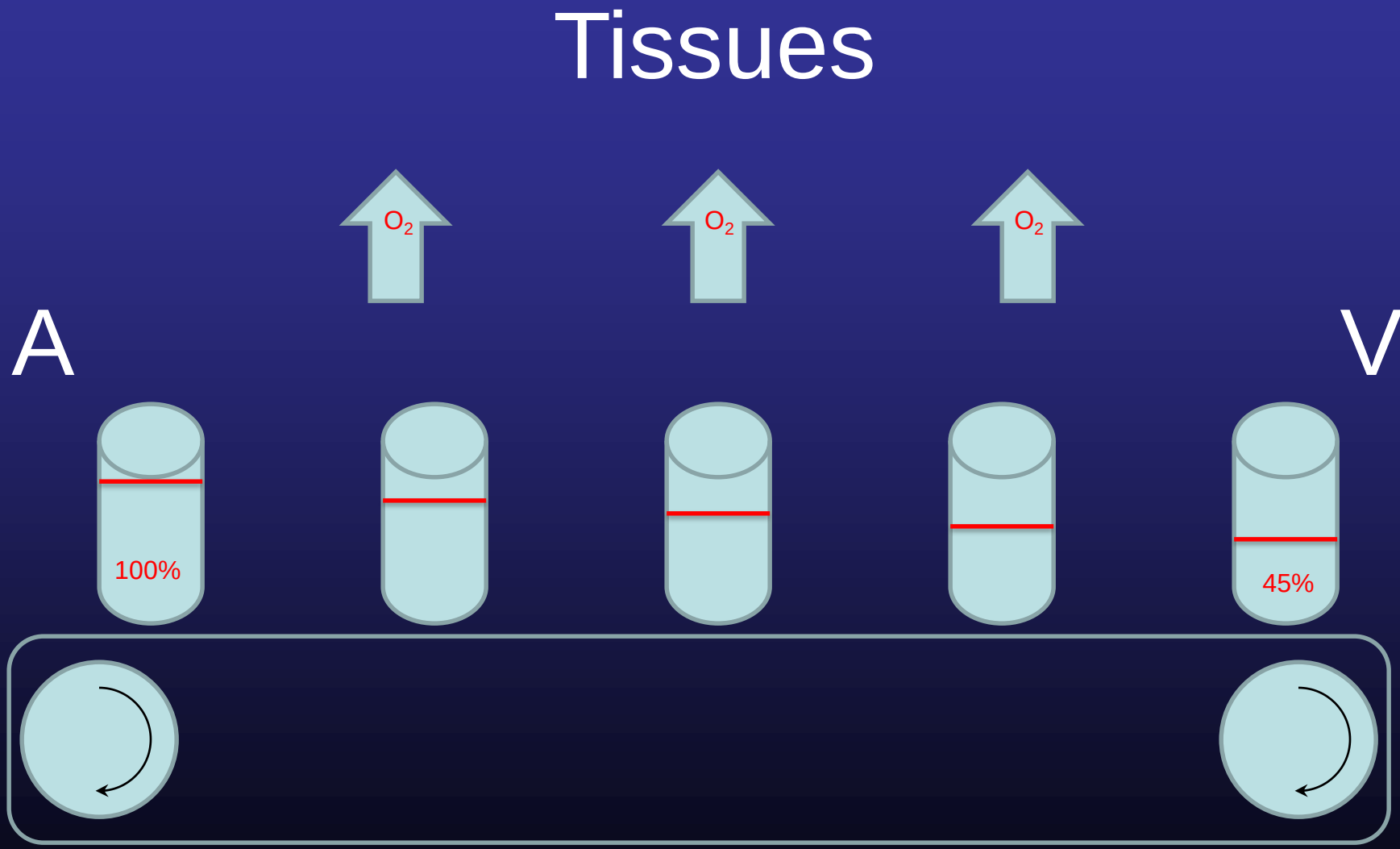
OF ACIDOSIS

Mixed Venous Saturation



Mixed Venous Saturation

Low hematocrit



What can we change to deliver more oxygen to the tissues ?

Oxygen Delivery – DO_2

DO_2 = Oxygen content x CO

(mL O_2 per minute)

OC = Hgb x SaO_2 x 1.36 + dissolved

(mL O2 per 100 mL blood)

CO = HR x SV

(liters per minute)

Stroke Volume

Amount of blood ejected with each beat

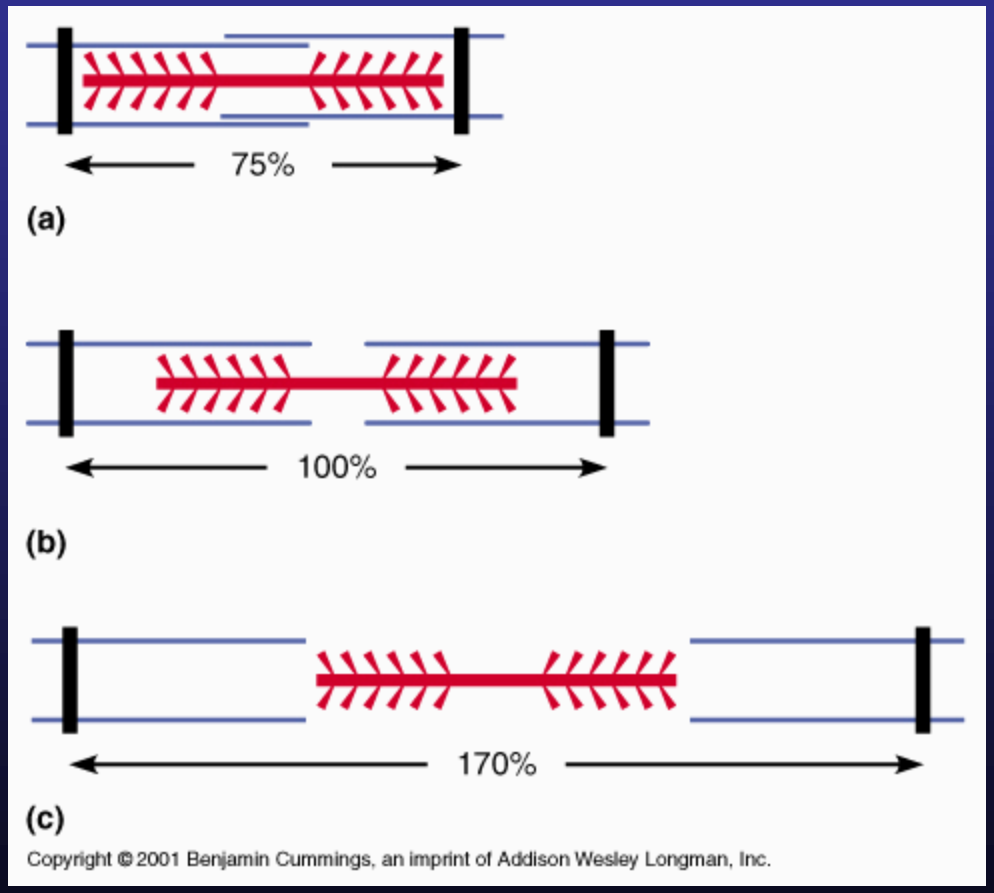
depends on

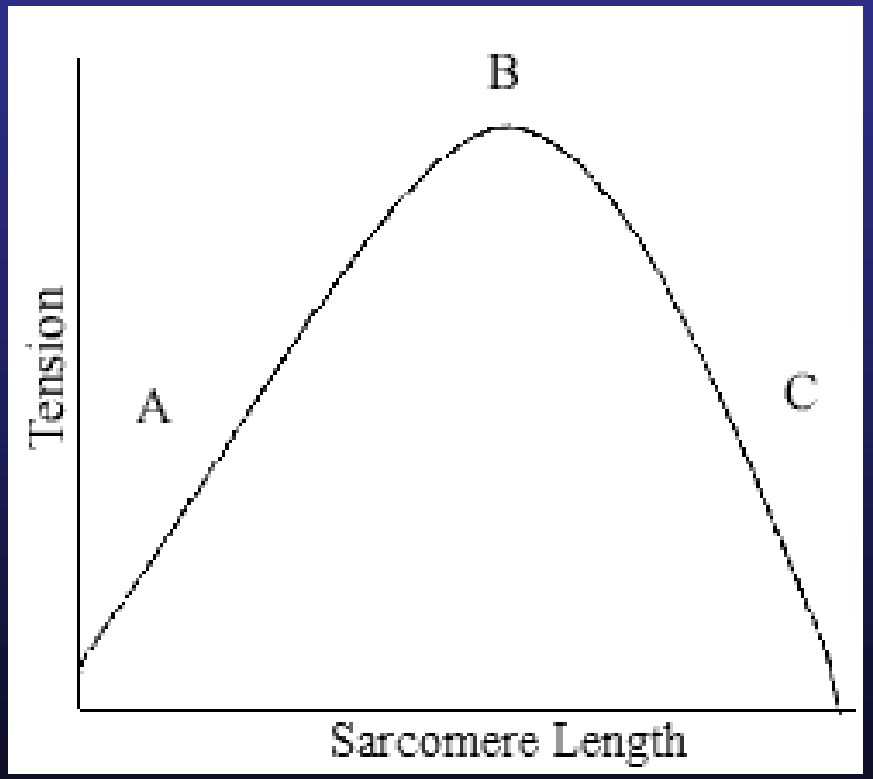
PRELOAD

CONTRACTILITY

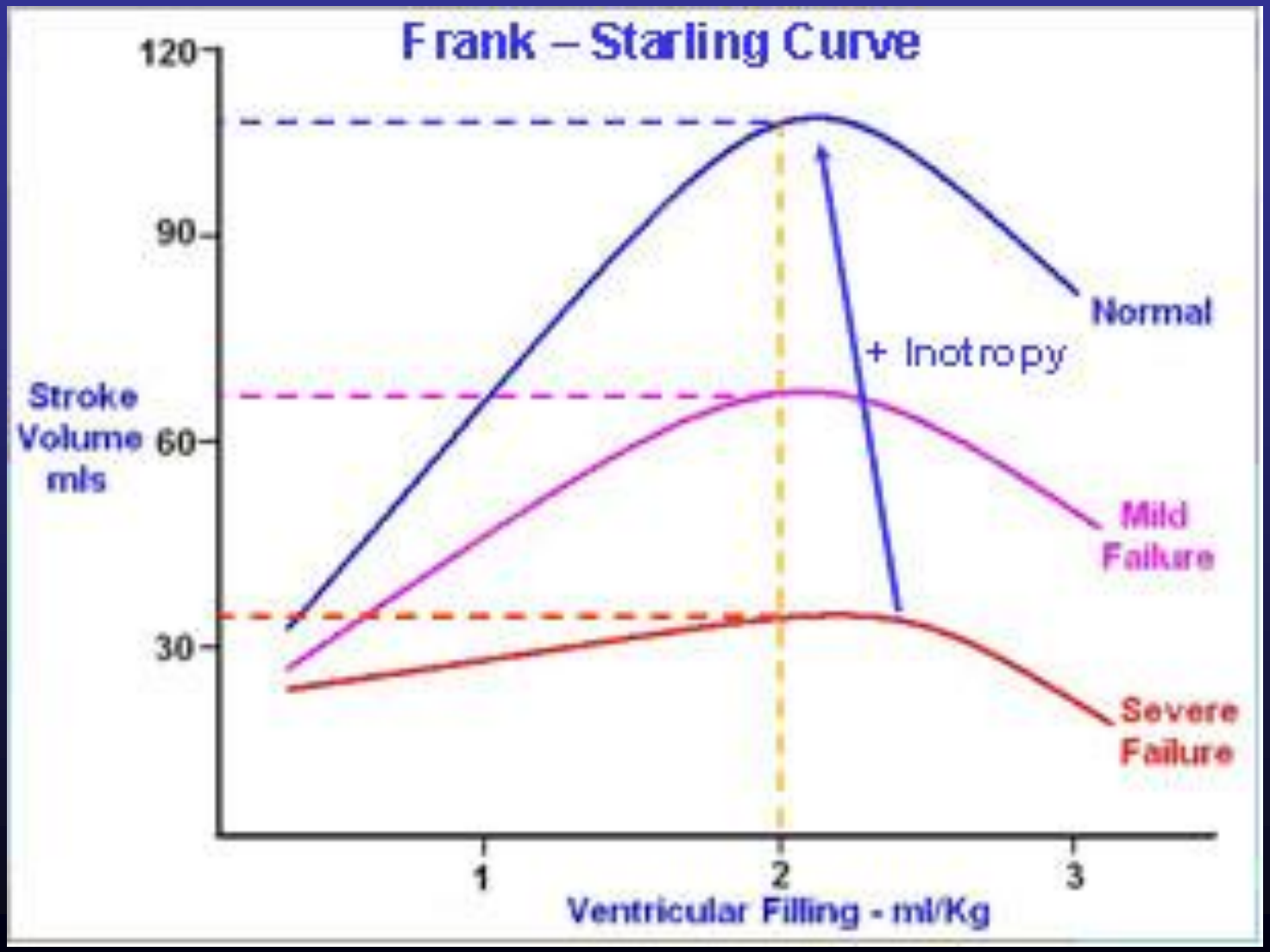
AFTERLOAD

Preload and Length-Tension Relation





Frank-Starling Relation



Oxygen Delivery – DO_2

DO_2 = Hgb x SaO_2 x 1.36 x HR x SV

(mL O_2 per minute)

<u>SV dependent on</u>

PRELOAD

AFTERLOAD

CONTRACTILITY

Hemodynamic Menu

Adjustable parameters

- Hgb
- SaO_2 (FiO_2/pO_2)
- HR / Rhythm
- Preload (CVP)
- Afterload (SVR)
- Contractility

Blood Pressure and SVR

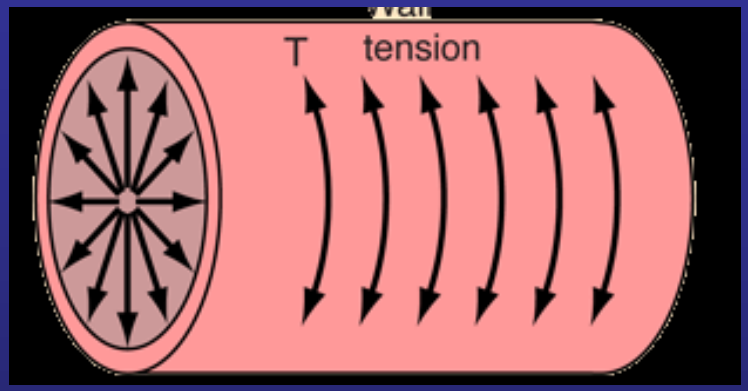
BP (MAP) = CO x SVR = HR x SV x SVR

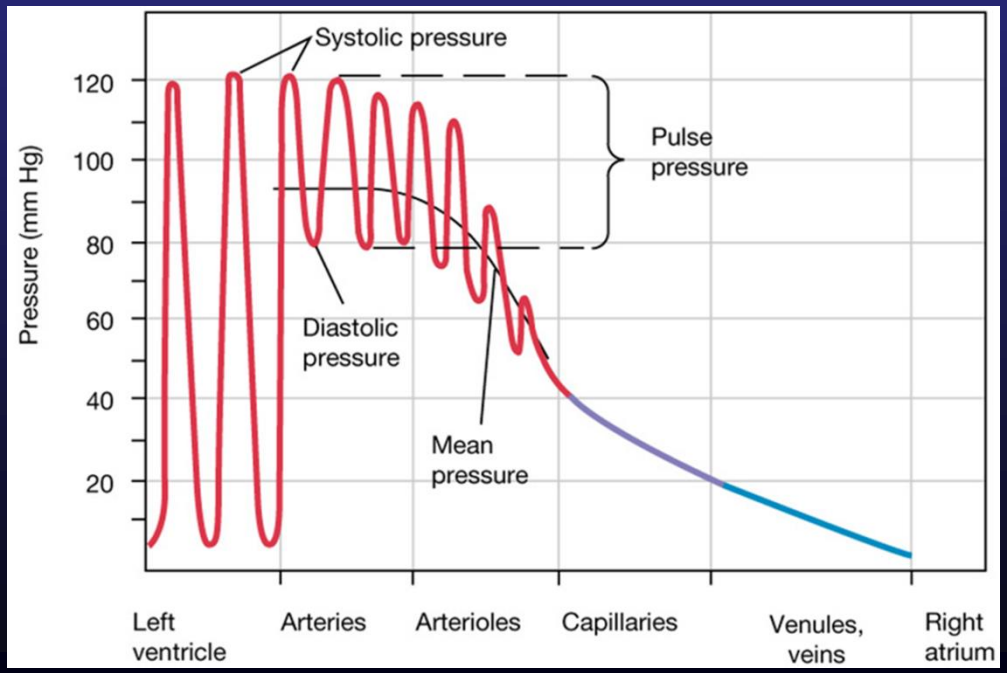
SVR = 80 x (MAP – CVP) / CO

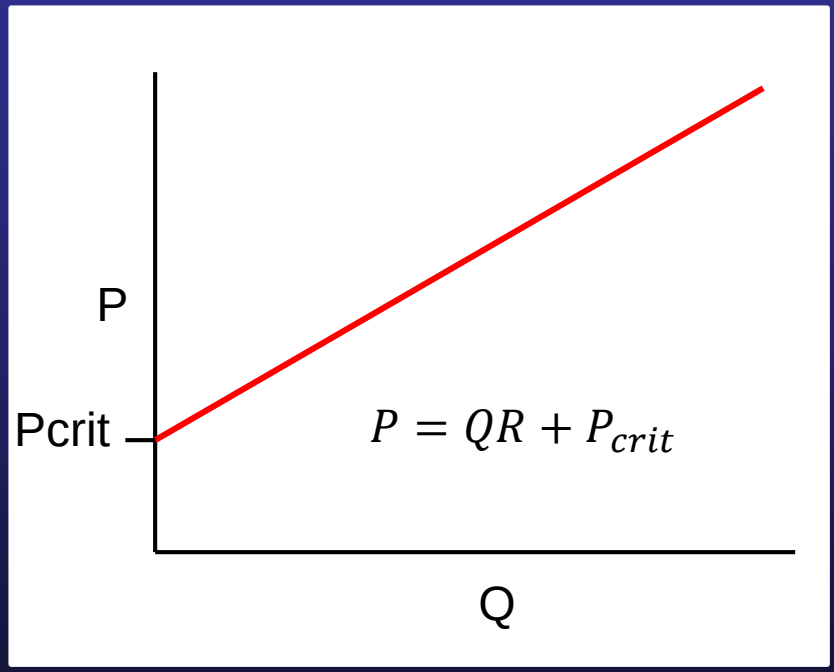
(dyne x sec / cm^5)

To get WOODS Units do not multiply by 80 (0 – 10).

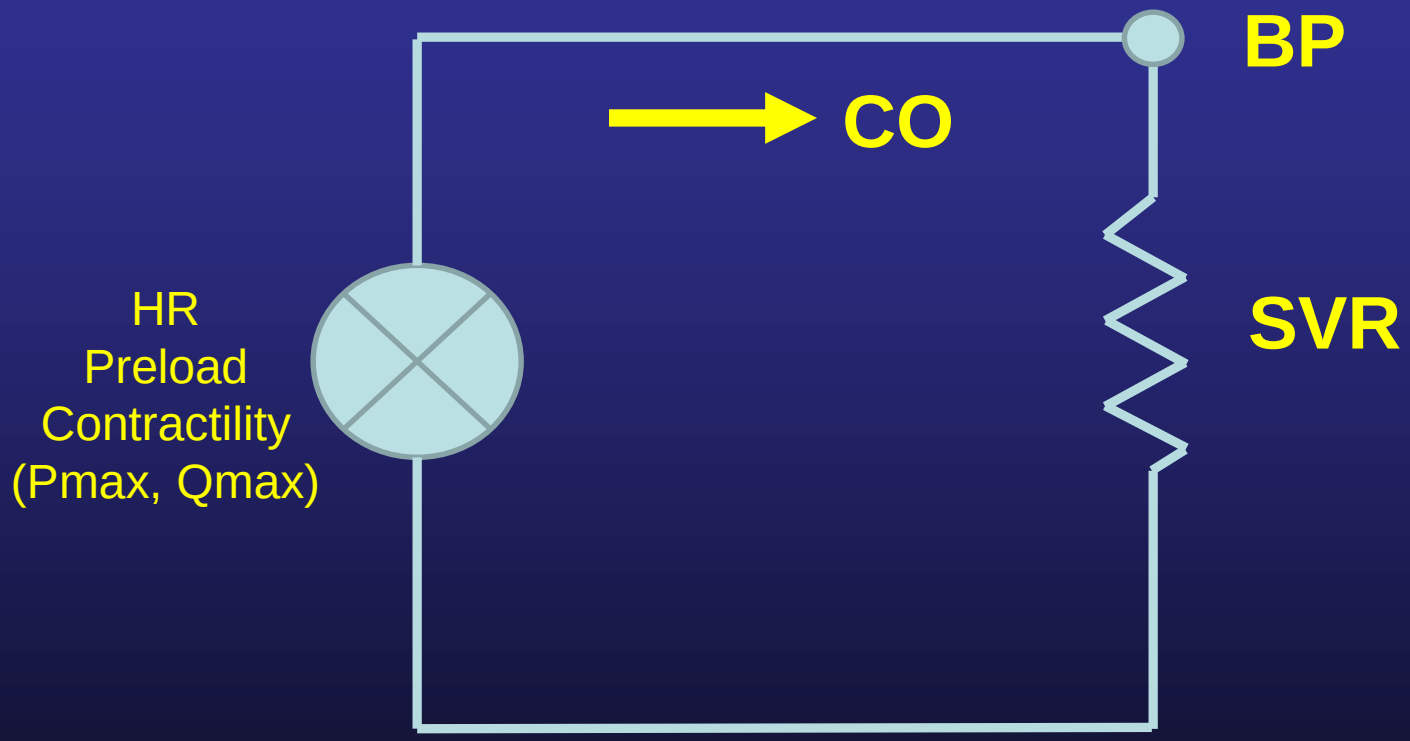
Critical Closing Pressure



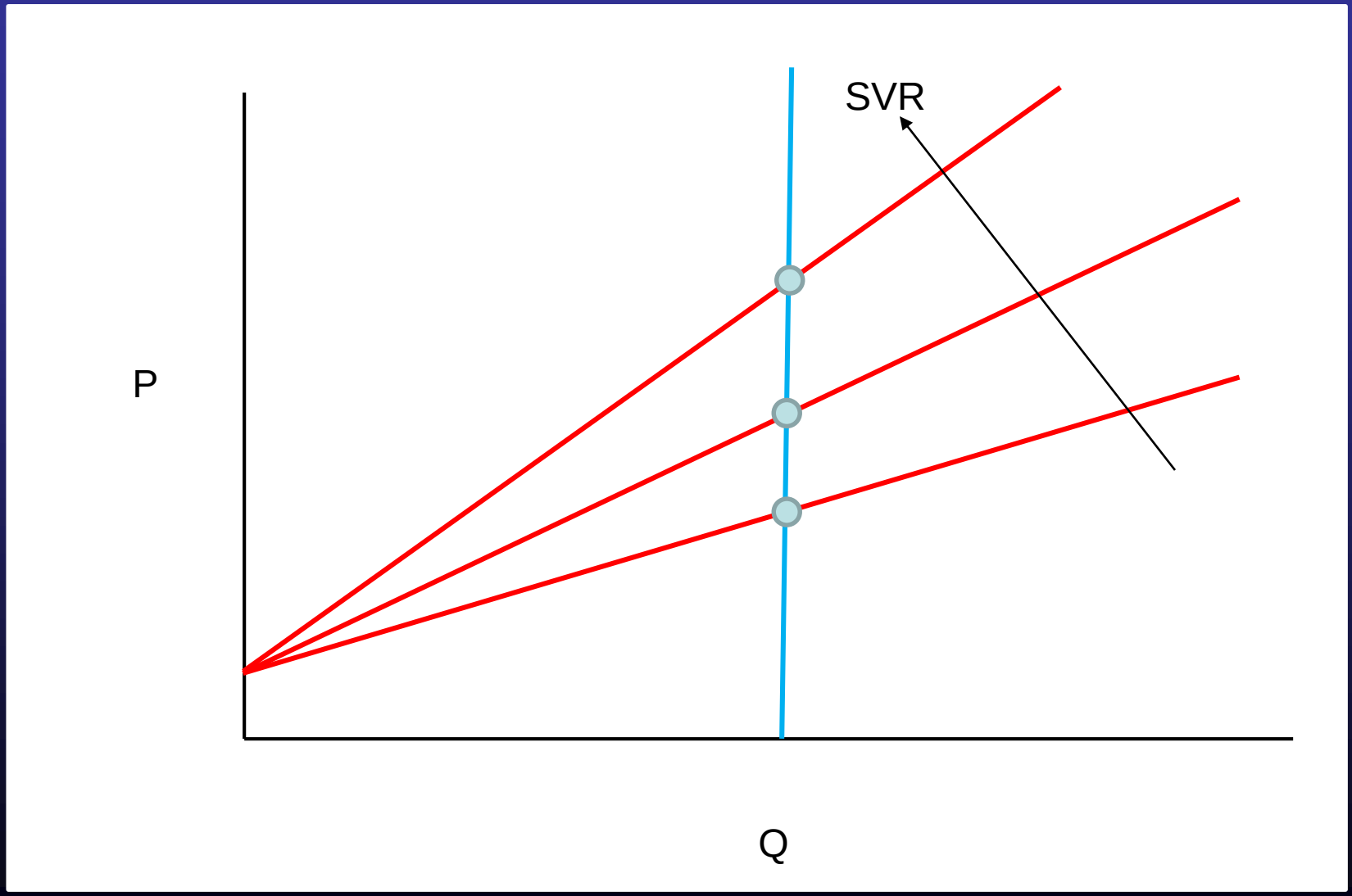




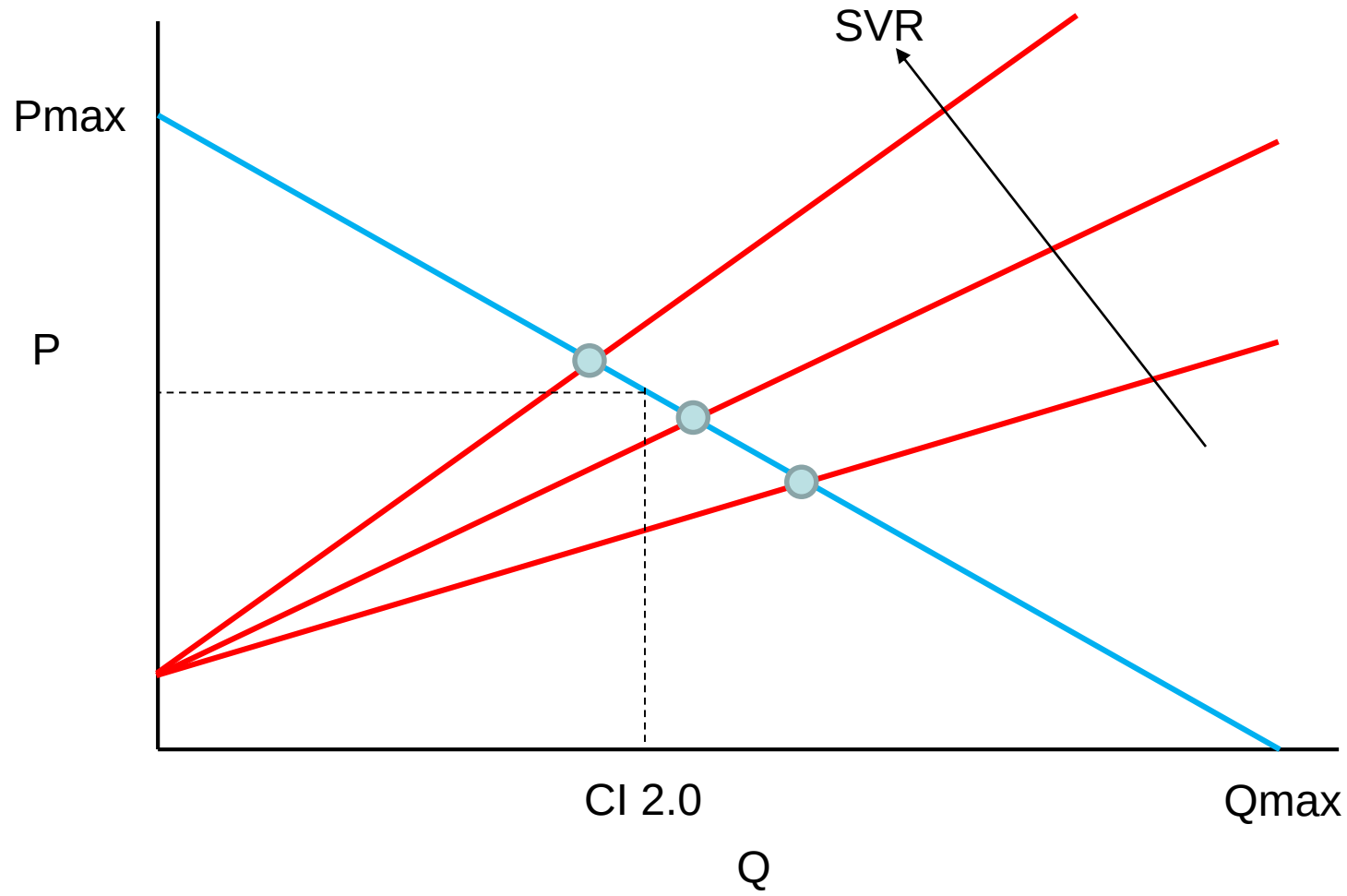
Ideal Flow Pump



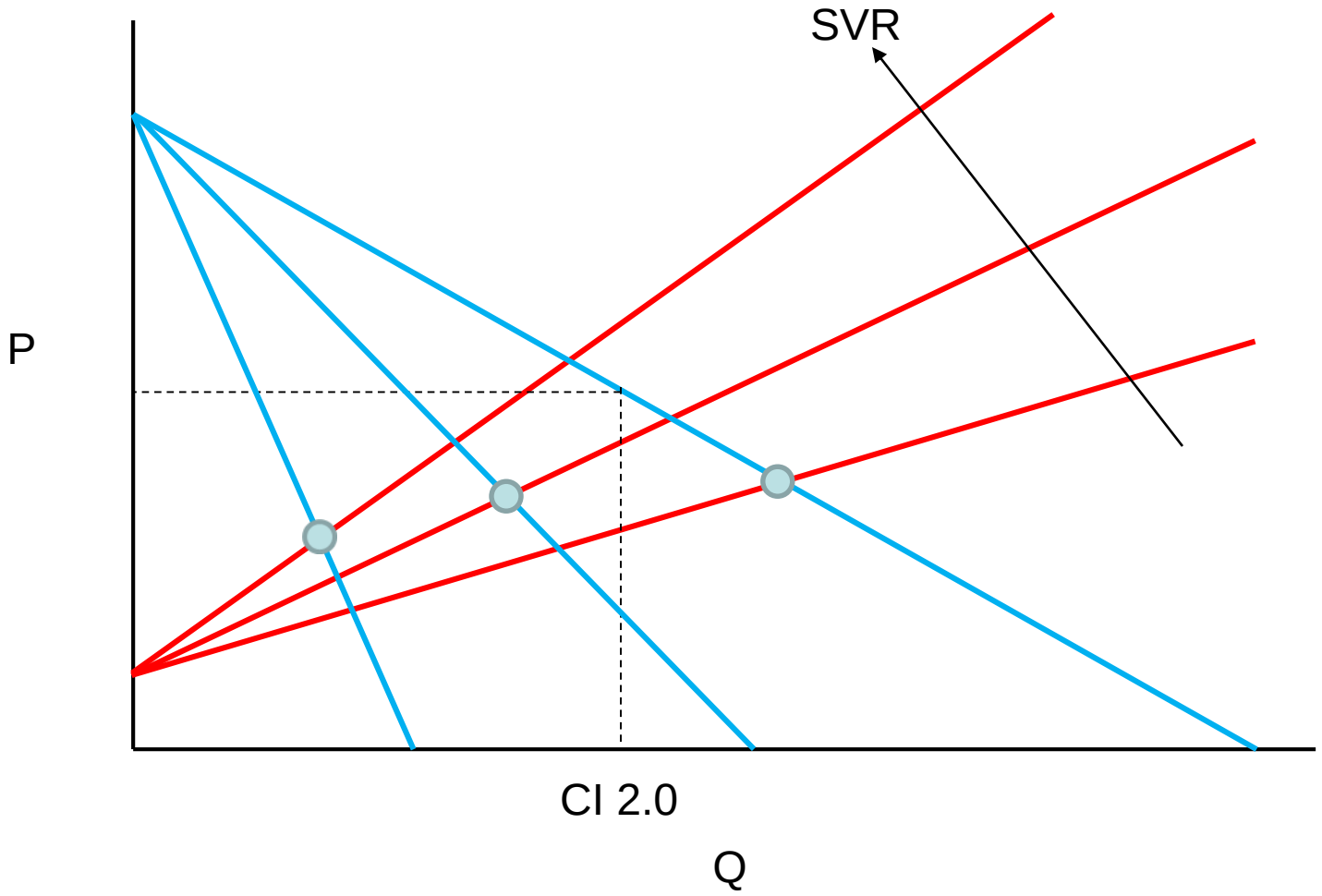
Operating Point
Ideal Pump



Operating Point
Non-ideal Pump



Operating Point
Non-ideal pump



Pharmacology

Drug	HR	Preload	Contractility	Afterload
Levophed	+			+++
Vasopressin				+++
Epinephrine	++		+++	++
Dobutamine	++		+++	-
Dopamine	++		++	++
Milrinone			+++	--
Colloid/Cryst		+++		
INO / Flolan				-- (PVR)

Hemodynamic Menu

Adjustable parameters

- Hgb
- SaO_2
- HR / Rhythm (Pacing, DCCV, Antiarrhythmics)
- Preload – CVP, PAD
- Afterload – SVR (Temp, Sedation, etc)
- Contractility

Assessment parameters

- HCO_3^-
- pH
- Base Excess
- Lactate
- Mixed venous
- CO
- SVR
- BP, HR
- EKG, CT output, u/o
- LFTs, Cr, etc

Postop Heart Surgery

- CVP 8
- HR 80
- BP 120/70
- MAP 85
- SVR 1000
- CO 6.1, CI 2.8
- T 37
- Sat 100%
- Hgb 10
- CT 30 / hr
- u/o 75 / hr
- BX -0.5
- Bicarb 23
- MV 65%
- Lactate 0.3

Relax!!!
Pt is stable!!!

Postop CABG – Normal EF

- CVP 4
- HR 100 ST
- BP 90/60
- MAP 70
- SVR 1200
- CO 4.4, CI 1.8
- T 37C
- Sat 100%
- Hgb 12
- CT 30 / hr
- u/o 150 / hr
- BX -4
- Bicarb 21
- MV 55%
- Lactate 2.5

Hypovolemia

Give fluids

Postop CABG

- CVP 4
- HR 100 ST
- BP 90/60
- MAP 70
- SVR 1200
- CO 4.4, CI 1.8
- T 37
- Sat 100%
- Hgb 7
- CT 300/hr
- u/o 30/hr
- BX -5
- Bicarb 20
- MV 50%
- Lactate 4

Bleeding

Give blood
Correct coagulopathy
Call Attending and the OR

Postop AVR

- CVP 13
- HR 80
- BP 140/90
- MAP 100
- SVR 1700
- CO 3.85, CI 2.0
- T 37
- Sat 100%
- Hgb 10
- CT 30/hr
- u/o 30/hr
- BX -4
- Bicarb 21
- MV 50%
- Lactate 3

High afterload limiting CO

Stop pressors
Give cardene

Postop CABG – Low EF

- CVP 13
- HR 90SR
- BP 80/50
- MAP 60
- SVR 1500
- CO 2.5, CI 1.5
- T 37
- Sat 100%
- Hgb 10
- CT 30 / hr
- u/o 20 / hr
- BX -6
- Bicarb 19
- MV 45
- Lactate 4

Low CO due to low contractility

Start milrinone

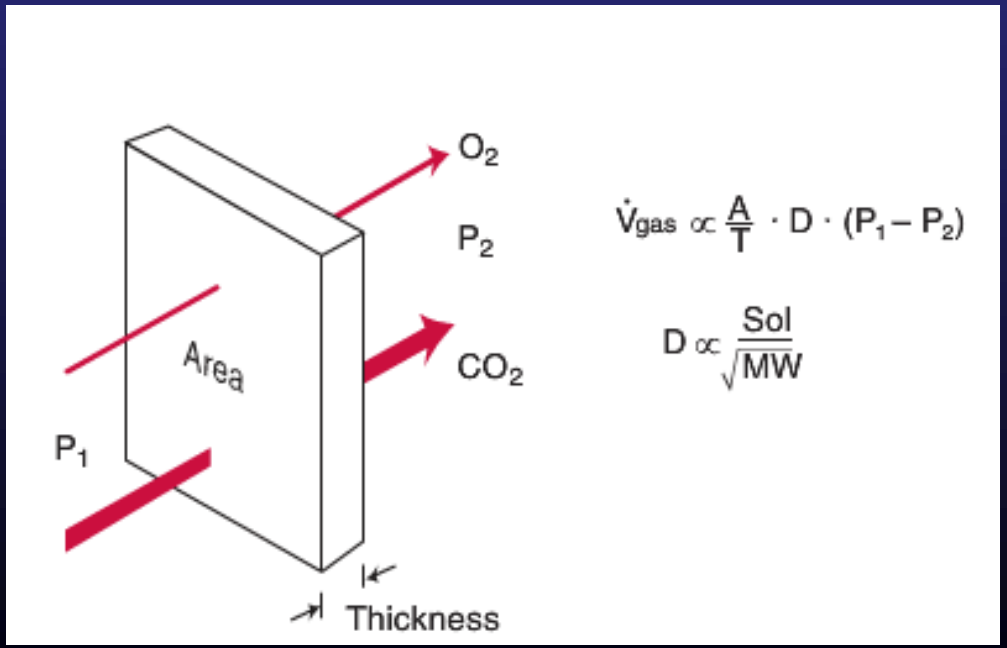
Postop CABG

- CVP 12
- HR 80SR
- BP 110/70
- MAP 80
- SVR 1000
- CO 5.6, CI 2.4
- T 37
- Sat 90%
- Hgb 10
- CT 10/hr
- u/o 100/hr
- BX -1
- Bicarb 23
- MV 50%
- Lactate 1

Hemodynamics OK. Impaired oxygen diffusion

Increase FiO2 / PEEP

Diurese



Postop CABG

- CVP 13
- HR 45SB
- BP 80/50
- MAP 60
- SVR 1000
- CO 2.5, CI 1.5
- T37
- Sat 100%
- Hgb 10
- CT 30/hr
- u/o 20/hr
- BX -5
- Bicarb 19
- MV 45%
- Lactate 4

Low CO due to bradycardia

Increase pacemaker rate

Postop MV repair for MR

- CVP 19
- HR 90SR
- BP 80/50
- PAP 32/15
- MAP 60
- SVR 900
- CO 3.7, CI 1.7
- Hgb 10
- CT 20/hr
- u/o 15/hr
- BX -6
- Bicarb 19
- MV 45%
- Lactate 4

RV failure

Start dobutamine
Diurese

Postop MV repair for MS

- CVP 19
- HR 90SR
- BP 80/50
- PAP 65/35(40)
- MAP 60
- SVR 900
- CO 3.7, CI 2.0
- Hgb 10
- CT 30/hr
- u/o 20/hr
- BX -5
- Bicarb 19
- MV 45%
- Lactate 4

Low CO due to high PVR

Start INO or Flolan

Postop CABG

- CVP 2
- HR 80
- BP 85/60
- MAP 70
- SVR 1100
- CO 5.0, CI 2.7

- Hgb 10
- CT 30 / hr
- u/o 100 / hr
- BX 0
- Bicarb 23
- MV 68%
- Lactate 0.5

Transducers too high

Adjust transducer level

Questions?