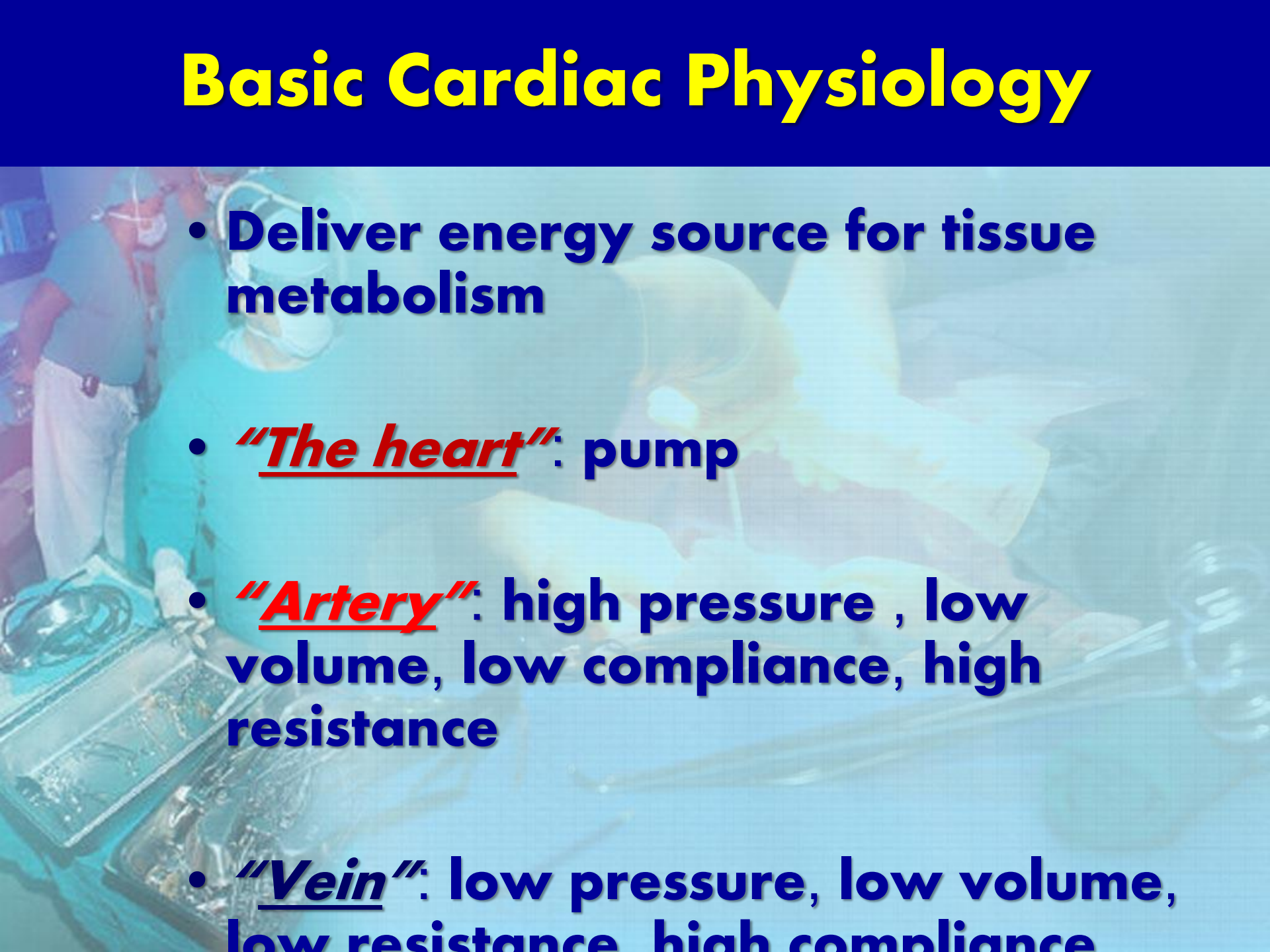




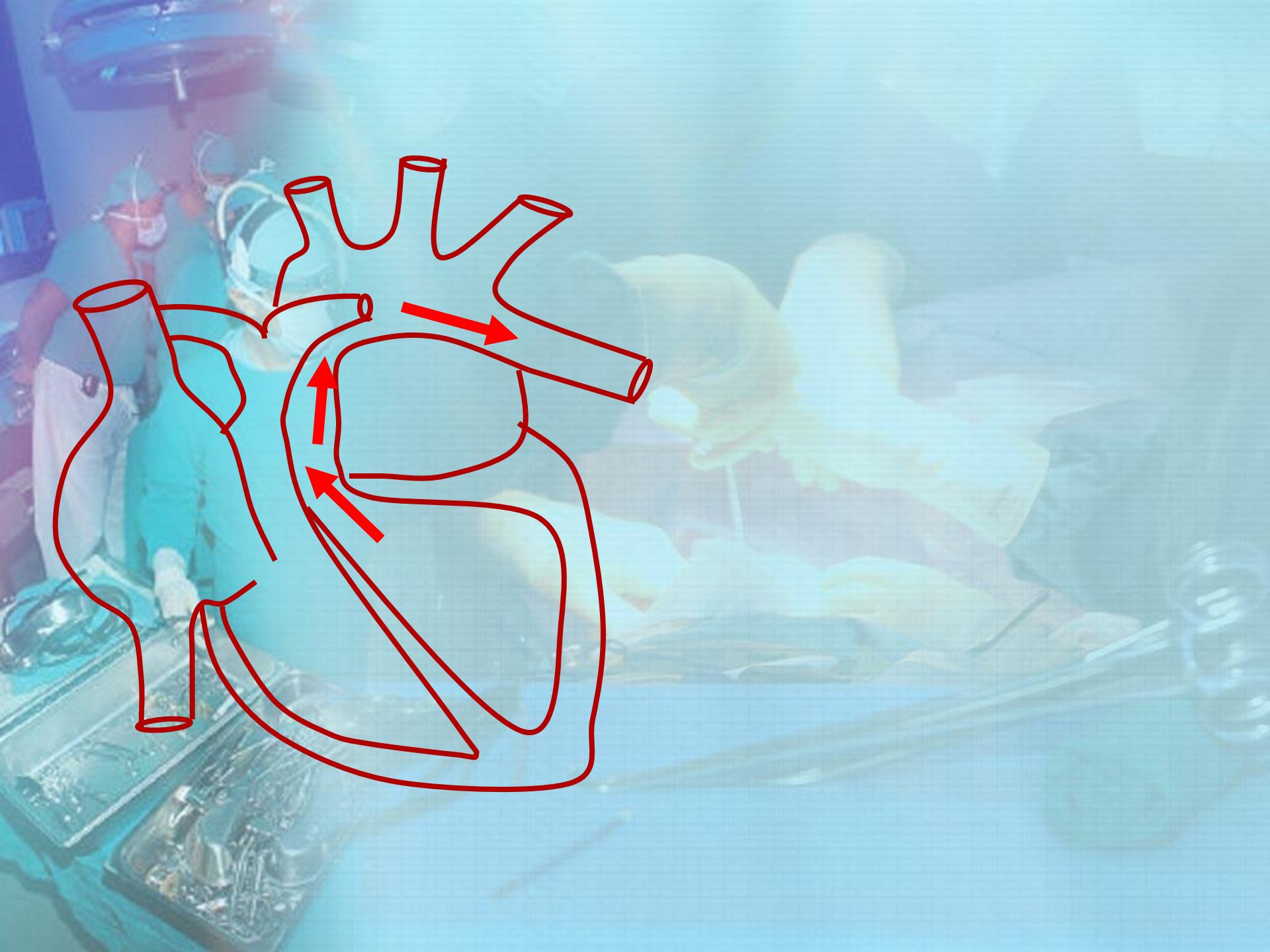
# **Shock and Fluid Management**

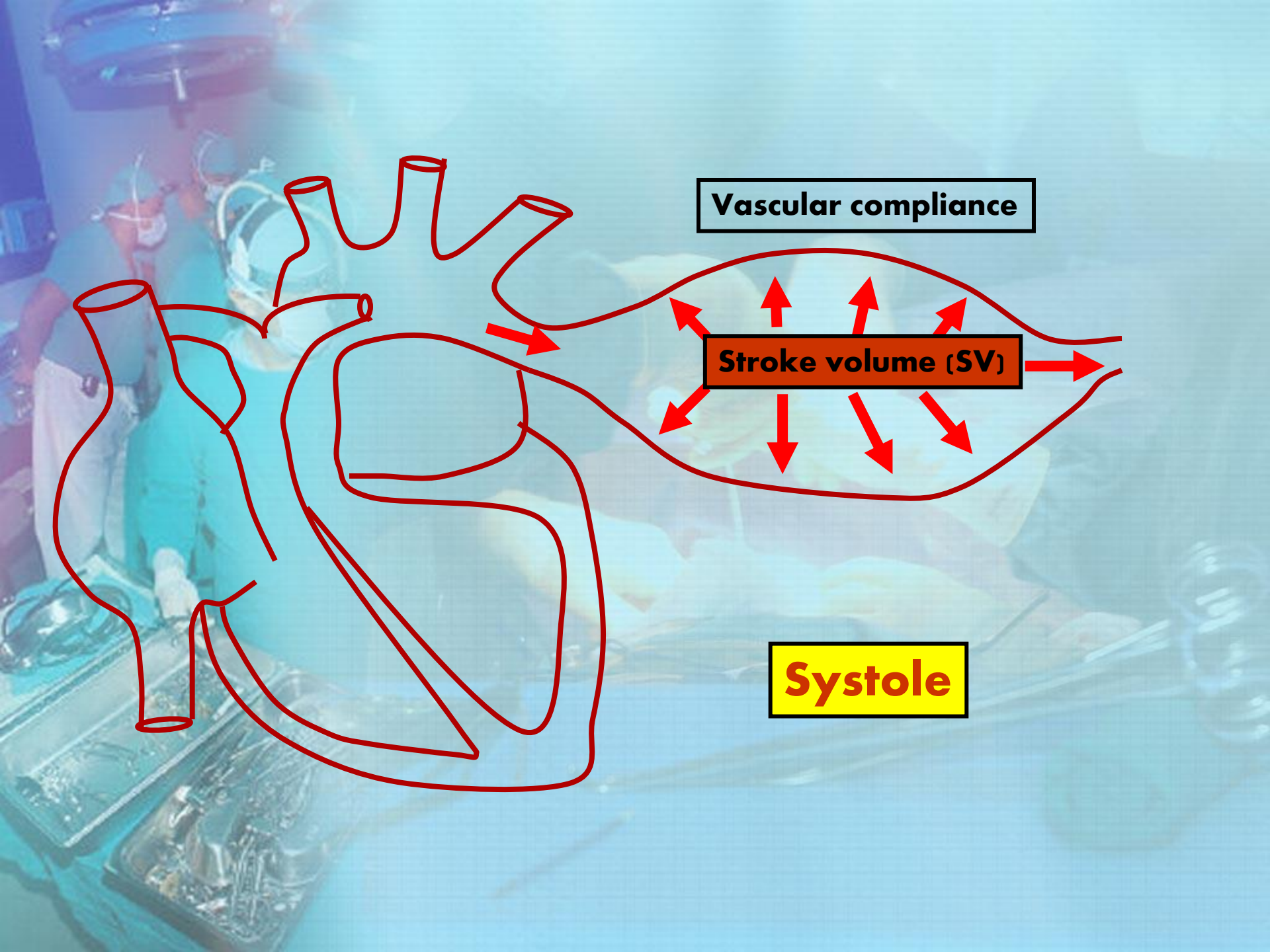
**Dr.Kunakorn Pooresathian**  
**Surgery Department**  
**Lerdsin Hospital**

# Basic Cardiac Physiology

- 
- Deliver energy source for tissue metabolism
  - **"The heart"**: pump
  - **"Artery"**: high pressure , low volume, low compliance, high resistance
  - **"Vein"**: low pressure, low volume, low resistance, high compliance



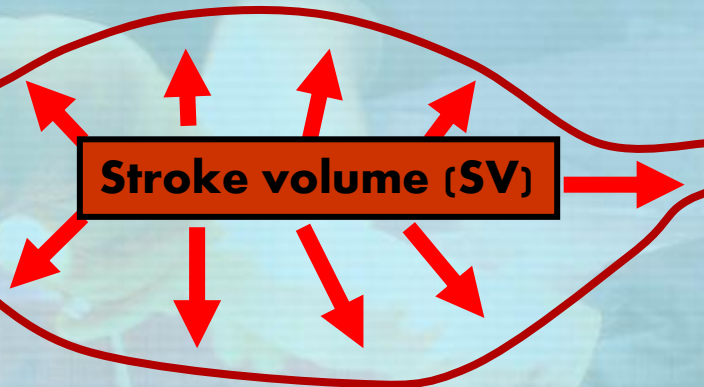




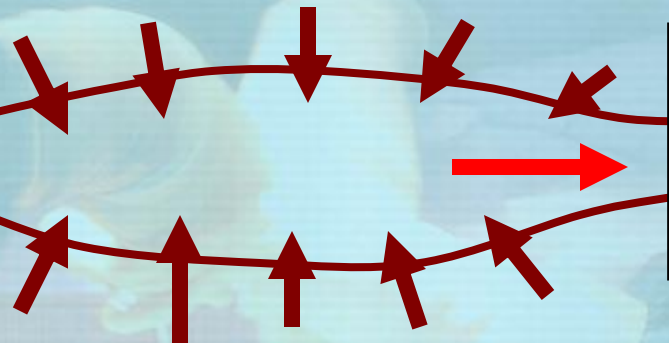
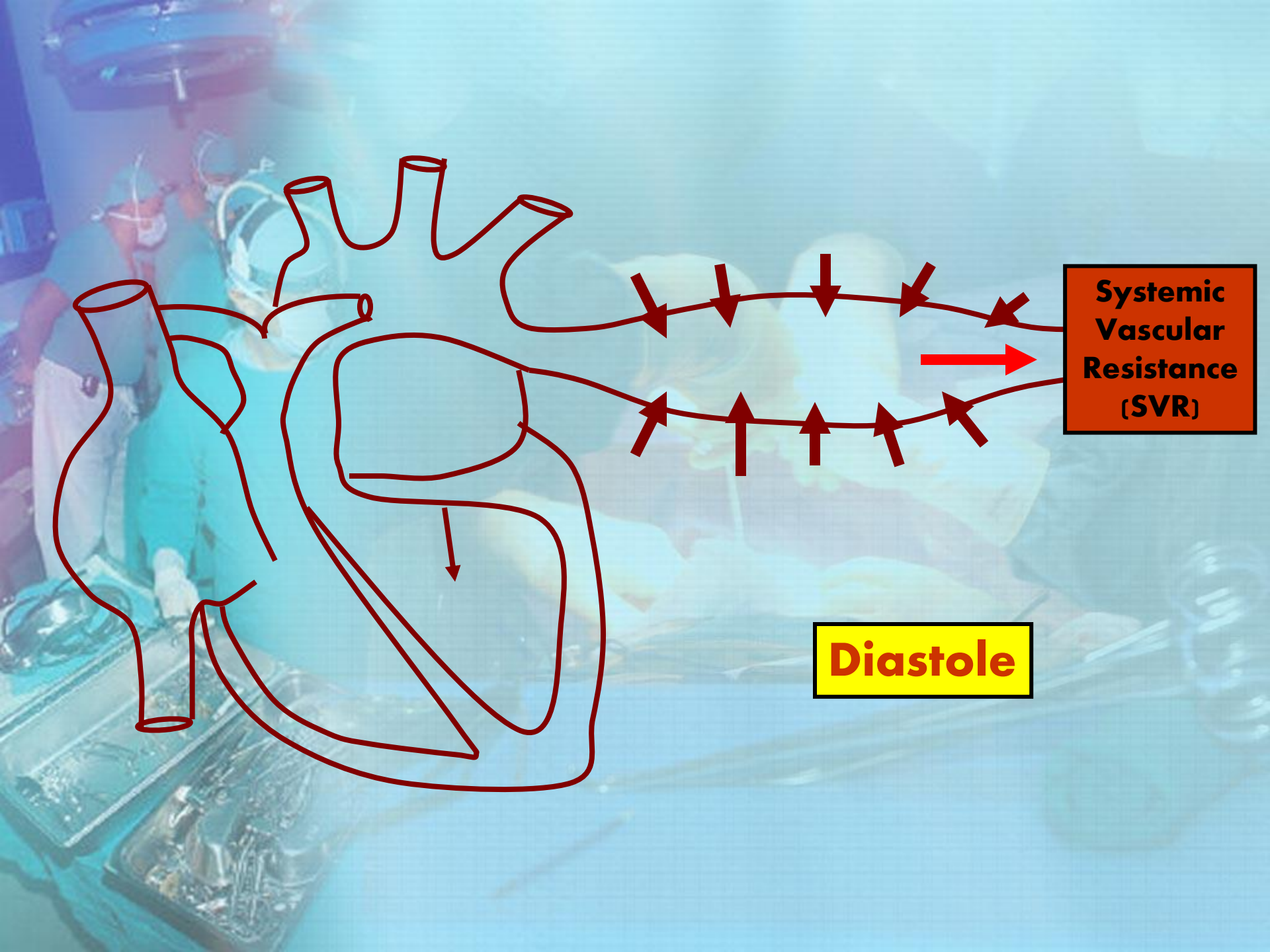
**Vascular compliance**

**Stroke volume (SV)**

**Systole**



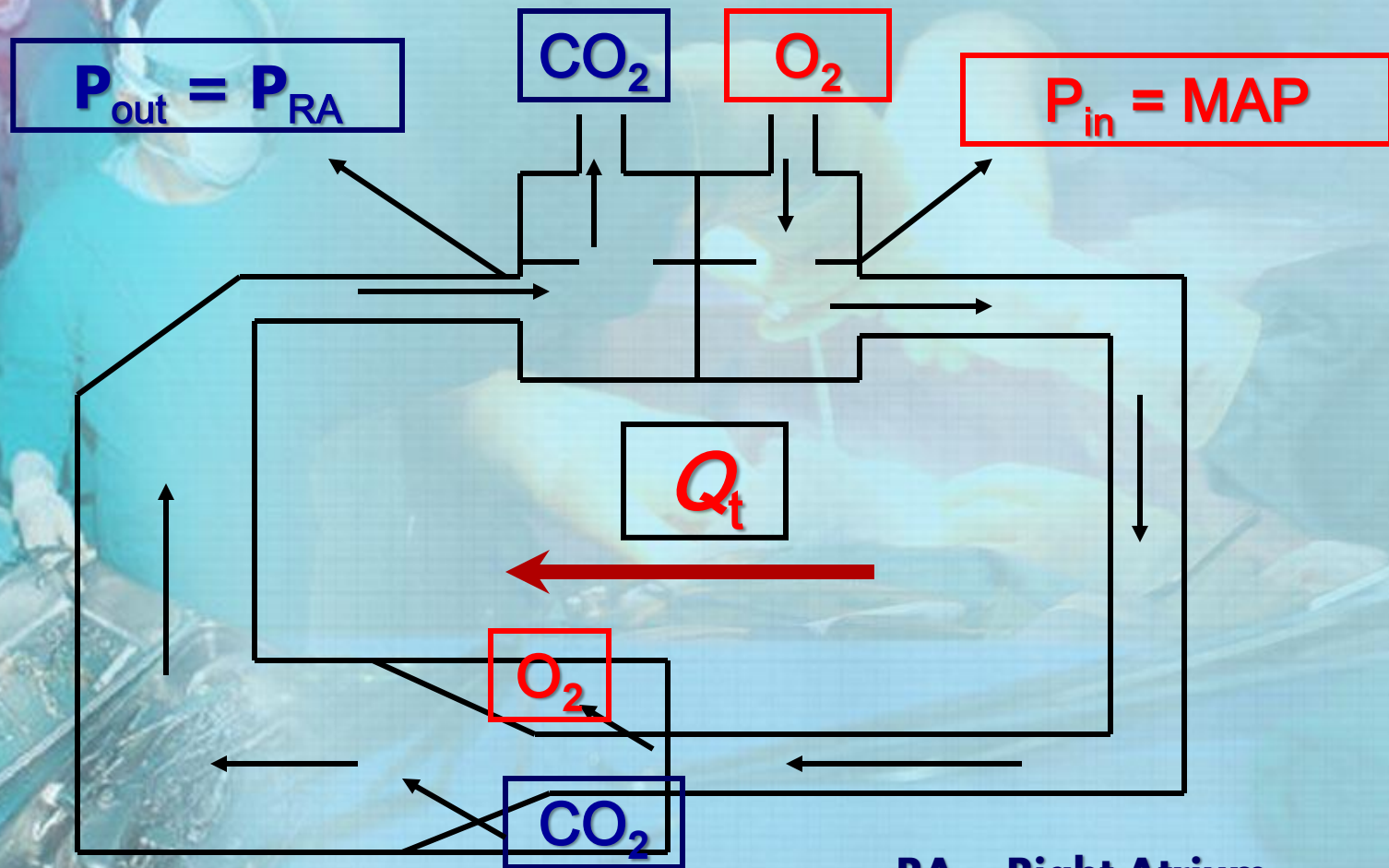




**Systemic  
Vascular  
Resistance  
(SVR)**

**Diastole**

# Basic Cardiac Physiology



RA = Right Atrium  
MAP = Mean Arterial Pressure



# Determinants of Blood Pressure

- Flow ( $Q_t$ ) =  $(P_{in} - P_{out}) / R$

$$= (MAP - P_{RA}) / SVR$$

- MAP =  $Q_t \times SVR$  ( $V = I \times R$ )

$$= SV \times HR \times SVR$$

$$= (EDV - ESV) \times HR \times SVR$$

$$= EDV \times \frac{(EDV - ESV)}{EDV} \times HR \times SVR$$

Preload

EDV

Rhythm

Contractility

Afterload

R = Resistance  
MAP = Mean Arterial Pressure  
 $P_{RA}$  = Right Atrium Pressure  
SVR = Systemic Vascular Resistance  
SV = Stroke Volume  
HR = Heart Rate  
EDV = End Diastolic Volume  
ESV = End Systolic Volume

# Definition

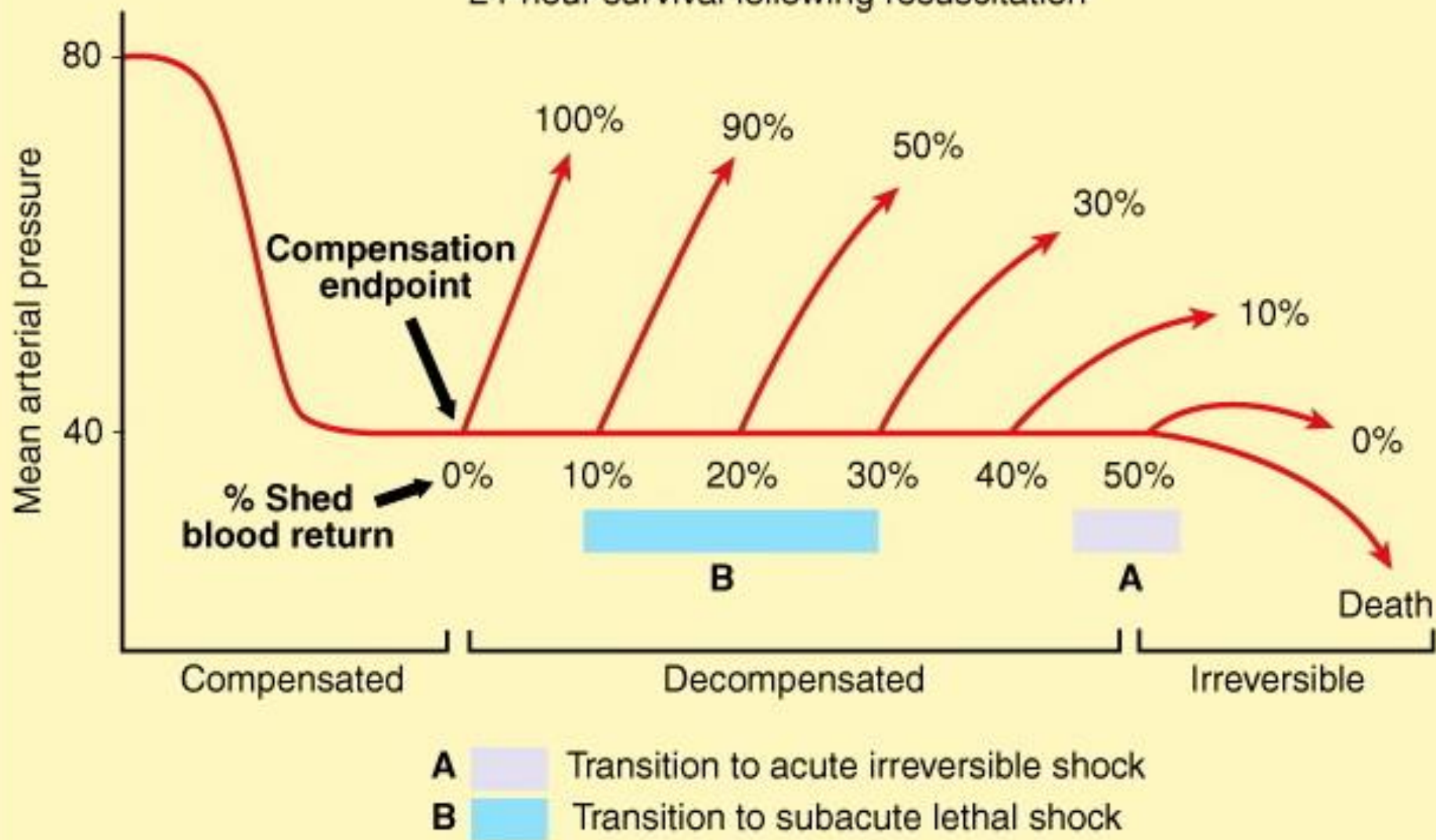
- ***"Inadequate Organs Perfusion"***
- ***"Inadequate Tissue Perfusion"***
- **Maintain Normal Tissue and Cellular Function**





VIEWIMAGES™

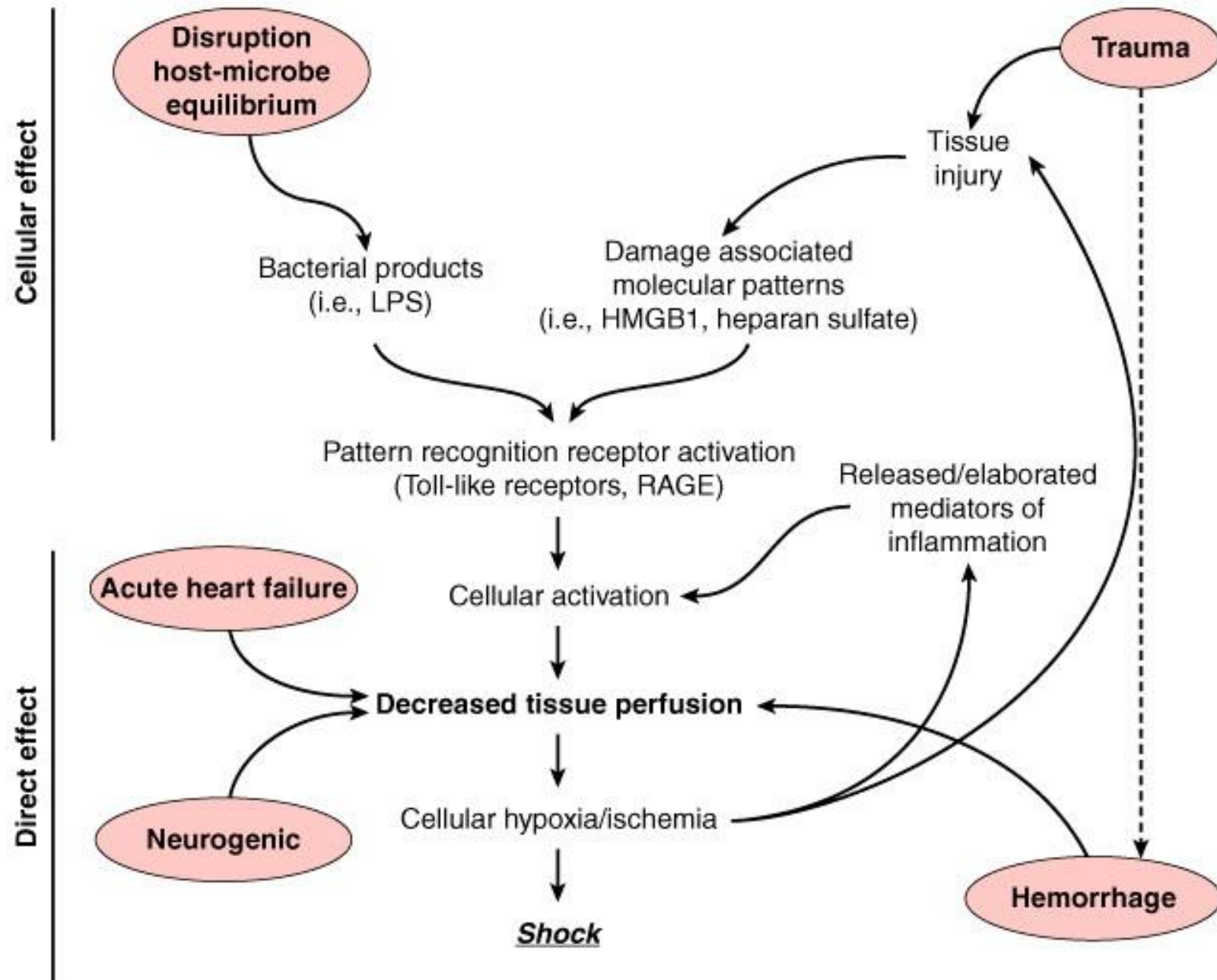
# Rat hemorrhagic shock model 24-hour survival following resuscitation



Source: Brunicaudi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE: *Schwartz's Principles of Surgery, 9th Edition*: <http://www.accessmedicine.com>

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Source: Brunicaudi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE: *Schwartz's Principles of Surgery, 9th Edition*: <http://www.accessmedicine.com>

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# Shock Classifications

## Hypovolumic shock

- **Absolute hypovolemia**
  - Hemorrhagic or other fluid loss

## Distributive shock

- **Relative hypovolemia**
  - *Neurogenic shock*
  - Vasovagal syncope
  - Sepsis
  - Drug overdose

## Mechanical shock

### •Obstructive

*Cardiac tamponade*

*Tension pneumothorax*

Massive pulmonary embolism

### •Cardiogenic

Myocardial contusion

Myocardial infarction



# Hypovolemic Shock

**Reduced circulating blood volume  
with secondary decreased cardiac  
output**

- **Hemorrhage**

- : Trauma

- : Non-Trauma

- **Non-Hemorrhage**

- : External Fluid Loss

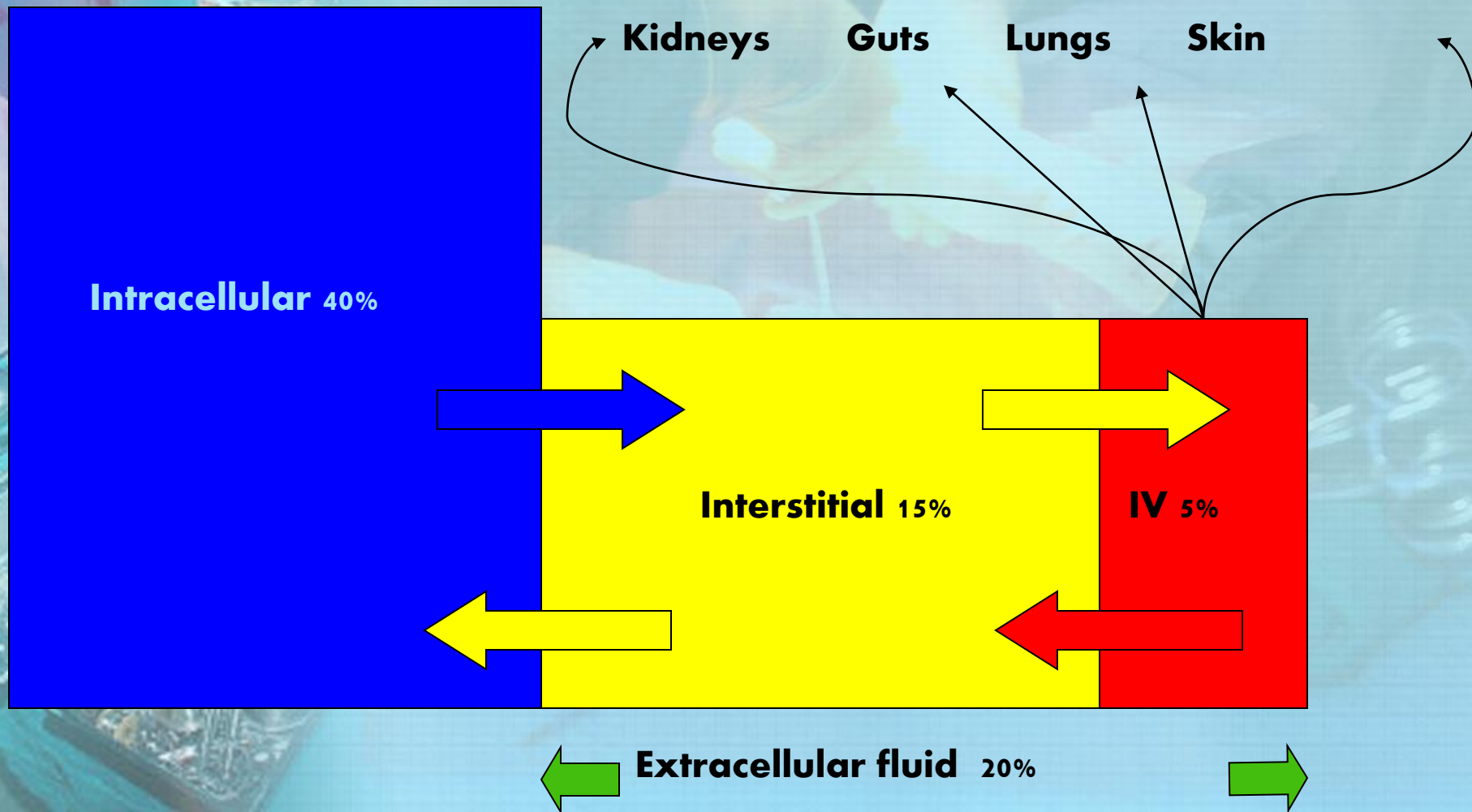
- : Interstitial Fluid Redistribution

# American College of Surgeon's Classes of Acute Hemorrhage

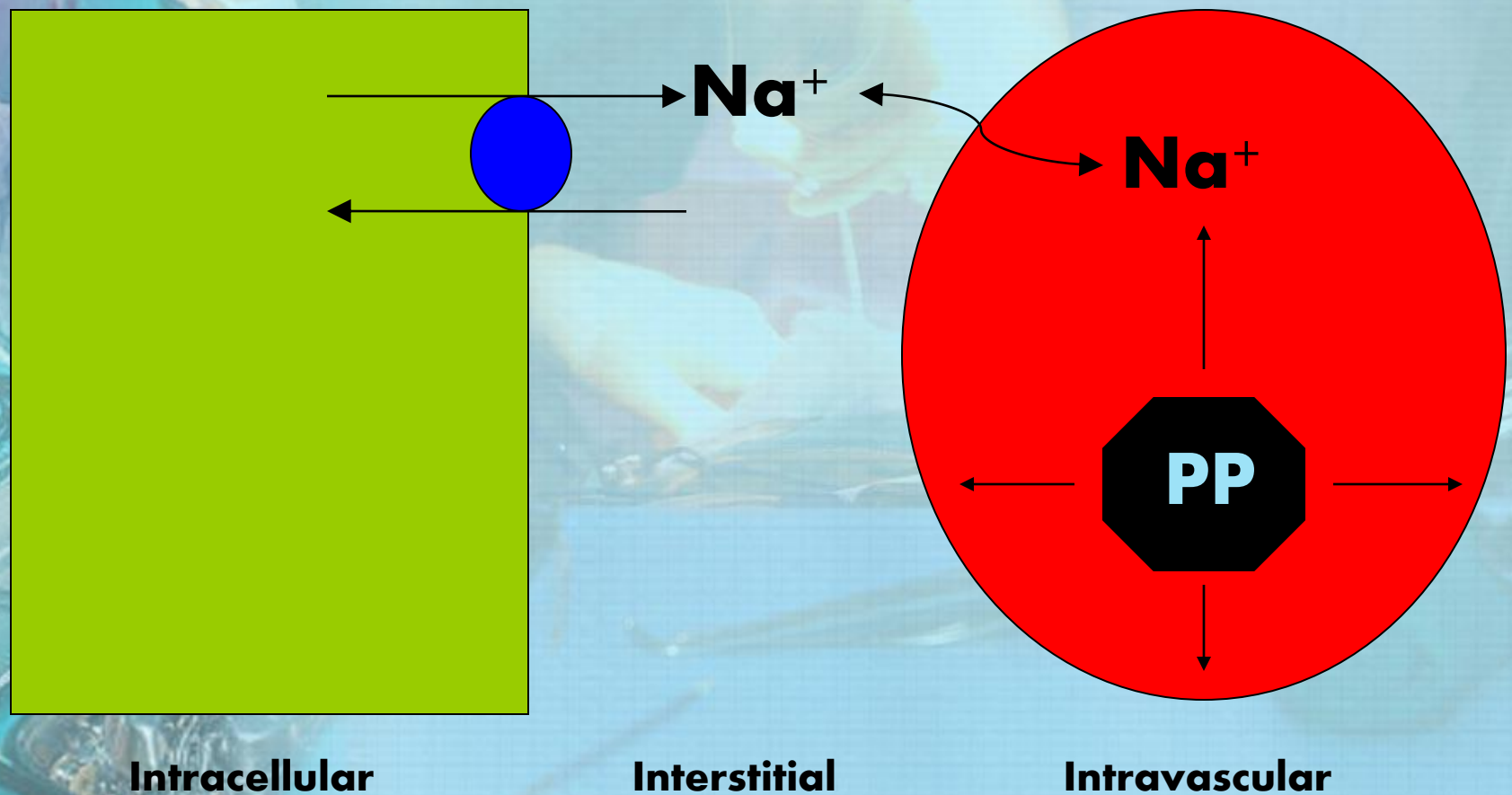
Class	I	II	III	IV
Blood loss (ml)	$\leq 750$	750-1500	1500-2000	$\geq 2000$
Blood loss (% blood volume)	$\leq 15\%$	15-30%	30-40%	$\geq 40\%$
Pulse rate	$< 100$	$> 100$	$> 120$	$\geq 140$
Blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mmHg)	Normal or increased	Decreased	Decreased	Decreased
Capillary refill test	Normal	Positive	Positive	Positive
Respiratory rate	14-20	20-30	30-40	$> 35$
Urine output (ml/hr)	$\geq 30$	20-30	5-15	Negligible
CNS-mental status	Slightly anxious	Mildly anxious	Anxious and confused	Confused, lethargic
Fluid replacement (3:1 rule)	Crystalloid	Crystalloid	Crystalloid + Blood	Crystalloid + Blood



# Fluid distribution



# Osmotic (oncotic) Pressure





# Hemorrhage

- **Acute Circulating Volume Loss**
- **Blood Volume = 7% BW (70 ml/kg)**
- **BW=70 kg Blood Volume= 5 L**
- **Clinical presentation depend on magnitude and rate of circulating volume loss**

# Three-For-One Rule (3:1)


- **From Class III Hemorrhage**
- **Initial Fluid Resuscitation**
- **Interstitial vs ECF**
- **BW=70 kg In Class III**
- **Volume Loss= 1.7 L**
- ***Fluid Rx = 3 x 1.7 = (5 L)***

# Fluid Resuscitation of Shock


- 
- **Crystalloid Solutions**
    - **Normal saline**
    - **Ringers Lactate solution**
  - **Colloid Solutions**
    - **Pentastarch**
    - **Blood products (albumin, RBC, plasma)**



# Crystalloid Solutions

- 
- **Normal Saline**
  - **Lactated Ringers Solution**
  - **Plasmalyte**
  - **Require 3:1 replacement of volume loss**
  - **e.g. estimate 1 L blood loss, require 3 L of crystalloid to replace volume**

# Colloid Solutions

- 
- **Pentaspán**
  - **5% Albumin**
  - **Red Blood Cells**
  - **Fresh Frozen Plasma**
  - **Replacement of lost volume in 1:1 ratio**

# American College of Surgeon's Classes of Acute Hemorrhage

Class	I	II	III	IV
Blood loss (ml)	$\leq 750$	750-1500	1500-2000	$\geq 2000$
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Fluid replacement (3:1 rule)	Crystalloid	Crystalloid	Crystalloid + Blood	Crystalloid + Blood



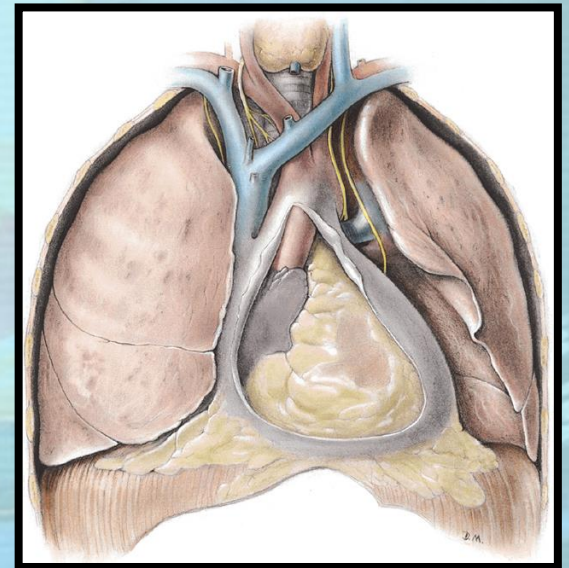
# Mechanical Shock

**Obstructs blood flow to or through heart**

- **Slows venous return**
- **Decreases cardiac output**

**Clinical presentation**

- **Distended neck veins**
- **Cyanosis**
- **Catecholamine effects**
  - **Pallor, tachycardia, diaphoresis**



# **Mechanical shock Management**

## **Cardiac tamponade**

- **Blood fills “potential” space; prevents heart filling**
- **May occur >75% with penetrating cardiac injury**
- **“Beck’s triad”**
  - **Shock, muffled heart tones, distended neck veins**

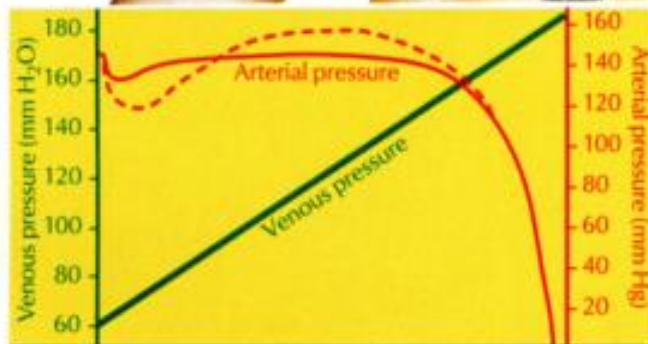
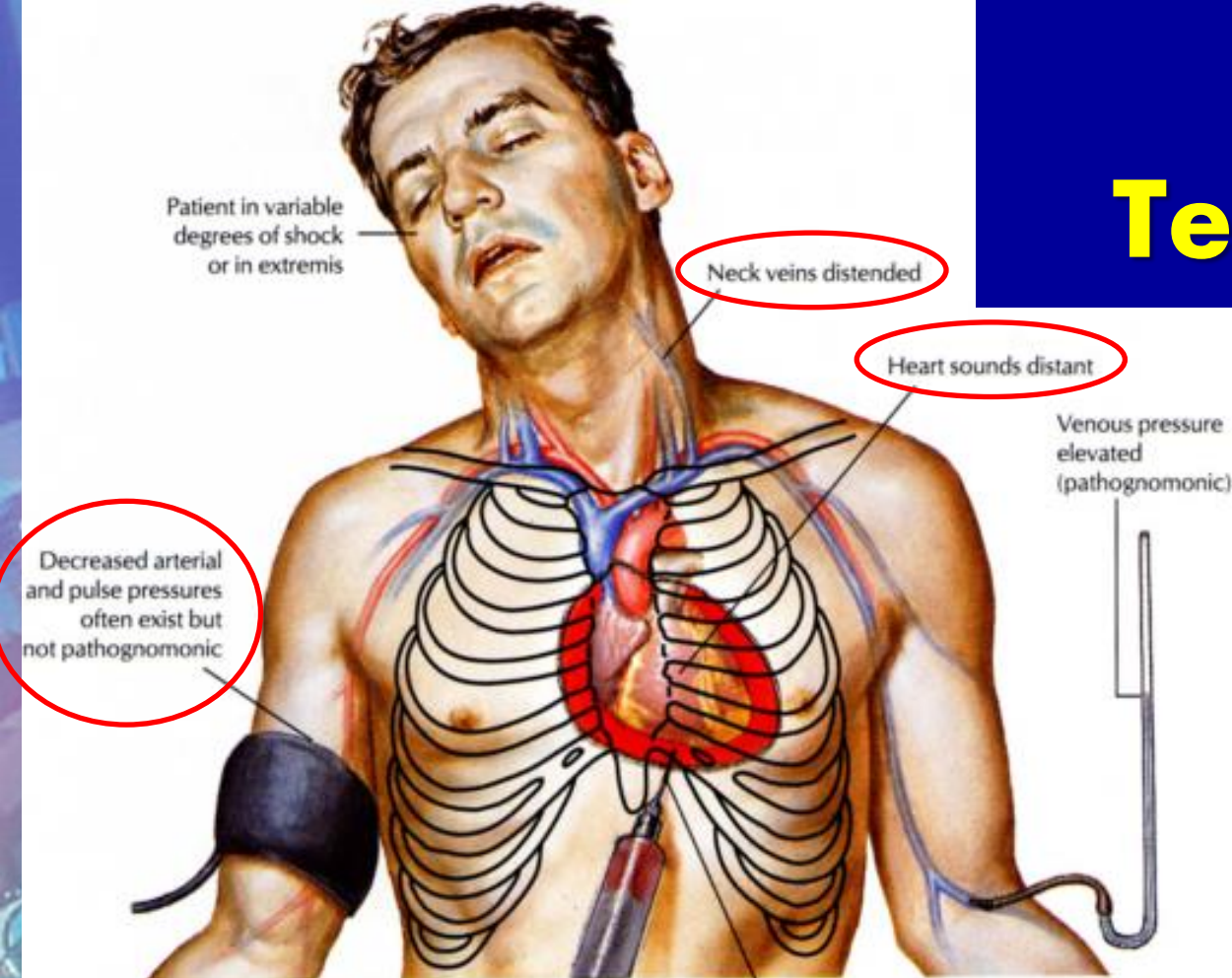
## **Management**

- **Rapid safe transport to appropriate facility**
  - **Cardiac arrest can occur in minutes**
- **Fluid administration by local medical direction**



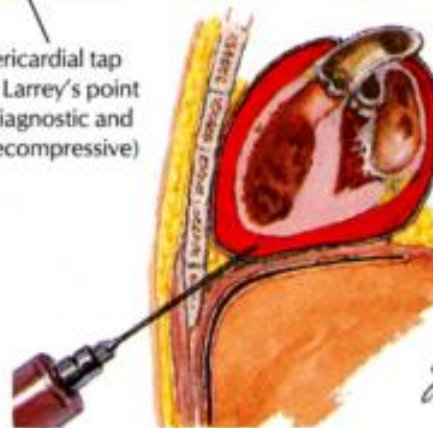
# Cardiac Tamponade

## -Beck 's Triad



In cardiac tamponade venous pressure rises progressively and linearly; arterial pressure may be normal or elevated and is diagnostically unreliable.

Pericardial tap at Larrey's point (diagnostic and decompressive)



F. Netter M.D.  
© IGV



# Mechanical shock Management

## **Tension pneumothorax**

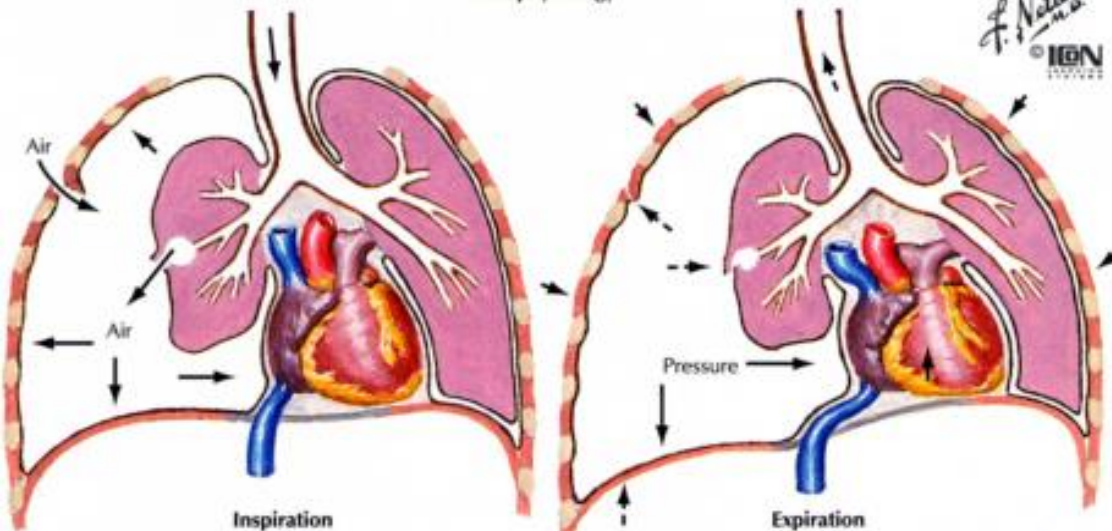
- **Vena cava collapses, prevents venous return**
- **Mediastinal shift lowers venous return**
- **Tracheal deviation away from affected side**
- **Decreased cardiac output**

## **Management**

- **Chest decompression**
- **Prompt decompression of pleural pressure**

# Tension Pneumothorax

## Tension pneumothorax Pathophysiology



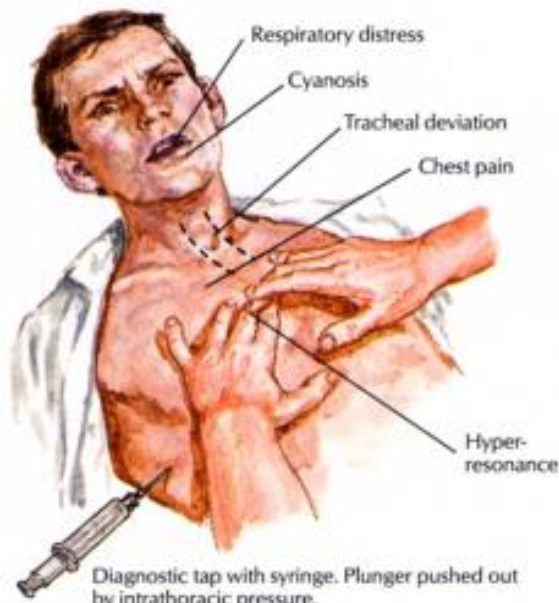
### Inspiration

### Expiration

Air enters pleural cavity through lung wound or ruptured bleb (or occasionally via penetrating chest wound) with valvelike opening. Ipsilateral lung collapses and mediastinum shifts to opposite side, compressing lung.

Intrapleural pressure rises, closing valvelike opening, thus preventing escape of pleural air. Pressure is thus progressively increased with each breath. Mediastinal and tracheal shifts are augmented, diaphragm is depressed, and venous return is impaired.

## Clinical manifestations



Left-sided tension pneumothorax. Lung collapsed, mediastinum and trachea deviated to opposite lung.



# Properties of Vasopressors

Drug	HR	Contractility	Arterial constriction
Dobutamine	+	+++	-
Dopamine	++	++	++
Epinephrine	+++	+++	++
Norepinephrine	++	++	+++
Phenylephrine	0	0	+++
Amrinone	+	+++	--



# Distributive Shock

## Relative hypovolemia

- “Vasodilatory shock”
- Large intact vascular space
- Interruption of sympathetic nervous system
- Loss of normal vasoconstriction; vascular space becomes much “too large”

## Clinical presentation

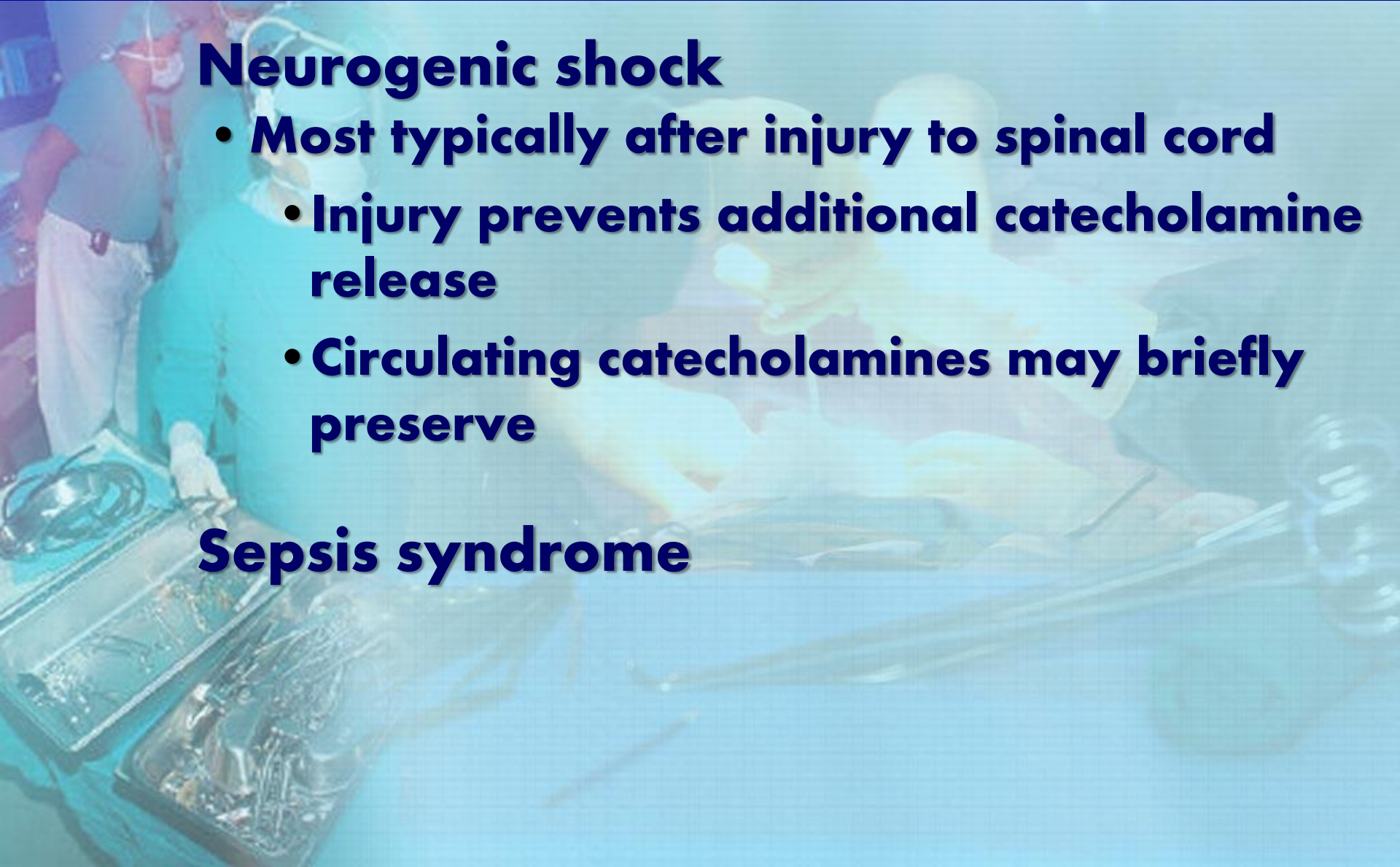
- Varies dependent on type of high-space shock

# Distributive Shock

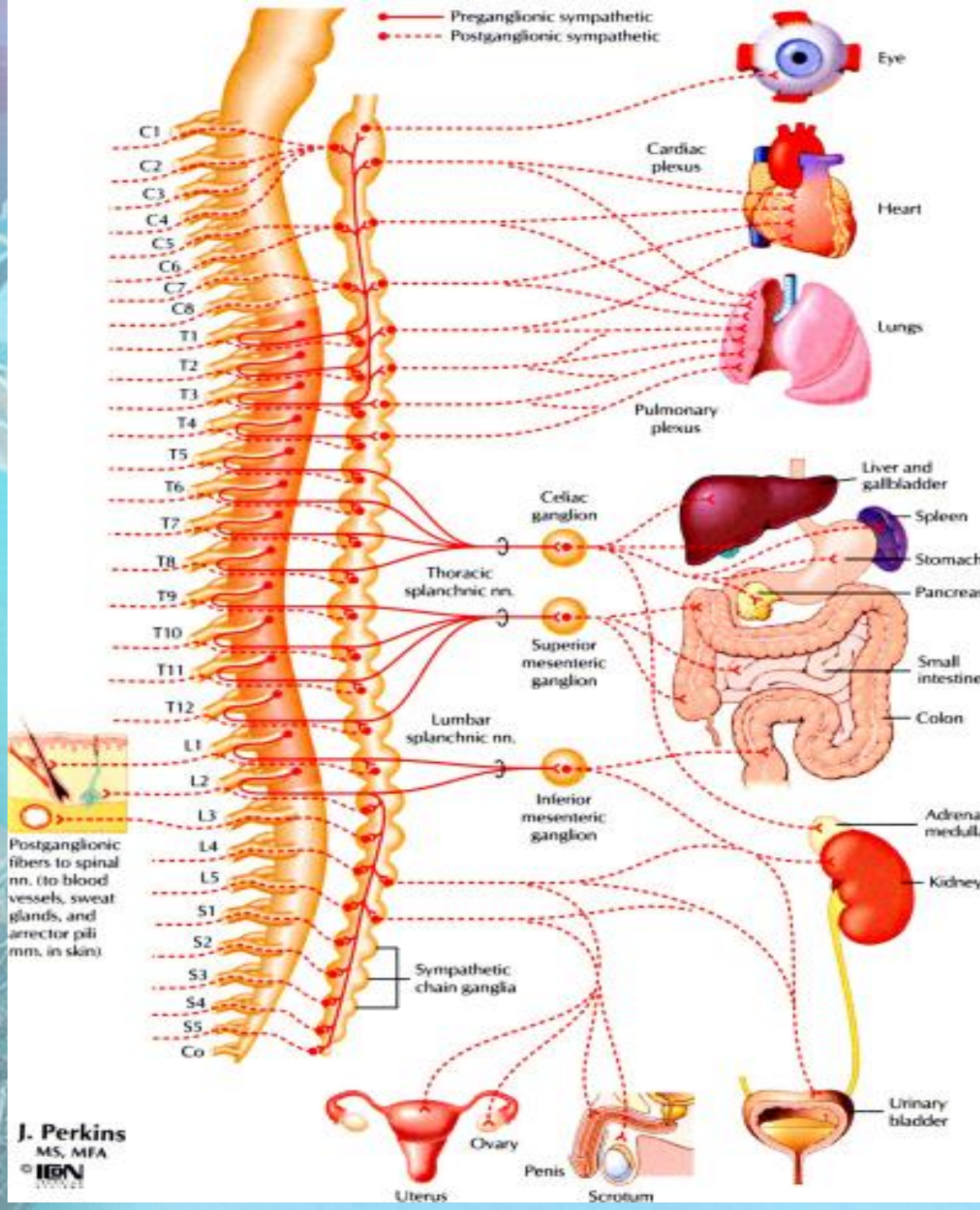
## Neurogenic shock

- Most typically after injury to spinal cord
- Injury prevents additional catecholamine release
- Circulating catecholamines may briefly preserve

## Sepsis syndrome





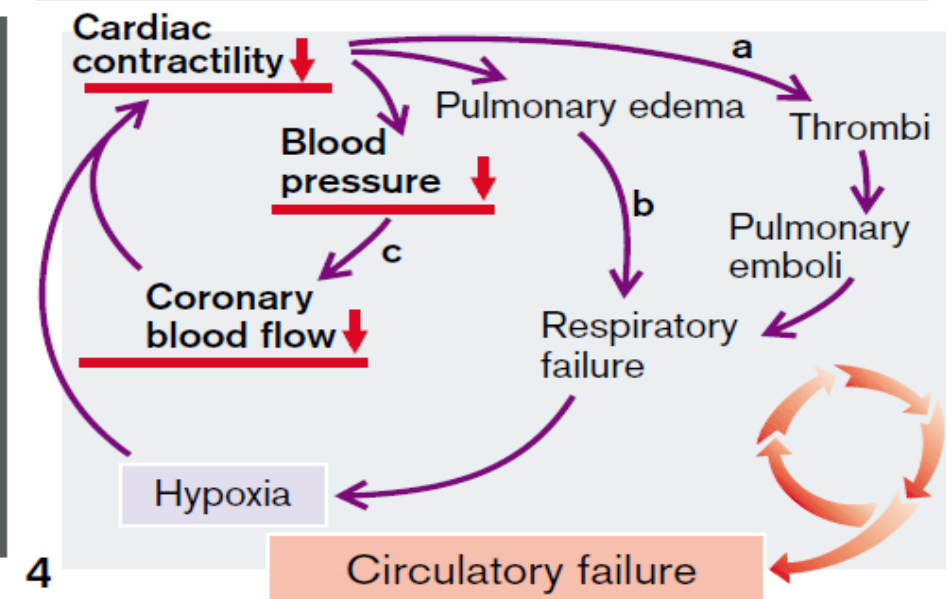
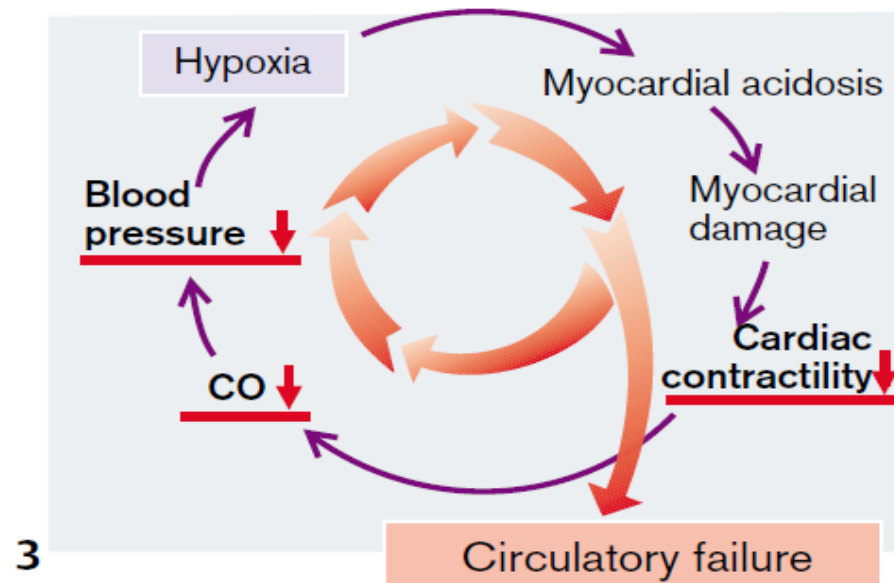
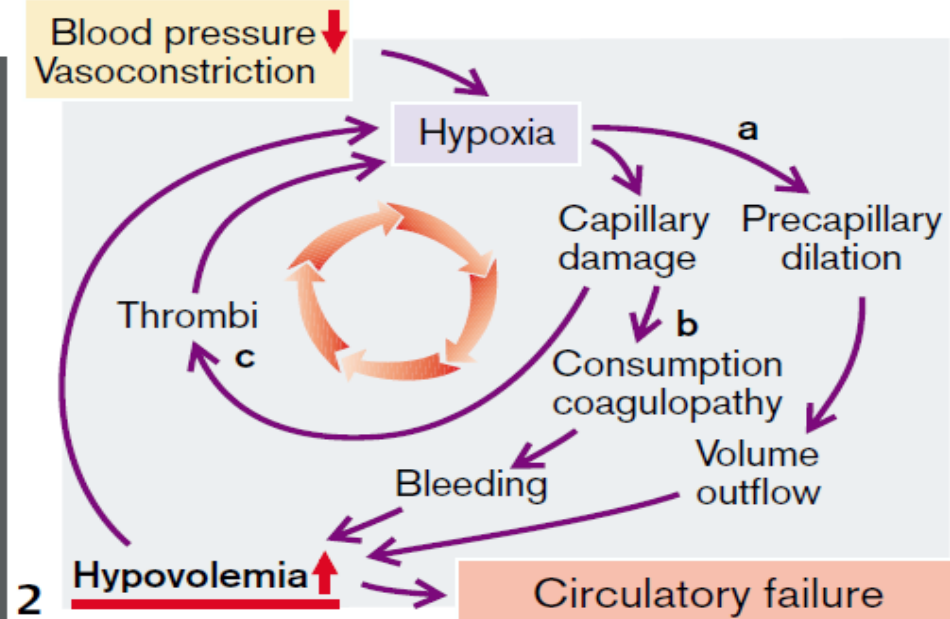
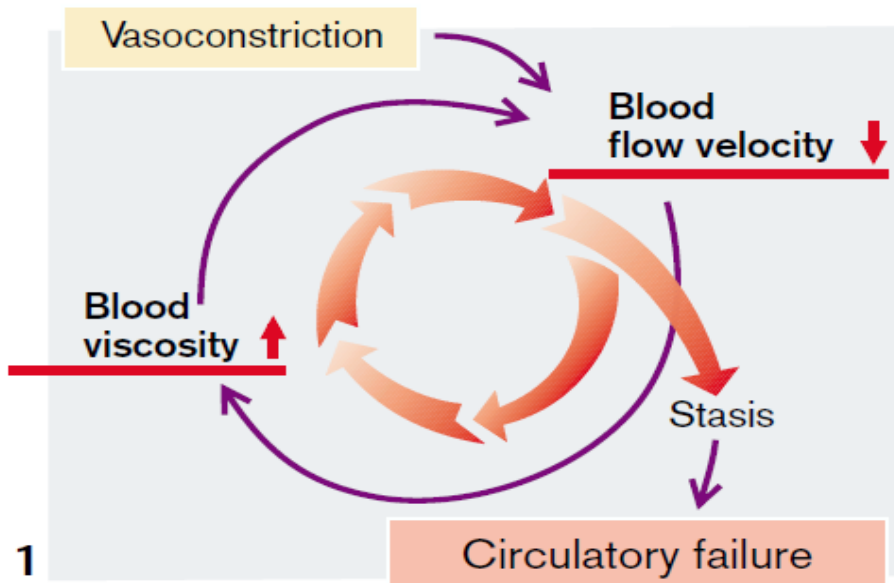




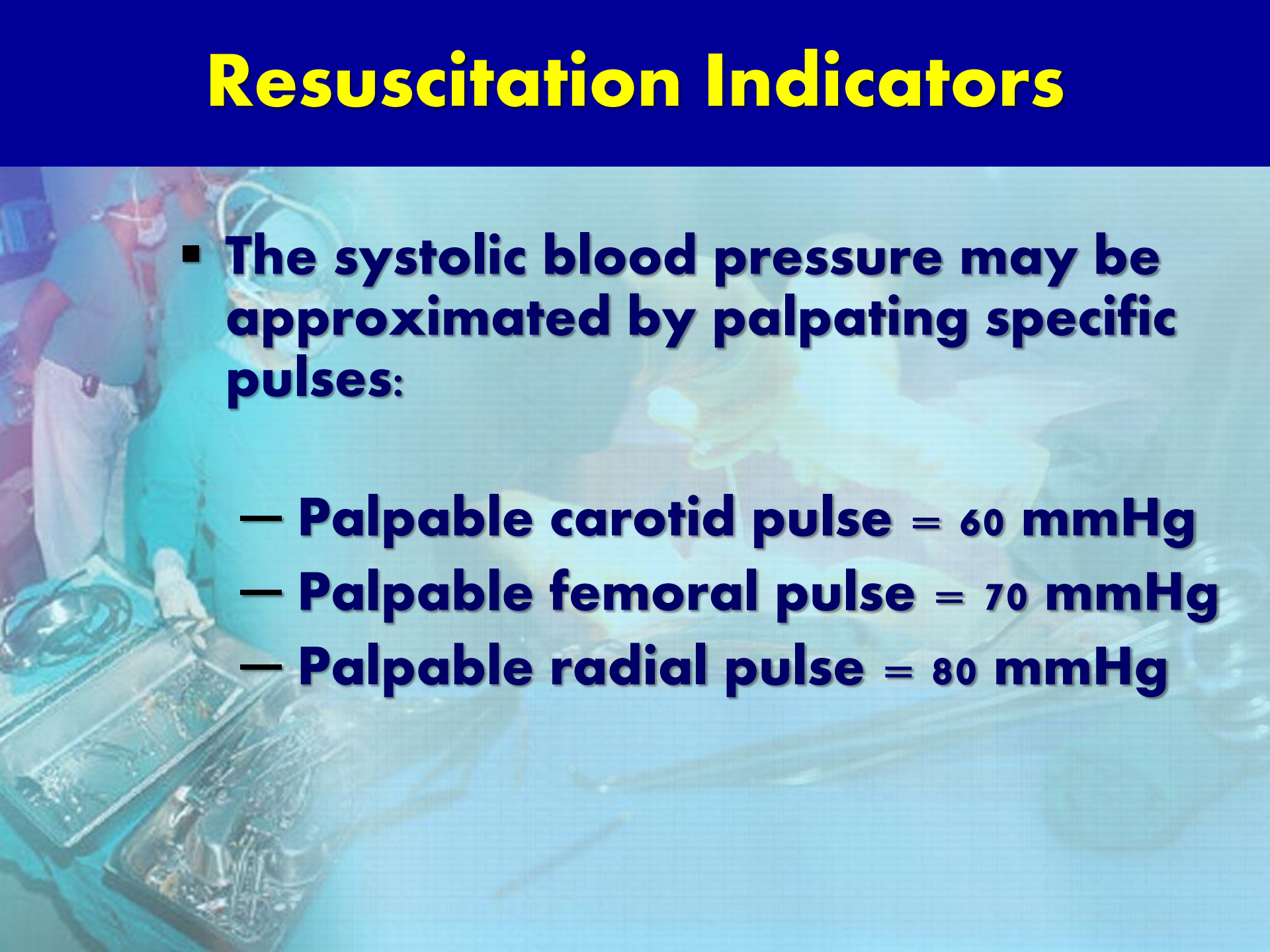
# Hemodynamic profile of shock

Physiologic variable	Preload	Pump function	Afterload	Tissue perfusion
Hypovolemic	Decreased	Decreased	Increased	Decreased
Cardiogenic	Increased	Decreased	Increased	Decreased
Distributive	Decreased	Increased	Decreased	Decreased

## C. Vicious circles (1–4) which Lead to Irreversible Shock



# Resuscitation Indicators

- 
- **The systolic blood pressure may be approximated by palpating specific pulses:**
    - **Palpable carotid pulse = 60 mmHg**
    - **Palpable femoral pulse = 70 mmHg**
    - **Palpable radial pulse = 80 mmHg**

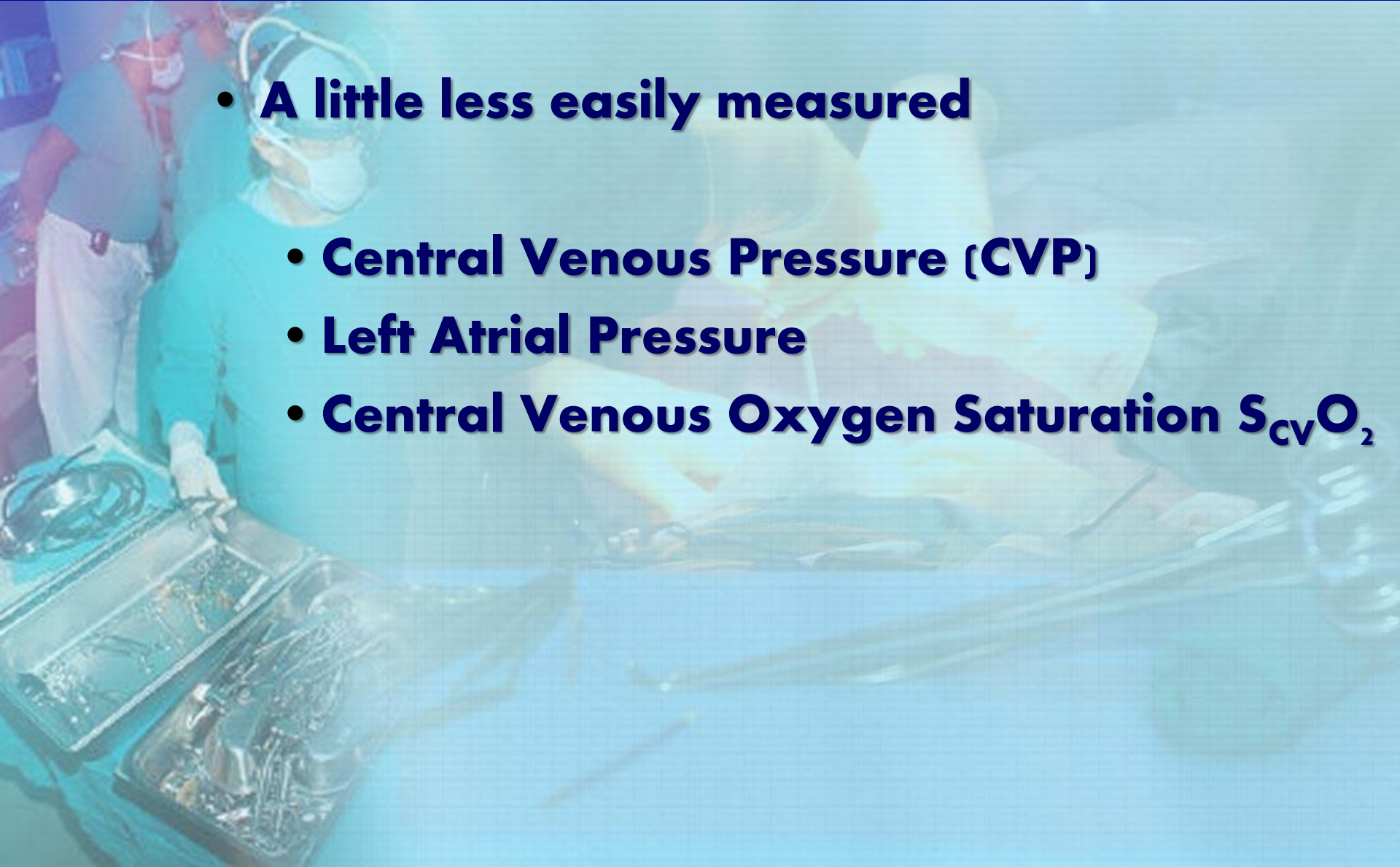


# Goals of Fluid Resuscitation

- 
- **Easily measured**
    - **Mentation**
    - **Blood Pressure**
    - **Heart Rate**
    - **Jugular Venous Pressure**
    - **Urine Output**

# Goals of Fluid Resuscitation

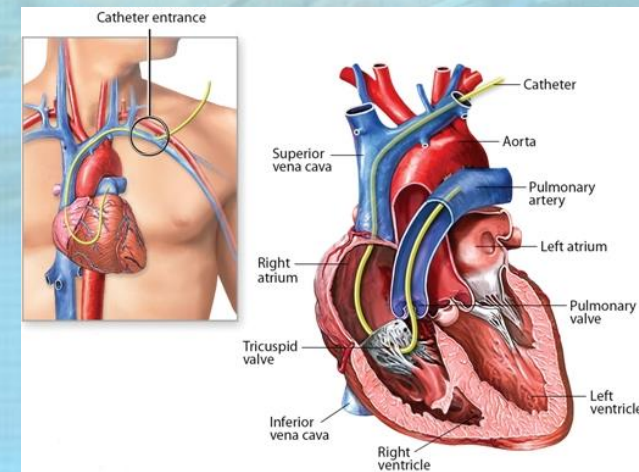
- **A little less easily measured**
  - **Central Venous Pressure (CVP)**
  - **Left Atrial Pressure**
  - **Central Venous Oxygen Saturation  $S_{cv}O_2$**





# Goals of Fluid Resuscitation

- **A bit more of a pain to measure**
- **Pulmonary Capillary Wedge Pressure (PCWP)**
- **Systemic Vascular Resistance (SVR)**
- **Cardiac Output / Cardiac Index**





# Fluid Administration

## Uncontrollable hemorrhage

- **May increase bleeding and death**
- **Dilutes clotting factors**
- **Early blood transfusion in severe cases**
  - **IV fluids carry almost no oxygen**
- **Moribund trauma patients**
  - **Fluid may be indicated to maintain some circulation**
- **Local medical direction**

# Hemorrhage Management

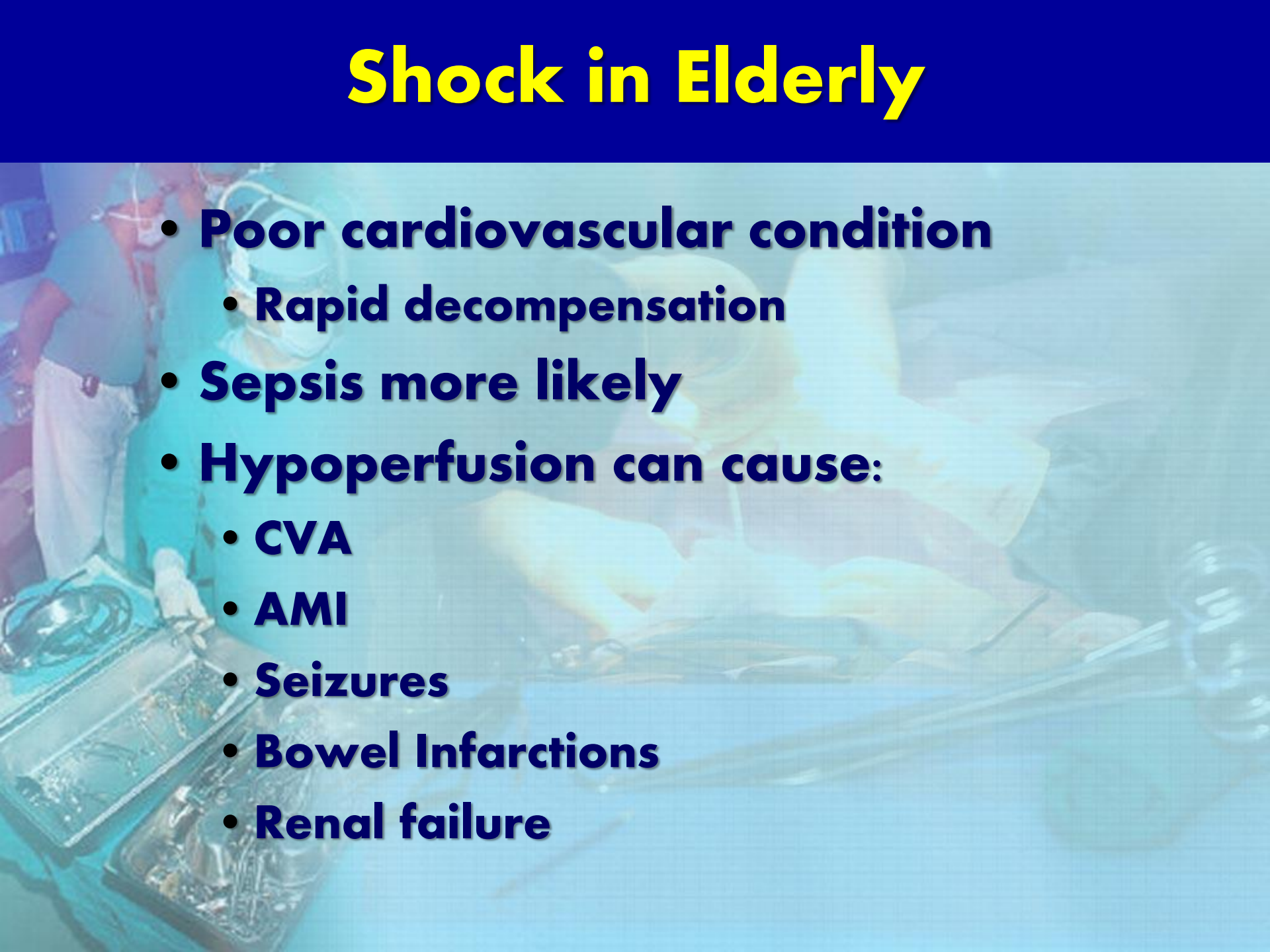
## Management

- **Control bleeding**
- **Shock position**
- **High-flow oxygen**
- **Rapid safe transport**
- **Large-bore IV access**
- **Fluid administration**
- **Cardiac monitor, SpO<sub>2</sub>, EtCO<sub>2</sub>**
- **Ongoing Exam**





# Shock in Elderly

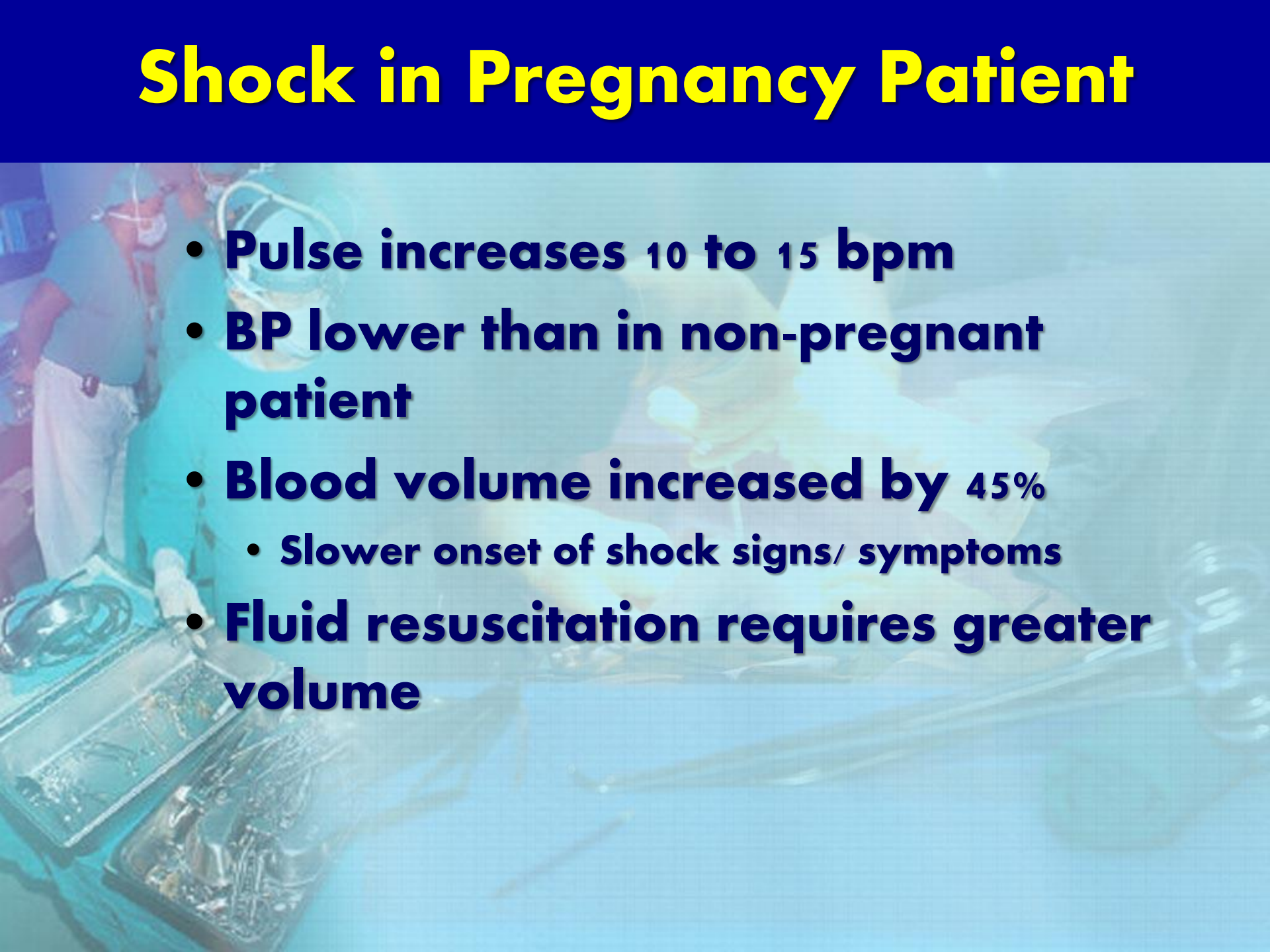
- 
- **Poor cardiovascular condition**
    - **Rapid decompensation**
  - **Sepsis more likely**
  - **Hypoperfusion can cause:**
    - **CVA**
    - **AMI**
    - **Seizures**
    - **Bowel Infarctions**
    - **Renal failure**



# Shock in Elderly

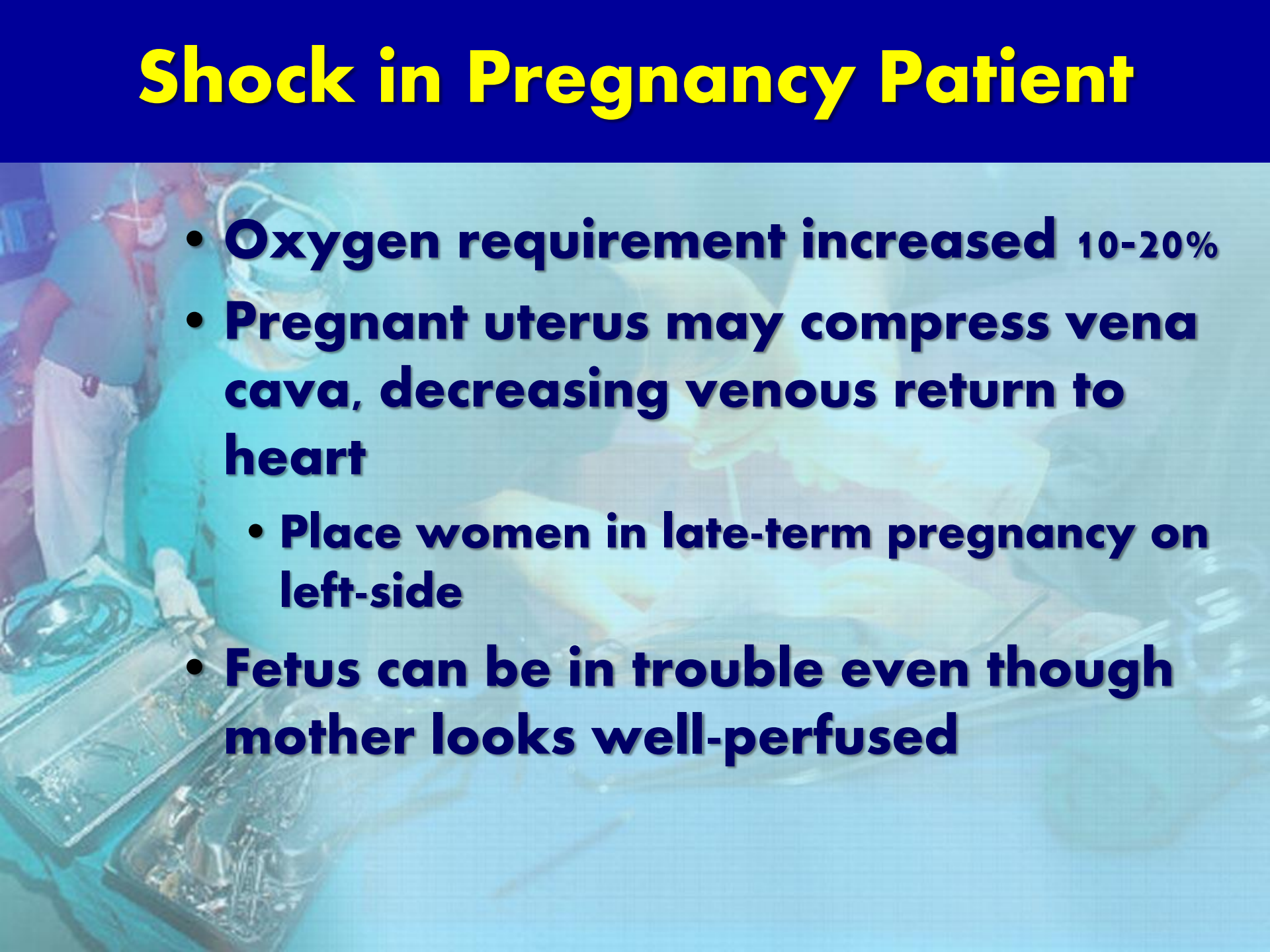
- 
- **Assessment more difficult**
    - **Peripheral vascular disease**
    - **Weak pulses**
    - **Altered sensorium**
    - **Hypertension masking hypoperfusion**
    - **Beta-blockers masking hypoperfusion**
  - **Fluid infusion may produce volume overload/CHF**

# Shock in Pregnancy Patient

- 
- **Pulse increases 10 to 15 bpm**
  - **BP lower than in non-pregnant patient**
  - **Blood volume increased by 45%**
    - **Slower onset of shock signs/ symptoms**
  - **Fluid resuscitation requires greater volume**



# Shock in Pregnancy Patient

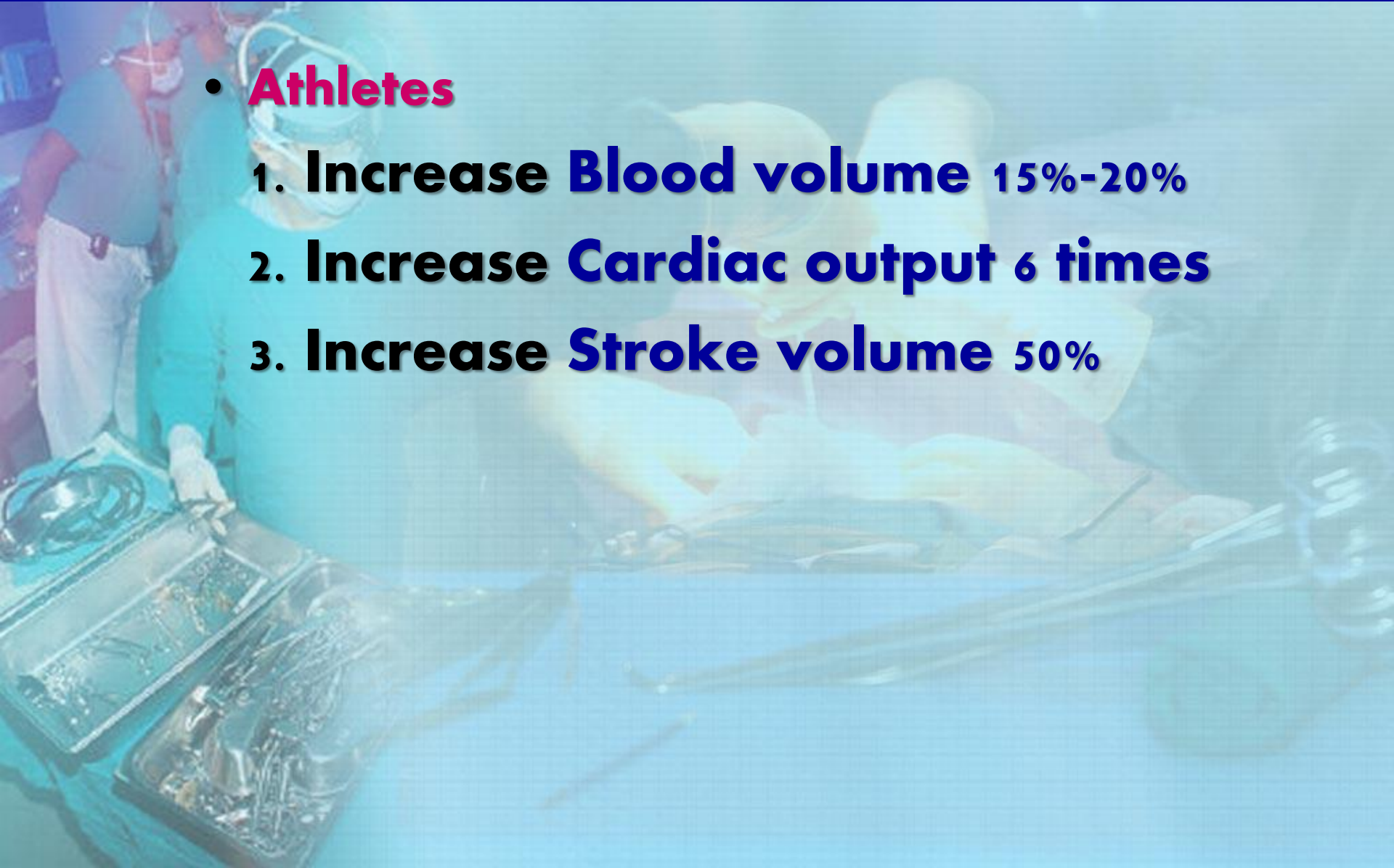
- 
- **Oxygen requirement increased 10-20%**
  - **Pregnant uterus may compress vena cava, decreasing venous return to heart**
    - **Place women in late-term pregnancy on left-side**
  - **Fetus can be in trouble even though mother looks well-perfused**



# Special Intrinsic Factor

- **Athletes**

1. **Increase Blood volume 15%-20%**
2. **Increase Cardiac output 6 times**
3. **Increase Stroke volume 50%**



# Special Intrinsic Factor

- 
- **Pacemaker**
  - **Medications**
    1. **Beta-adrenergic receptor blocker**
    2. **Calcium channel blockers**
    3. **Chronic diuretic**
    4. **Insulin overdosis**
    5. **NSAID**

# Special Intrinsic Factor

- **Hypothermia**
  1. Inducible for Coagulopathy
  2. Alcohol: Vasodilatation

**Monitor Core Temperature**

**Prevention is the best**





# Conclusion

- 
- **Definition Highly Suspicious**
  - ***Early Diagnosis***
  - **Pathophysiologic Response**
  - ***Empiric Management***
  - ***Search for Etiologies***
  - ***Organs and Tissue Perfusion***

A dramatic painting of a herd of horses running along a rocky beach at sunset. The sun is low on the horizon, casting a warm, golden glow over the scene. The sky is filled with large, billowing clouds that catch the light. The horses, in various shades of white, cream, and brown, are captured in mid-stride, their manes and tails flowing. They are running from left to right, towards the viewer. The ocean waves are breaking on the shore, creating white foam. The overall mood is one of freedom, power, and natural beauty.

**THANKS YOU**