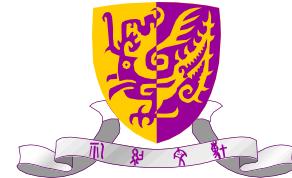


Shock

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BASIC



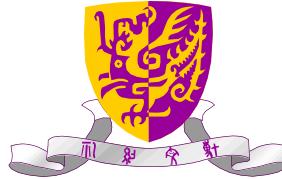
Shock

- State in which there is inadequate oxygen delivery to the tissues to meet demand

$$DO_2 = CO \times CaO_2$$

DO_2 = oxygen delivery; CO = cardiac output; CaO_2 = arterial oxygen content





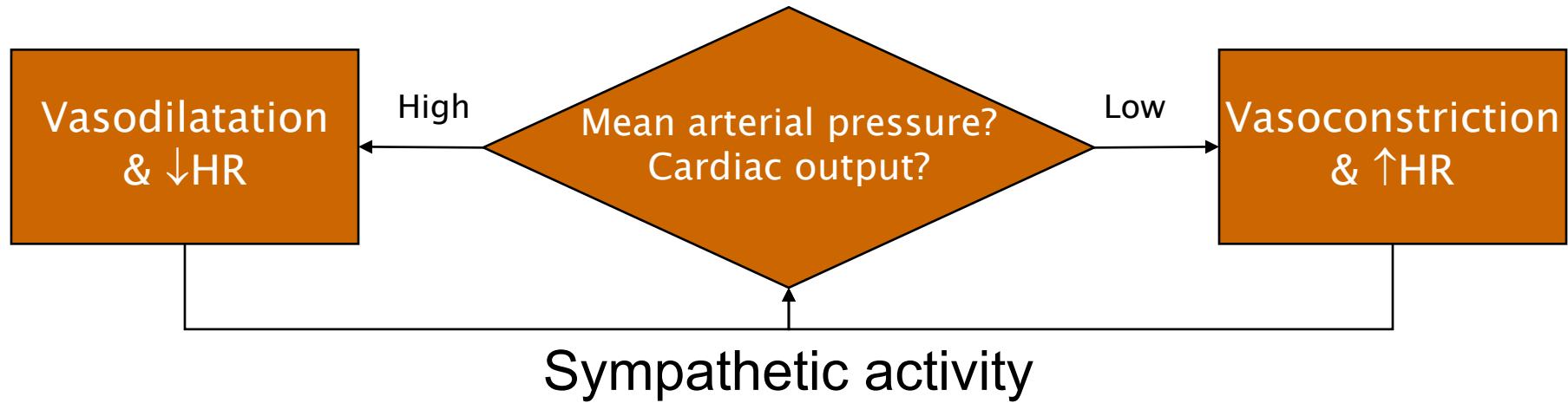
Shock

- Initial assessment
 - Focused clinical examination (Lungs, Heart, Lung, Skin, Abdomen)
 - Vital signs (BP, HR)
 - Oxygenation status (SrO_2 , FiO_2)
 - Metabolic status (venous or arterial ABG)

**CAVE: Hypotension
need not be present**



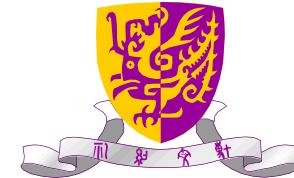
Hypotension does not need to be present!



Hypotension = Failure of compensation
⇒ Very severe disease



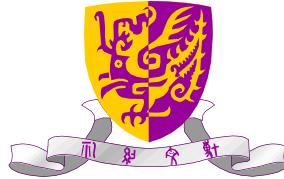
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Shock: Definition

- Hypoperfusion despite adequate fluid resuscitation
 - BP \leq or \geq 90
 - Tachycardia
 - Tachypnoea (low PaCO₂)
 - Mottled skin
 - Centralization
 - Lactic acidosis
 - Oligo-anuria





Case A

- Our clinical case: 45 years old male
 - BP 70/50/35 mmHg
 - SaO₂ 95% ScvO₂ 57%
 - Mottled skin
 - PaCO₂ 2.7 kPa
 - Lactate 8.5 mmol/l
 - pH 7.25
 - Urine output = 10 ml/h

Mean BP = 50 mmHg
What does is mean?



Global haemodynamic relationships

$$\text{MAP} = \text{CO} \times \text{TPR}$$



Global haemodynamic relationships

$$\text{MAP} = \text{CO} \times \text{TPR}$$

Peripheral perfusion



Global haemodynamic relationships

$$\text{MAP} = \text{CO} \times \text{TPR}$$

Peripheral perfusion

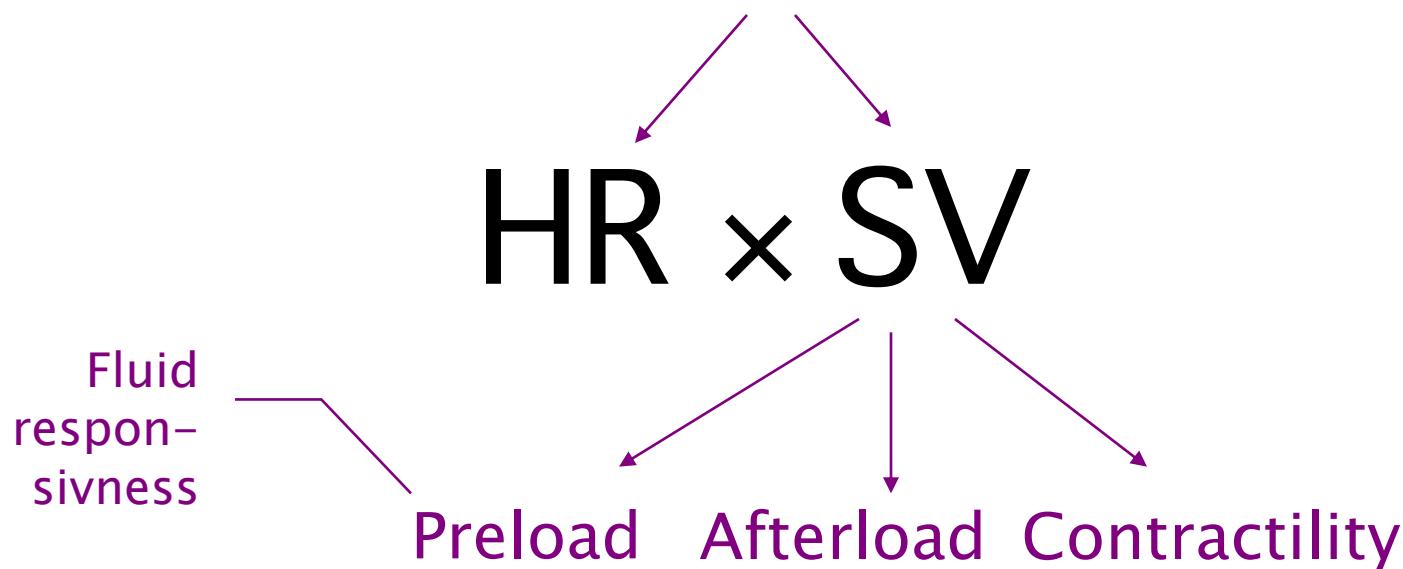
$$\text{HR} \times \text{SV}$$

The diagram illustrates the global haemodynamic relationships. It starts with the equation $\text{MAP} = \text{CO} \times \text{TPR}$. A purple bracket labeled "Peripheral perfusion" groups the terms CO and TPR . Two arrows point downwards from this bracket to the terms HR and SV in the equation $\text{HR} \times \text{SV}$.



Global haemodynamic relationships

$$\text{MAP} = \text{CO} \times \text{TPR}$$



Case A

- Differential diagnosis
 - Septic shock (distributive)
 - Cardiogenic shock
 - Obstructive shock due to pulmonary embolus
 - Hypovolemic shock



Clinical presentation of shock

	HR	JVP or CVP	Peripheries
Cardiac	↑ or ↓↓ or ↑↑	↑	Cold
Hypovolaemic	↑	↓	Cold
Distributive	↑	↓-N	Warm
Obstructive*	↑	↑↑	Cold

* Obstructive shock due to cardiac tamponade, tension pneumothorax or massive PE



BASIC

Case A

- Differential diagnosis
 - Septic shock (distributive)
 - Cardiogenic shock
 - Obstructive shock due to pulmonary embolus
 - Hypovolemic shock
- **What next?**



BASIC

Case A

- Start fluid infusion
- Give oxygen
 - Oxygenation status unclear at the moment
- Investigations
 - ECG
 - Echocardiography
 - Biochemistry, complete blood count



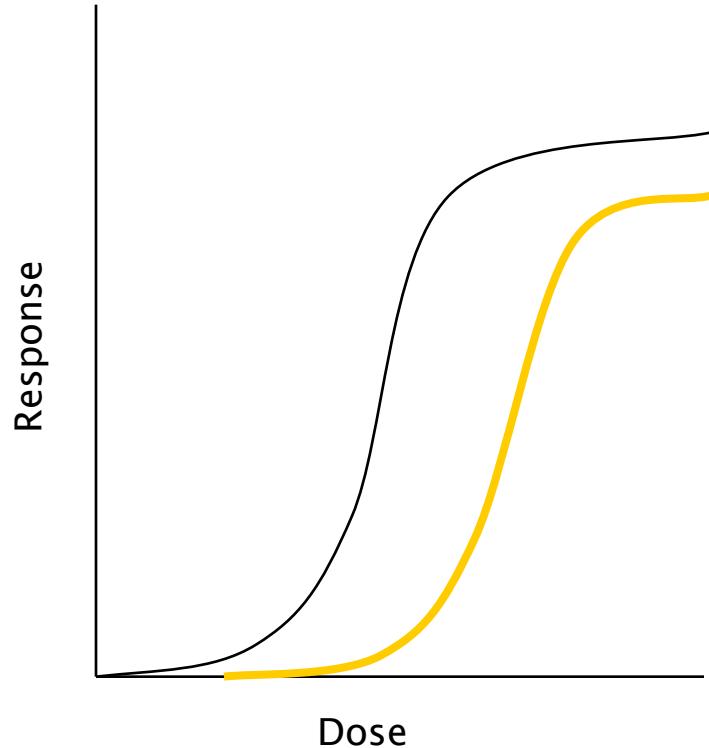
Immediate resuscitation of the shocked patient

- Immediately life threatening hypotension
 - Norepinephrine boluses
 - Vasopressor infusion
 - Fluids



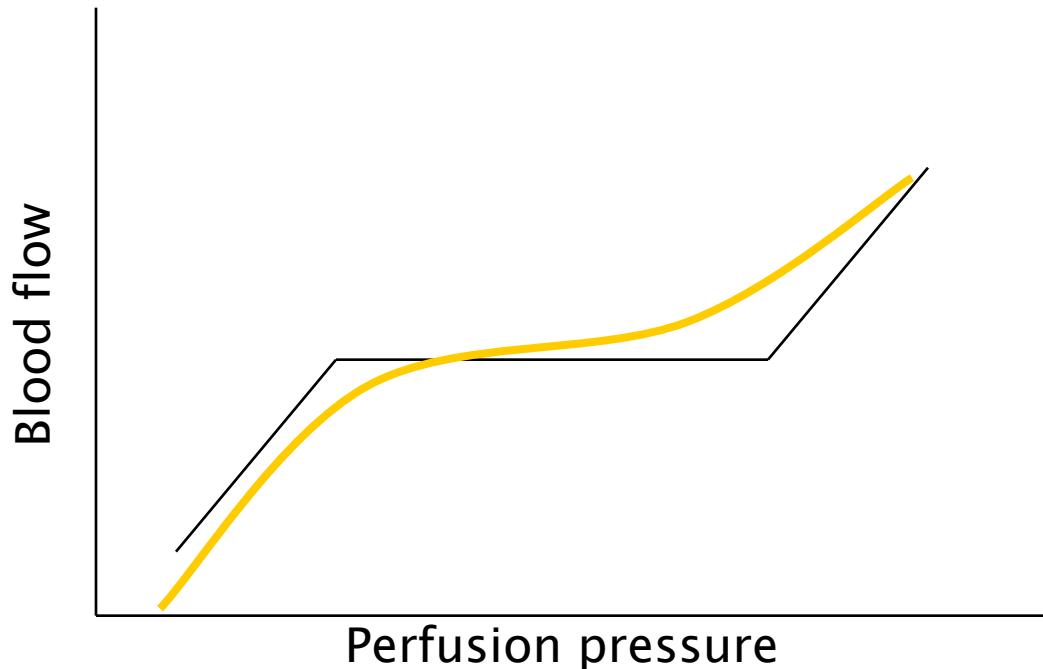
How much?

- Altered dose-response curve in critically ill, particularly sepsis
 - Excessive vasodilation
 - Metabolic acidosis



Blood Pressure

- Autoregulation of organ perfusion pressure



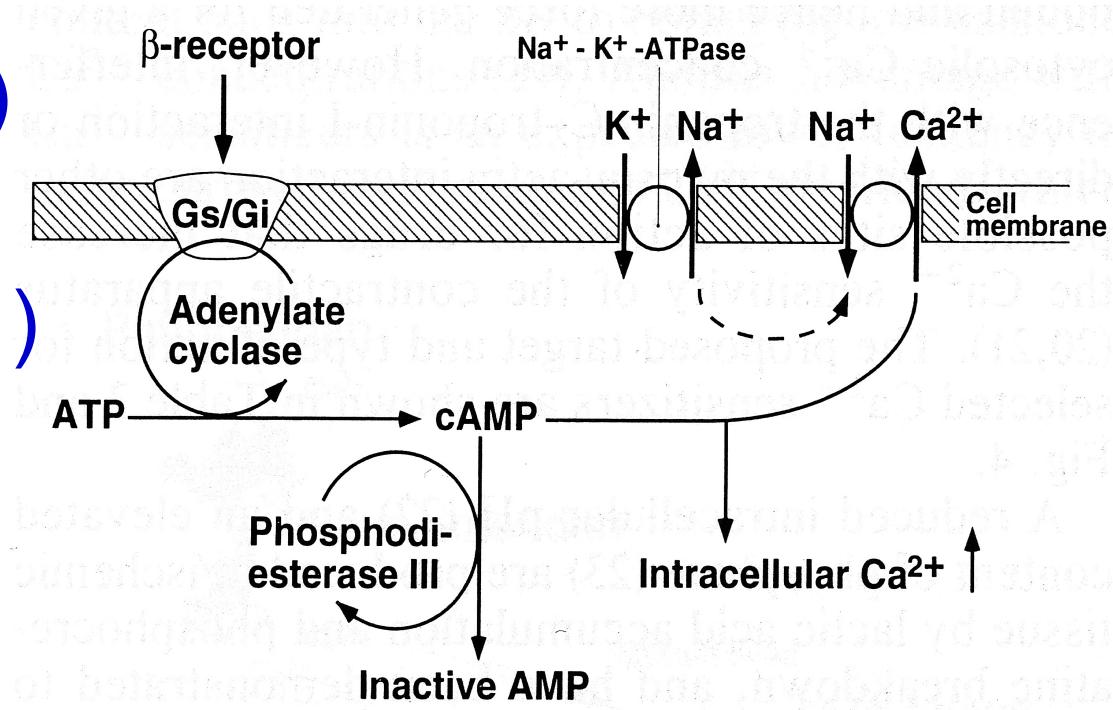
What if fluids are not enough?

- Inadequate cardiac output (SV * HR)
 - Inotrope
- Inadequate blood pressure
 - Vasopressor



Dobutamine

- Inotrope (β_1)
- Vasodilator (β_2)
- Positive chronotrope (β_1)



Norepinephrine

- Vasopressor (α)
- Increases cardiac output in hypotensive patients
 - Increases venous return to the heart
 - Increases coronary perfusion and hence cardiac function

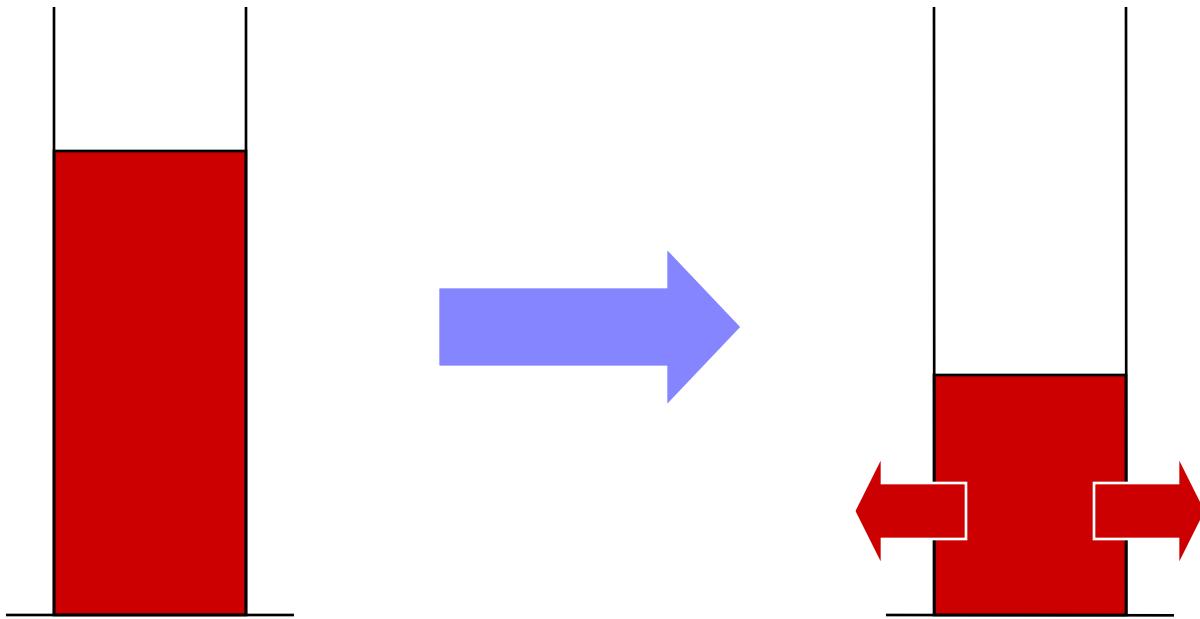


Mechanisms of Shock

- Excessive loss of fluids
- Sepsis
- Cardiac failure
- Obstruction to blood flow



Hypovolaemic



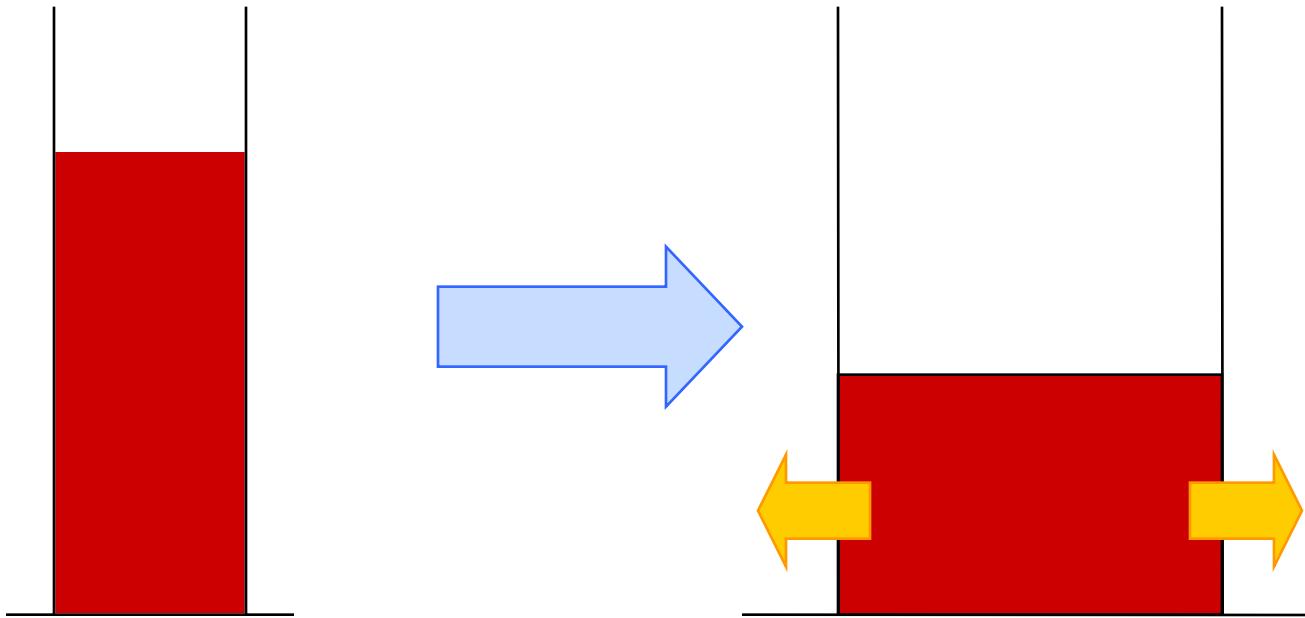
Hypovolaemic: Treatment

- Fluid resuscitation
 - Crystalloids, colloids
 - Blood products
- Vasopressors
 - Life threatening hypotension
 - Distributive shock phase
- Treat underlying cause



Septic

- Pathophysiology
 - ✓ Vasodilatation
 - ✓ Capillary leak
 - ✓ Cardiomyopathy



Septic: Treatment

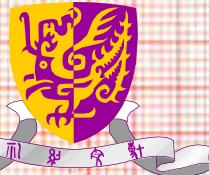
- Norepinephrine or epinephrine (or dopamine)
- Dobutamine
 - Tissue hypoperfusion despite normotension
- Blood cultures
- Antibiotics (within 1 hours of diagnosis!)
- Source control





Which is your diagnosis?





Cardiogenic

- Coronary perfusion to LV dependent on diastolic blood pressure
- LV function dependent on coronary perfusion
- Tachycardia decreases duration of diastole, hence stroke volume

Cardiogenic

- Early referral
 - Revascularization
 - Inotropic drugs
 - LV assist devices
- Treat cause



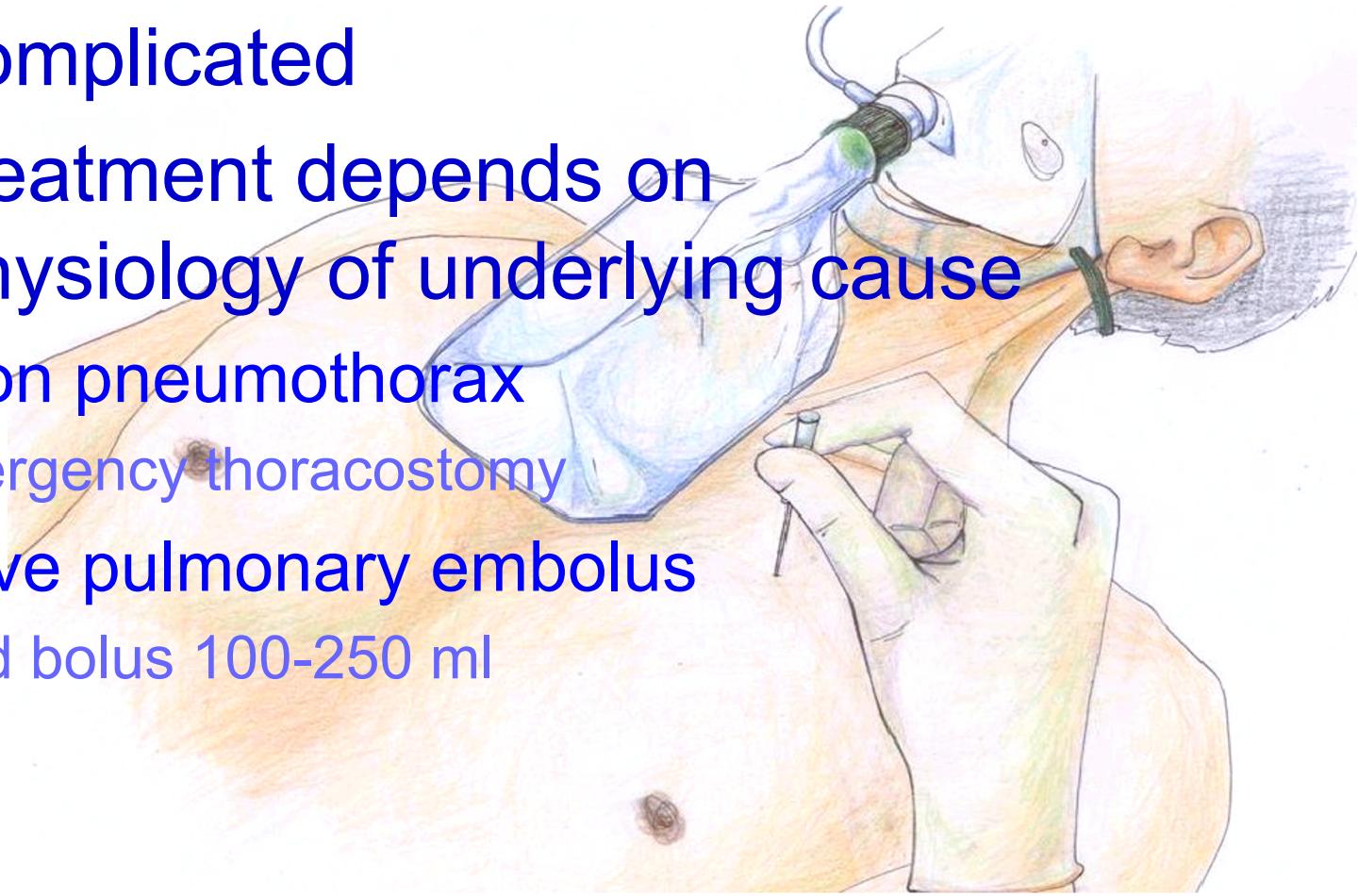
Cardiogenic: Treatment

- Aims:
 - Adequate diastolic pressure without tachycardia
 - Increase cardiac output
- Normotensive patient with poor peripheral perfusion
 - Dobutamine infusion
- Hypotensive patient
 - Dobutamine infusion
 - Norepinephrine infusion



Obstructive

- More complicated
- Initial treatment depends on pathophysiology of underlying cause
 - Tension pneumothorax
 - Emergency thoracostomy
 - Massive pulmonary embolus
 - Fluid bolus 100-250 ml



Obstructive: Treatment

- Complex, call for help
- Early relief of obstruction
- Dobutamine-induced vasodilatation
 - ⇒ severe hypotension due to relatively fixed cardiac output
- Norepinephrine probably drug of choice for initial management



Summary

- Cardiovascular assessment
 - Assess tissue perfusion
 - Vital signs
 - Conscious state
 - Temperature of limbs
 - Skin perfusion
 - Urine output
 - pH
 - Lactate



Summary

- Resuscitation
 - Fluid
 - Vasopressor to restore BP
 - Inotrope to increase cardiac output
 - Titrate against patient response
- Treat underlying cause

