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Shock – types, pathophysiology and diagnostics

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Learning outcomes

- Student will learn how to diagnose and differentiate different types of shock

Shock

- Circulatory failure
- supply ≠ demand

1. cardiogenic – pump
2. obstructive – obstruction
3. hypovolemic – filling
4. distributive - shunts

Pathophysiology

- The main problem is cell **hypoxia**

- **Stress response**
  - catecholamines, RAAS, cortisol, glucagon

- **Systemic inflammatory response**
  - Imunity, inflamatory mediators
  - Localy OK, but generalized response is harmful

Phases of Shock

1. **Compensation**
2. **Decompensation**
3. **Refractory**

- Inflammatory cascade induction and organ damage - „secondary-hit model“
- Organ damage further increases inflammatory cascade induction – vicious circle
- Each type of shock differs at the beginning, however during the late phase all types of shock look similar (like distributive shock)

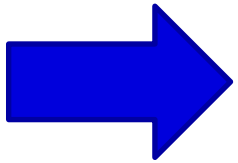
Changes are in ...

1. Macrocirculation

- „blood flow centralization“
- Sepsis „warm shock“

2. Microcirculation

- Endothelium damage
- Increased vascular leakage, leucocytes adherence
- Main role in shock



MODS / MOF

1. **Circulation -** vasoplegia, cardiomyopathy
2. **Lungs -** ARDS
3. **Kidney -** AKI
4. **Coagulation -** DIC
5. **CNS -** altered consciousness
6. **GIT -** loss of barrier function

Signs/Symptoms

Tachypnea

- > 30 breaths/min, dyspnea

Hypotension, tachycardia:

- SBP < 90 mmHg
- MAP < 60 mm Hg
- Tf > 100/min
- Cave compensatory shock/BB

Mental state:

- Confusion
- Iritation
- coma

Quick SOFA score

- SBP ≤ 100 mmHg
- BF ≥ 22/min
- GCS ≤ 14

- Bad prognosis ≥ 2

Symptoms - mottling

Oliguria:

- diuresis < 0,5 ml/kg/hr for 1 – 6hrs

Skin:

- Wet, cold
- CRT(> 2 s)
- mottling

Contou; N Engl J Med 2016; 375:2187

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1. Hypovolemic shock

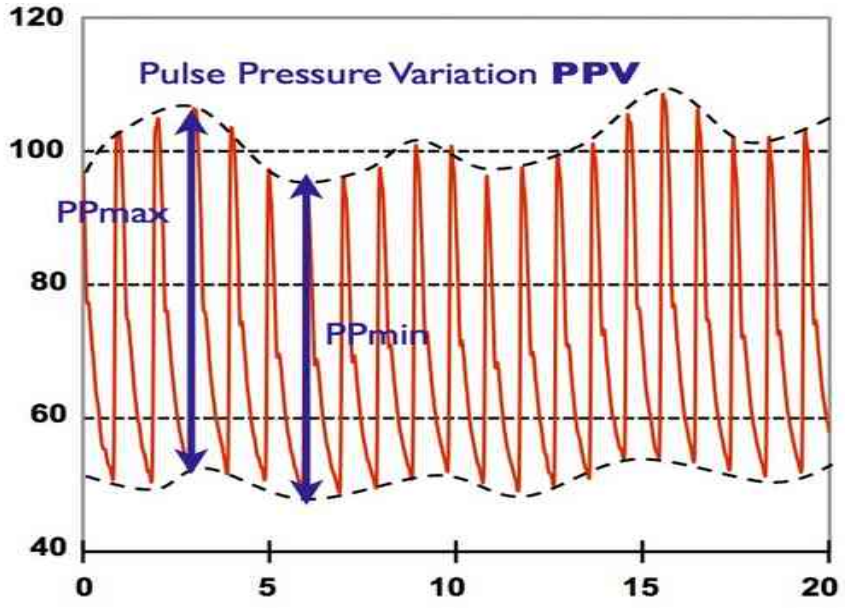
(dehydration, hemorrhagic shock)

Most common Causes of Hypovolemia

- Bleeding
- Loss of fluids (sweating, vomiting, diarrhea, renal failure ....)
- 3rd space losses (Ileus)
- Inadequate intake

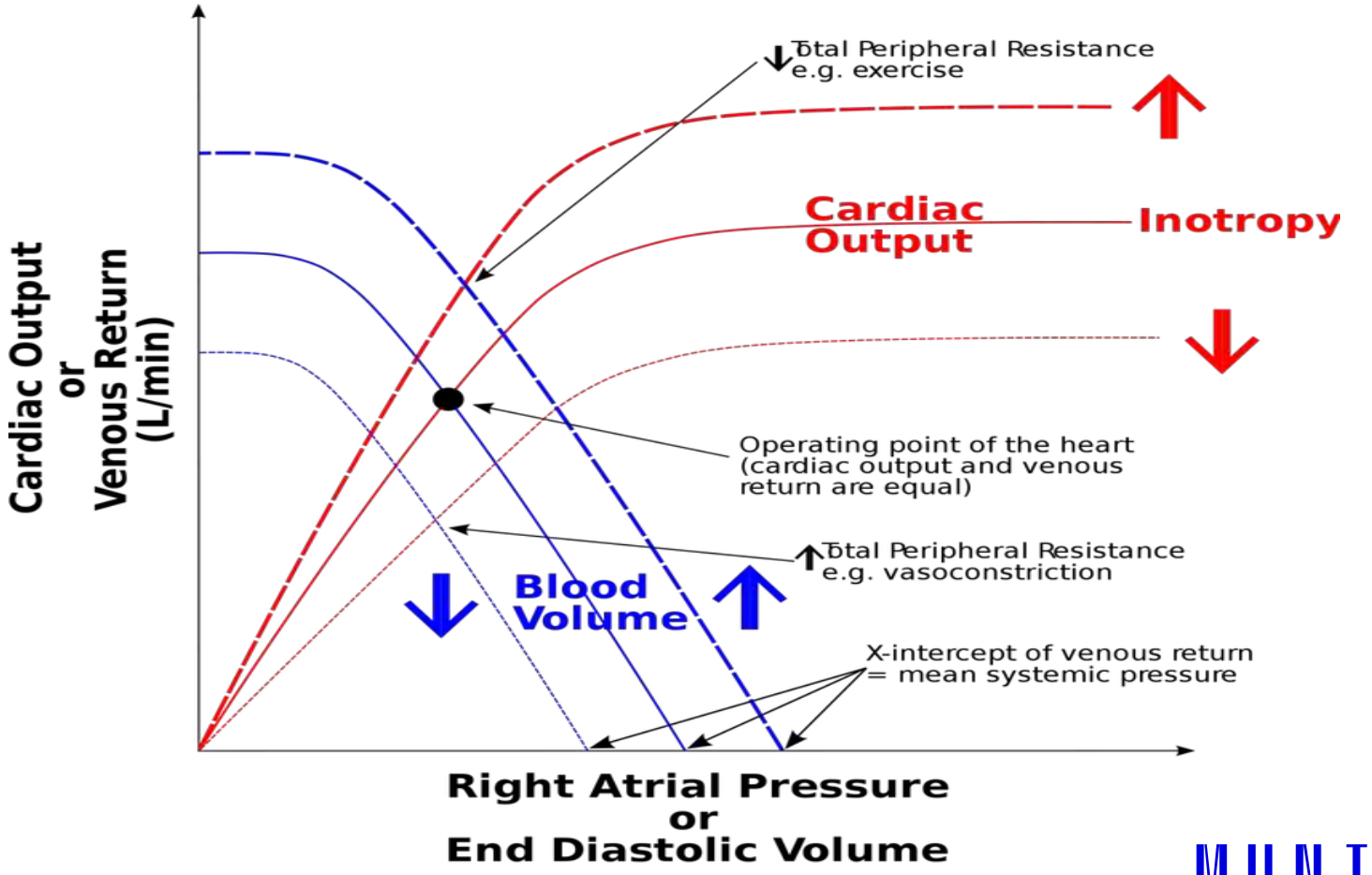
Diagnostics

- Patient history
- Clinical examination
- Labs (signs of dehydration, anemia…)
- ECG (dif. dg.), Chest X ray (dif. dg.), ECHO (signs of hypovolemia, dif. dg.), USG (bleeding, dif. dg.)
- Parameters of invasive monitoration – PPV, SPV, etc…



https://commons.wikimedia.org/wiki/File:Pulse_pressure_variation.jpg

MAP = CO x SVR



https://en.wikipedia.org/wiki/Frank%E2%80%93Starling_law

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2. Cardiogenic shock

(ACS, arrhytmia, myocarditis)

ACS - myocardial ischemia

Causes

1. Increased demand – tachycardia
2. Low oxygen content – anemia, CO poisoning, hypotension, pulmonary disease
3. Low coronary artery blood flow

- 90 % low coronary artery flow – coronary atherosclerosis
- Transmural ischemia – 3/4 of the myocardial wall (complete closure)
- Laminar/subendomyocardial – 1/3 of the myocardial wall (partial closure + increased demand)

Diagnostics

1. Patinet history/clinical evaluation
2. ECG a Lab
3. ECHO, SCG

	STEMI	NSTEMI	AP
History	Chest pain	Chest pain	Chest pain
ECG	ST elevation at least 2 mm in leads V1–V3 or at least 1 mm in V4–V6, I, aVL, II, III, aVF. ST elevation in at least two adjacent leads. New LBBB or (RBBB + LAH, RBBB + LPH).	ST depression at least 1 mm and /or T wave inversion	ST depression at least 1 mm and /or T wave inversion
Lab	Positive TNT	Positive TNT	Negative TNT

https://www.wikiskripta.eu/w/Infarkt_myokardu

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3. Obstructive shock

(e.g. pulmonary embolism, pericardial tamponade, tension pneumothorax)

Pulmonary Embolism

- Sudden obstruction of pulmonary vasculature with emboli (blood clot, fat, tumor, air/gas, foreign body, ...)

Etiology:

- 85% low extremity/pelvic DVT

Diagnosis

History

- Sudden dyspnea, chest pain, tachypnea, cough, syncope, hemoptysis (late)

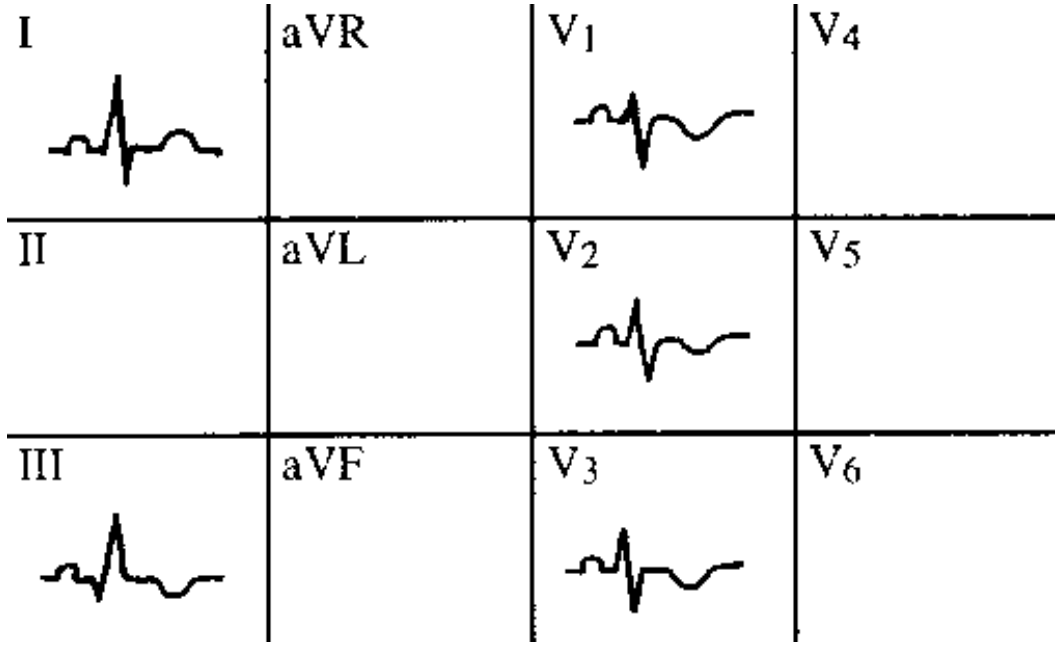
Clinical evaluation

- tachypnea, cyanosis, hypotension, tachycardia, neck veins distension

Lab

- ABG: hypoxemia, $PaCO_2$ – $ETCO_2$ gap
- DD: negative – practically excludes PE
- DD: positive – tumors, inflammation, post-surgery, sepsis ...

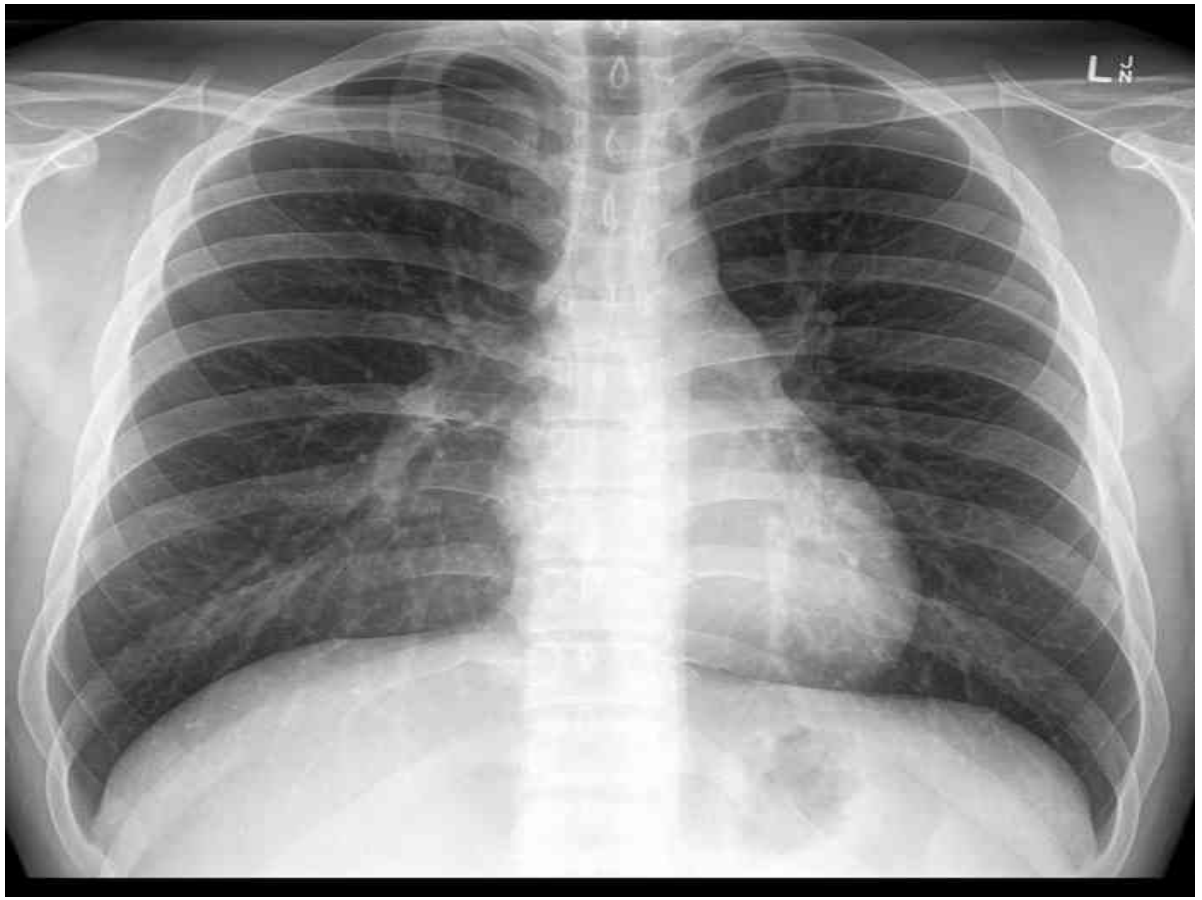
ECG



- In 30% of cases
- P pulmonale
- SI,Q3,T3
- neg T V1-V3, afib, tachycardia, RBBB

https://www.priznaky-projevy.cz/interna/kardiologie-srdce-cevy/208-cor-pulmonale-priznaky-projevy-symptomy

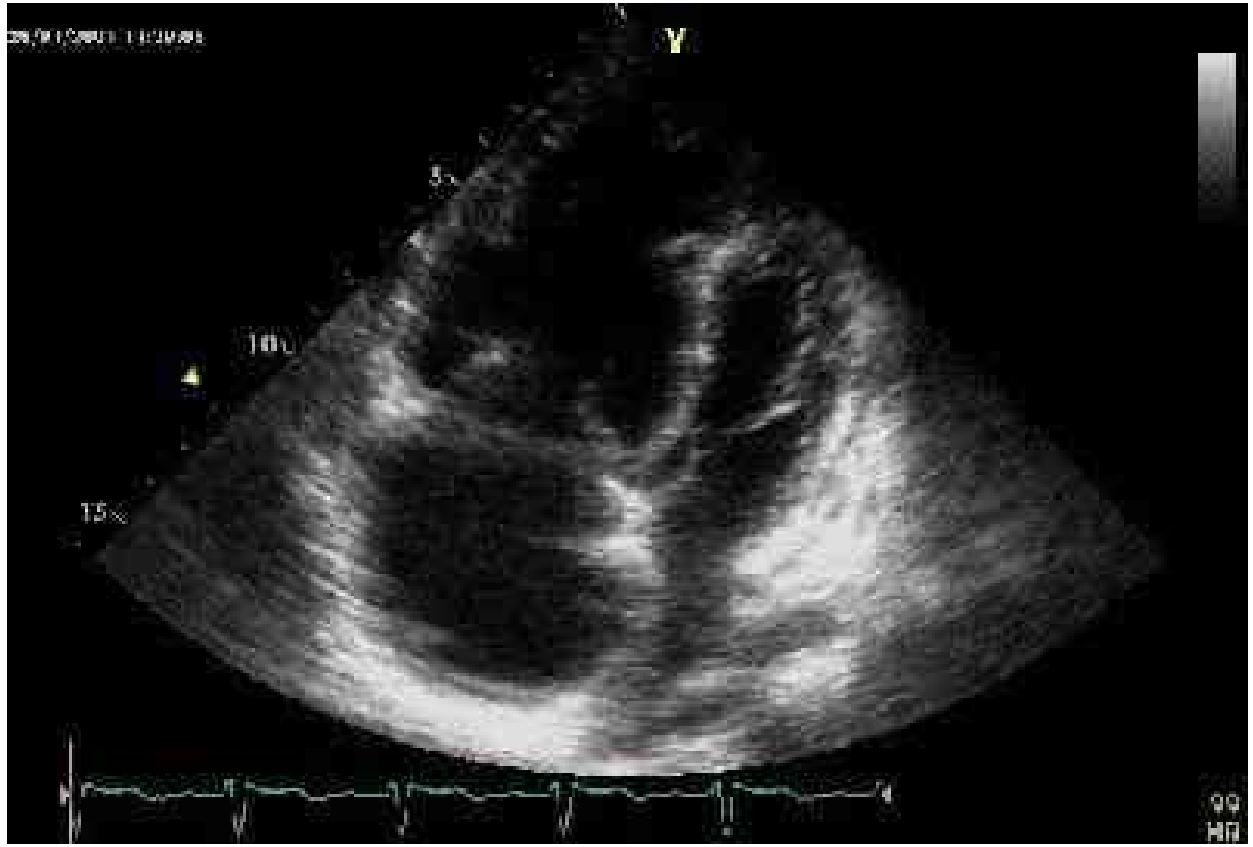
Chest X-ray



https://journals.viamedica.pl/advances_in_respiratory_medicine/article/view/PiAP.2014.0031/31908

Excludes other reasons for dyspnea
Fleischman sign - atelectasis
Westerman sign – decreased pulmonary vascularization

ECHO



https://www.kardiochirurgie.cz/ph-soucasny-stav?confirm_rules=1

- RV dilatation, paradoxical septum movements, pulmonary hypertension, Tri regurgitation

CT - AG

https://www.siemens-healthineers.com/cz/news/mso-pe-in-pregnant-women.html

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4. Distributive shock

(e.g. septic shock, anaphylactic shock, neurogenic shock, …)

Septic shock

Sepsis

- formerly SIRS (fever, leukocytosis, tachycardia, tachypnea) + infection
- New definition: organ dysfunction caused by dysregulation of immune response to an infection

Septic shock

- sepsis + circulatory/metabolic dysfunction (higher mortality)

Screening

Easy and simple … **qSOFA**

Signs of infection + at least two of the following:

1. Breathing frequency ≥ 22/min
2. Systolic blood pressure ≤ 100 mmHg
3. GCS ≤ 14

Others

- Anaphylaxis – immune mediated release of vasodilatory substances
- Anaphylactoid reaction – non-immune mediated release of vasodilatory substances
- Neurogenous – spinal cord lesion – impaired sympathetic tone - vasodilatation

Take home message

- Shock is a circulatory failure
- It is a life threating condition
- It could be divided into four types: hypovolemic, cardiogenic, obstructive and distributive

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2021