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Acute Respiratory Distress Syndrome (ARDS)

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Intensive care- practice (aVLAM9X1c)

Learning outcomes

- Student learns ARDS causes and symptoms
- Student understands ARDS pathophysiology
- Student knows basics of ARDS treatment

ARDS definition

- syndrome caused by various diseases
- definition: acute diffuse inflammatory lung injury
- criteria:
  - acute = onset over 1 week or less
  - bilateral lung opacities
  - hypoxemia: PaO_2/FiO_2 (P/F) ratio < 300 mmHg (with PEEP/CPAP at least 5 cm H_20)
  - not explained by cardiac failure or fluid overload

paO_2 8.3 kPa; FiO_2 0.6
1 kPa = 7.5 mmHg
P/F = 8.3/0.6*7.5 = 104

severity	mild	moderate	severe
PaO_2/FiO_2 (mmHg)	200-300	100-200	< 100
mortality	27 %	32 %	45 %

Underlying causes of ARDS

- pneumonia (bacterial, viral, …)
- sepsis
- aspiration
- pancreatitis
- severe trauma (lung contusion, fat embolism)
- shock states
- transfusion-related lung injury (plasma), massive transfusions
- rare: inhalation injury, drugs (amiodarone), near drowning

Pathophysiology

- inflammatory lung injury → ↑ pulmonary capillary permeability
  - edema formation (interstitial, alveolar)
  - extravasation of neutrophils and macrophages → toxic mediators
  - loss of alveolar surfactant

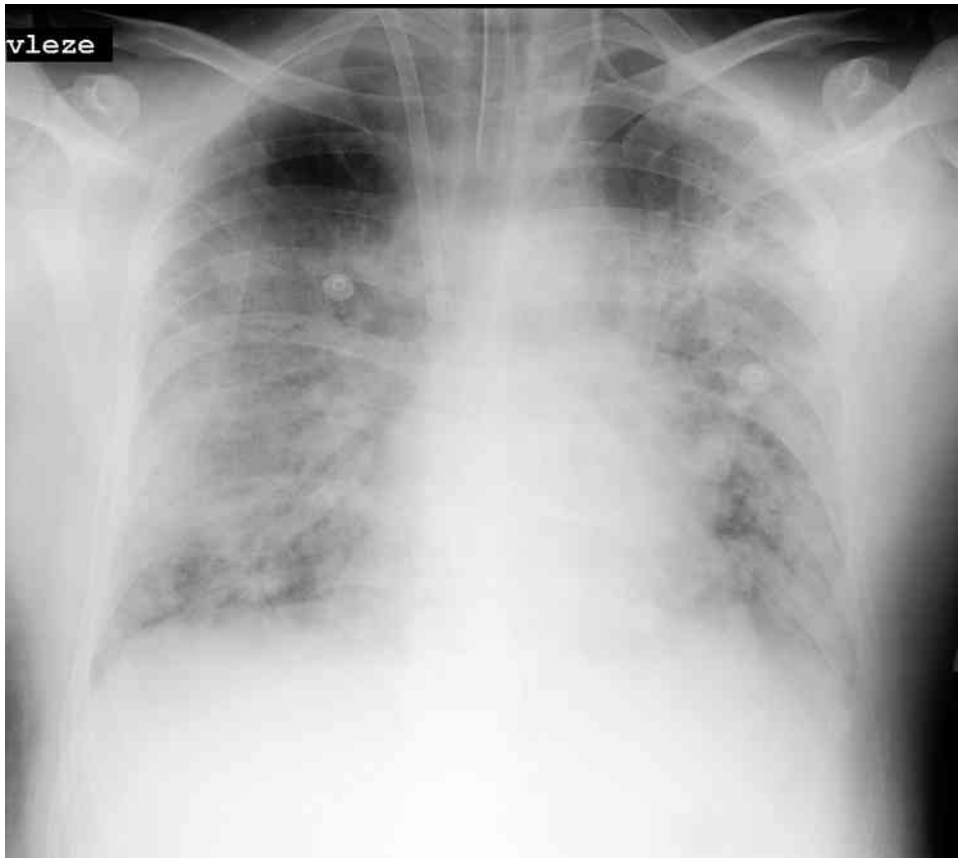
- consequences:
  - impaired diffusion (mainly O_2)
  - V/Q mismatch (R-L shunt)
  - alveolar collapse
  - pulmonary hypertension (25 %)

hypoxemia
↓ lung compliance
hypercapnia

Symptoms and diagnostics

- influence by underlying disease
- dyspnea, tachypnea, cyanosis
- auscultation: inspiratory crackles, bronchial breat sounds

- ABG: hypoxemia, initial hypocapnia, later hypercapnia
- Chest X-ray– difuse billateral lung consolidation



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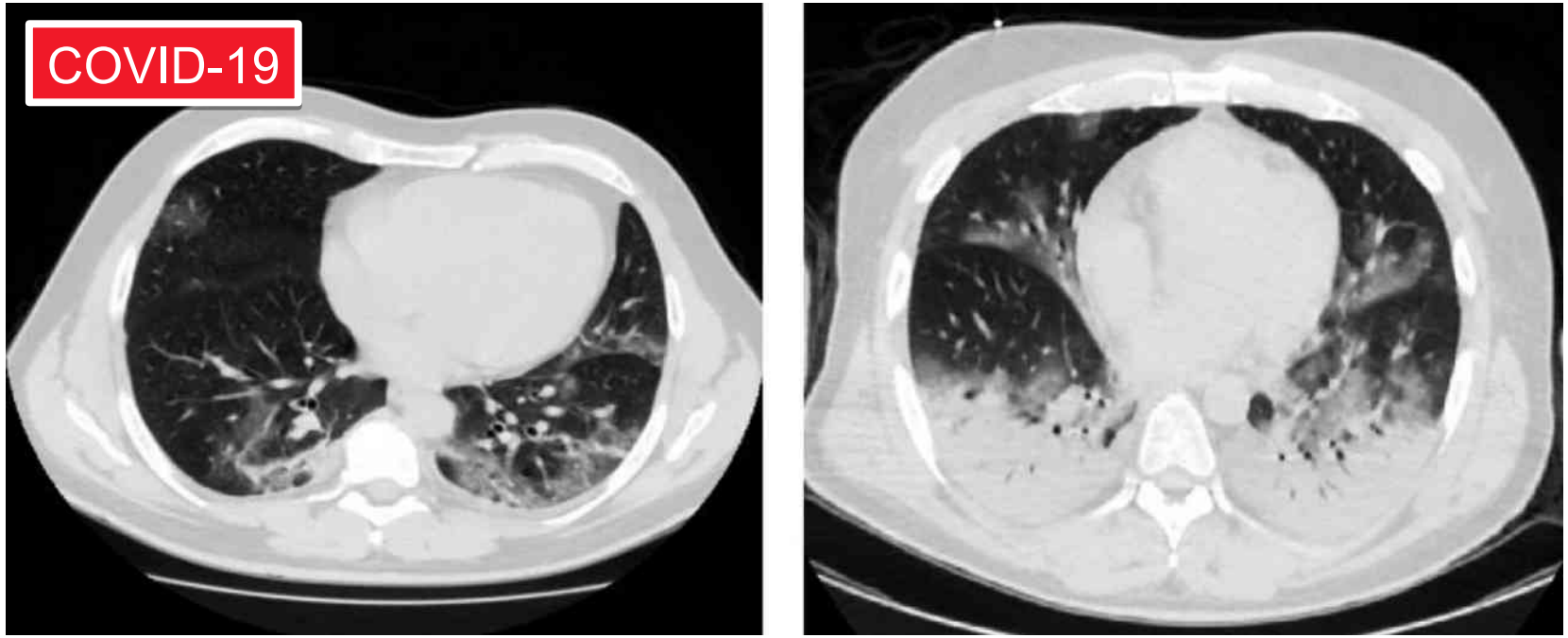
- Chest CT: lung consolidations mainly in dependent parts

(the lowest part of the lung in relation to gravity) Gattinoni L, Critical Care 24: 54 (2020)



- Echocardiography: exclusion of cardiac cause, right heart failure

Therapy

- management of hypoxemia
  - mild cases: oxygen, high-flow nasal oxygen
  - NIV – limited application
  - mechanical ventilation pro moderate/severe cases (on next slide)
- causal treatment:
  - antibiotic in case of bacterial pneumonia or sepsis, …
- restrictive fluid strategy
  - fluid overload worsens the function inflammatory lungs

Lung ventilation strategy for ARDS

aim: to provide acceptable blood gases while minimizing ventilator-induced lung injury *(lung protective ventilation)*

- the lowest FiO_2 to maintain SaO_2 88 – 95 %
- limit tidal volume to 6-8 ml/kg of ideal body weight
- higher PEEP to keep lungs aeriated (10 – 15 cm H_2O)
- keep driving pressure ≤ 15 cmH_2O (peak pressure ≤ 30 cmH_2O)
- tolerate hypercapnia – maintain pH > 7,20-7,25
  - increase respiratory rate, not tidal volume

Rescue measures

- deep sedation or muscle paralysis to avoid patient-ventilator dyssynchrony
- corticoids (methylprednisolone 1-2 mg/kg/day) – uncertain
  - severe COVID-19 cases: dexamethasone 6 mg/den
- prone position
  - mainly for severe cases with PaO_2/FiO_2 < 100 – 150 mmHg
  - improved distribution of ventilation and perfusion
  - ↓ lung compression by the heart
  - improved oxygenation in 2/3 of patients, ↓ mortality
- extracorporeal membrane oxygenation (ECMO)

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Take home message

- ARDS is a syndrome with different causes
- main symptom is hypoxemia
- secure acceptable blood gases while minimizing ventilator-induced lung injury (lung protective ventilation)
- treatment of the underlying cause is necessary

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