Acute Respiratory Failure

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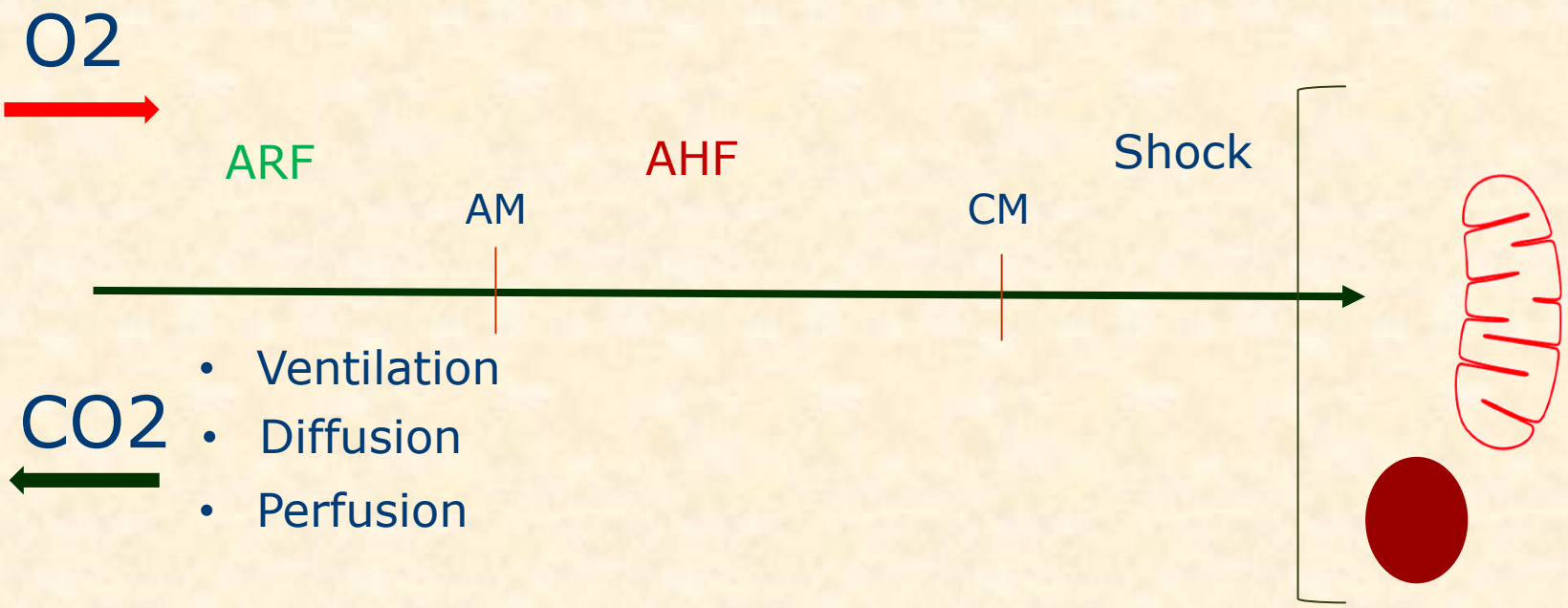
Oxygen Cascade:



$$DO_2 = CO * (1.34 * Hgb * SaO_2 + 0.0031 * PaO_2)$$

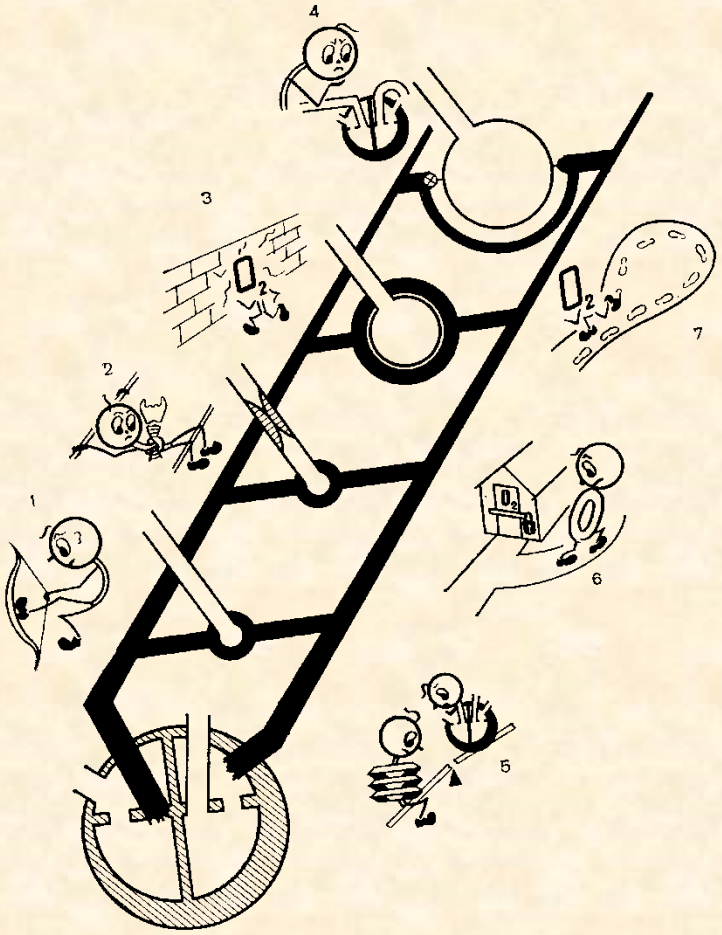
$$DO_2 = CO * 1.34 * Hgb * SaO_2$$

$$VO_2 = CO * 1.34 * Hgb * (SaO_2 - SvO_2)$$

Physiology of the Respiration
Non- respiratory functions of the lung

1. Blood filter
2. Participation to electolite & water balance
3. Production of protein & fat molecules (surfactant)
4. Participation in thermogenesis & thermolysis
5. Hemodynamic balance between “right” and “left” heart
6. Component of ABB
7. Control under various mediators (hormones, kinines, etc.)
8. Part of hemostasis and fibrinolitic systems
9. Part of the immune system

Physiology of the Respiration
Main physiologic mechanisms involved in Acute Respiratory Failure



1. Restrictive (decrease in the number of functional lung units)
2. Obstructive (disturbances of air passage to alveoli)
3. Impaired diffusion through ACM
4. Impaired perfusion
5. Ventilation-Perfusion mismatch
6. Alveolar shunting
7. “Dead Space”

Physiology of the Respiration

Some physiological values (normal range)

Rate	12-16 /min
Resp.min.volume(cm3/kg min)	70-130
Tidal volume (cm3/kg)	6-8
Vital capacity (cm3/kg)	60-70
PaO2 mm Hg	90-100
PvO2 mm Hg	37- 42
PaCO2 mm Hg	36 – 44
Vd/Vt	0.3 – 0.35
Qs/Qt %	less than 7

Alternative view on ARF classification:

- Hypercapnic RF: $PaCO_2 > 45$ mmHg
- Hypoxemic RF : $PaO_2 < 60$ mmHg / $FiO_2 = 0.21$ (21%)
- Combined

Respiratory Failure

Five types of hypoxia

1. **Respiratory (pulmonary)**
2. **Circulatory (impaired micro-circulation)**
3. **Hematic (impaired oxygen binding capacity of hemoglobin)**
4. **Tissue (inability of the cell enzymes to use oxygen – cyanic and CO)**
5. **Combined**

Management of Acute Respiratory Failure

I. Non-specific measures

A. Free Airway

B. Optimization of the inhaled gas blend

C. Artificial Ventilation

II. Specific measures

Airway desobstruction

I. Mechanical measures

a. Maneuvers

b. Devices

- supraglottic
- infraglottic

II. Pharmacological means

(bronchodilators, mucolytics, etc.)

Management of Acute Respiratory Failure

Oxygen Therapy

- Nasal cannula ~ $FiO_2 = 0.4$
- Simple mask ~ $FiO_2 = 0.5$
- Non-rebreathing mask ~ $FiO_2 = 0.7$
- Tracheal/ tracheostomic tube ~ $FiO_2 = 1.0$

Artificial Ventilation

I. Non-invasive vs Invasive

II. Assisted vs Controlled

III. Volume controlled vs Pressure controlled

IV. Modes: CPAP, SIMV, HFJV, etc.

Ventilatory Failure

Most common causes:

A). Pharmacological

1. Muscle relaxants (diaphragmatic paralysis)
2. Narcotics (direct respiratory depression)

B). Neuromuscular Diseases

C). Limitations to Diaphragmatic Excursion

1. Postoperative
2. Obesity
3. Intestinal obstruction
4. Supine position
5. Bandages or casts

D). Flail Chest (ribs fractured in two places)

E). Hydro/Hemo/Pneumo Thorax

F). Asthma

Respiratory Failure

The most common causes:

1. Pulmonary Edema
2. Atelectasis
3. Infection (pneumonia, especially massive)
4. Embolism
5. Aspiration
6. Pulmonary Contusion
7. Massive Hemoptysis
8. Pulmonary Burns
9. Interstitial Fibrosis

Management of Status Asthmaticus

1. Check air movement, cardiac status & oxygenation
2. R/o pulmonary embolus, pulmonary edema, pneumothorax, or mucous plugs
3. Nasal O2 early
4. Albuterol (or equivalent)
5. Epinephrine 0.3 ml (1:1000) SQ
6. Theophylline (500 mg/500 ml D5W or D5 ½ NS); Loading dose 6 mg/kg, then 0.9 mg/kg/min
7. Methylprednisolone 40-60 mg q6h/ Solucortef 100 –200 mg q4h
8. Monitor ABG's (watch for increase in pCO2)
9. D5 ½ NS with potassium supplementation for hydration
10. Pulmonary toilet

PULMONARY EDEMA

is increased extravascular lung water due to a rate of fluid and protein transport from the intravascular space that exeeds the normal clearance mechanisms of the interstitium

PULMONARY EDEMA

Symptoms:

- dyspnea
- orthopnea
- paroxysmal noctural dyspnea
- fatigue
- nausea
- cough
- agitation
- loss of consciousness

PULMONARY EDEMA

Signs:

- **rales**
- **tachypnea,**
- **cyanosis**
- **tachycardia**

Chest X ray reveal interstitial or alveolar pulmonary edema
ABG's – hypoxemia usually with a normal or low pCO_2

PULMONARY EDEMA

Management of Acute Pulmonary Edema

1. Assess vital signs rapidly: pulse, respiratory rate and BP. Perform a rapid physical examination looking for: cyanosis, status of pripheral perfusion, jugular venous distension, abnormal heart and lung sounds & peripheral pulses
2. Administer O2 either by mask or by endotracheal intubation
3. Obtain ABG's
4. Elevate head of the bed
5. Establish a reliable IV line and place foley catheter
6. Obtain: ECG, CXR, electrolites, blood sugar, BUN, creatinine, type blood and complete blood count
7. Establish continuous ECG monitoring, CVP, PCWP

Management of Acute Pulmonary Edema

8. Begin non-specific treatment:
   - Morphine Sulfate
   - Furosemide
   - Nitroglycerine/Nitroprusside
9. Specific underlying precipitating factors such as arrhythmias, fluid overload, extent of pre-existing CHF, or possible new myocardial infarction should be identified and treated appropriately.
10. If necessary, optimize preload afterload and contactility
11. If allergic pulmonary edema is being treated – Epinephrine + Corticosteroids
12. Once intubation has been required , use PEEP

Some practical recommendation for patients with COVID - 19

- Non-invasive ventilation as well as simple oxygen therapy is usually not effective and delay the tracheal intubation and the start of invasive ventilation
- For an ICU patient: SpO2 on oxygen therapy should be > 90%
  -> if less: prone position -> if SpO2 < 90 % -> intubate
- At least once in every two hours stop supplementary O2: if SpO2 drops lower than 80% -> intubate
- Even if SpO2 = 90-92%, but the RR > 26 /min, the patent experience shortness of breath, become agitated or somnolent -> intubate
- ECMO -> if PaO2/FiO2 < 80
- Early tracheostomy for patients on artificial ventilation
- Intubation better to be performed by the most skilled doctor without preoxigenation and do not use Ambo bags, respect protective principles

TO THINK ABOUT:

https://link.springer.com/article/10.1007/s11239-020-02208-2?fbclid=IwAR0zG9j5WUlG8RfDd-r2U0yU2FdksXuj7amxJro9jkkAUQzT2ZxwbrQEu-g

Relation between PaO2 and SaO2