

# Respiratory Failure (RF)

- Definitions

Clinical conditions in which

- $\text{PaO}_2 < 60 \text{ mmHg}$  while breathing room air

or

a  $\text{PaCO}_2 > 50 \text{ mmHg}$

I e Failure of oxygenation and carbon dioxide elimination

- Type 1 or 2

# Arterial Blood Gases (ABG)

## Normal values at sea level

- pH            7.35-7.45
  - PaO<sub>2</sub>        >70 mmHg
  - PaCO<sub>2</sub>      35-45 mmHg
  - HCO<sub>3</sub>        22-28 mmol/l
- ↓pH            Acidosis
  - ↑pH            Alkalosis
  - ↓ PaO<sub>2</sub>        Hypoxemia
  - ↑PaCO<sub>2</sub>      Hypercapnia
  - ↓pH+ ↑PaCO<sub>2</sub> Resp acidosis
    - ▣ ↑HCO<sub>3</sub>

# Classification of resp failure:

## ▣ Type 1

- ▣ Hypoxemic RF \*\*
- ▣ PaO<sub>2</sub> < 60 mmHg with normal or ↓ PaCO<sub>2</sub>
- ▣ Associated with acute diseases of the lung
- ▣ Pulmonary edema (Cardiogenic, noncardiogenic (ARDS), pneumonia, pulmonary hemorrhage, and collapse)

## ▣ Type 2

- ▣ Hypercapnic RF
- ▣ PaCO<sub>2</sub> > 50 mmHg
- ▣ Hypoxemia is common
- ▣ Drug overdose, neuromuscular disease, chest wall deformity, COPD, and severe Bronchial asthma

# Distinction between Acute and Chronic RF

## □ Acute RF

- Develops over minutes to hours
- ↓ pH quickly to  $<7.2$
- Example; Pneumonia

## □ Chronic RF

- Develops over days
- ↑ in  $\text{HCO}_3$
- ↓ pH slightly
- Polycythemia, Corpulmonale
- Example; COPD

# Causes of Respiratory Failure

## Failure to Ventilate

### Neurological

- Respiratory Center**  
Opioids, Anesthetics, Brain Injuries
- Cervical Nerves C3,4,5**  
Spinal Injuries
- Phrenic Nerves**  
Chest trauma, Surgery
- Neuromuscular Junction**  
Neuromuscular Blockers  
Myasthenia Gravis

### Muscular

- Myopathy**  
Steroids  
Myasthenia Gravis  
Polyneuropathy/Polymyopathy of Critical Illness
- Diaphragm**
- Intercostals**

### Failure to Maintain Airway

#### Failure of Gas Flow:

##### Airway Obstruction

- Upper: teeth, tongue
- Glottic:
  - laryngeal edema
  - laryngospasm
- Lower: bronchospasm
- Inhaled objects

##### Chest Wall

Flail Chest

##### Pleural Cavity

- Pneumothorax
- Hemothorax
- Pleural Effusion

##### Abdominal Compression

- Ascites/Hemoperitoneum
- Surgical Packs etc

## Failure to Oxygenate



# Pathophysiologic causes of Acute RF

---

- Hypoventilation
- V/P mismatch
- pulmonary shunt
- Diffusion abnormality

# Pathophysiologic causes of Acute RF

## 1 - Hypoventilation

- Occurs when ventilation ↓ 4-6 l/min
- Causes :
  - ▣ Depression of CNS from drugs.
  - ▣ Neuromuscular disease of respiratory ms.

# Pathophysiologic causes of Acute RF

---

- Hypoventilation
- V/P mismatch
- Shunt
- Diffusion abnormality



# Pathophysiologic causes of Acute RF

## 2 -V/Q mismatch

- Most common cause of hypoxemia
- Low V/Q ratio, may occur either from
  - ▣ Decrease of ventilation 2ry to airway or interstitial lung disease

# Pathophysiologic causes of Acute RF

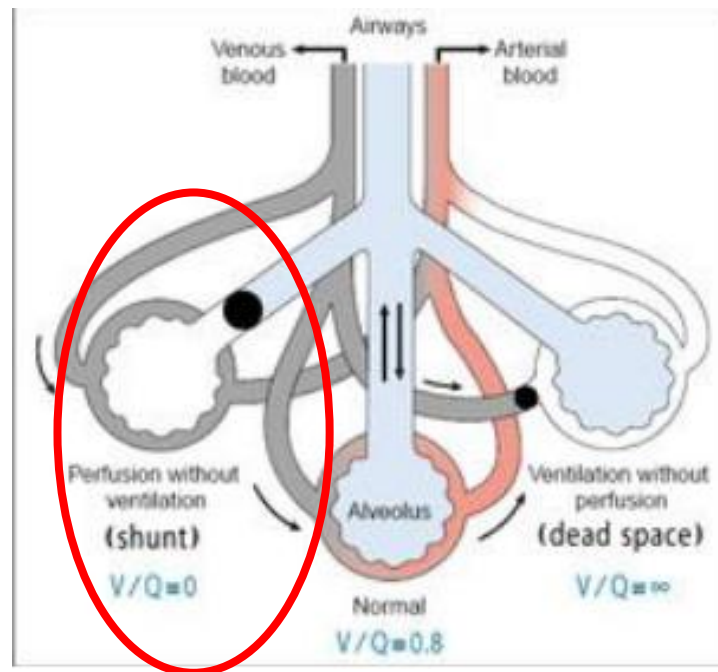
---

- Hypoventilation
- V/P mismatch
- Shunt
- Diffusion abnormality

# Pathophysiologic causes of Acute RF

## 3 -Shunt

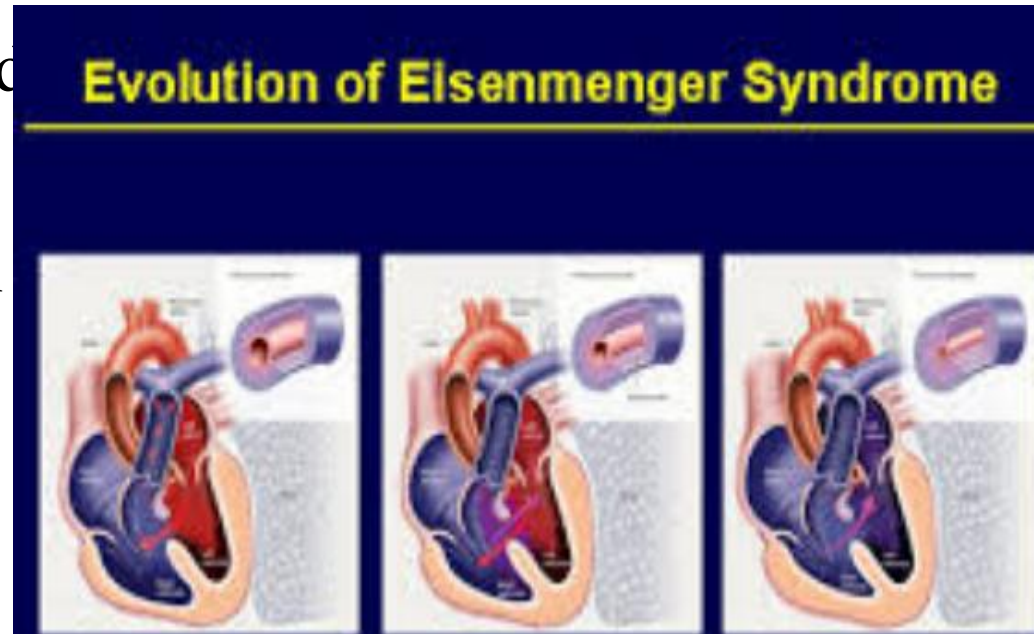
- The deoxygenated blood bypasses the ventilated alveoli and mixes with oxygenated blood → hypoxemia
- Persistent of hypoxemia despite 100% O<sub>2</sub> inhalation



# Pathophysiologic causes of Acute RF

## Causes of Shunt

- Intracardiac
  - ▣ Right to left shunt
    - Eisenmenger's syndrome
- Pulmonary
  - ▣ Pulmonary contusion



# Pathophysiologic causes of Acute RF

---

- Hypoventilation
- V/P mismatch
- Shunt
- Diffusion abnormality

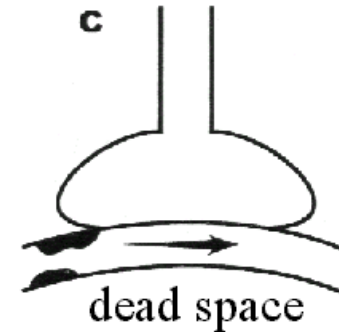
# Pathophysiologic causes of Acute RF

## Diffusion abnormality

- Due to
  - ▣ abnormality of the alveolar membrane
- Causes
  - ▣ ARDS
  - ▣ Fibrotic lung disease

# Increased Dead Space (wasted ventilation)

- Hypovolemia
- Low cardiac output
- Pulmonary embolus



# Causes of Respiratory Failure

## Failure to Ventilate

### Neurological

- Respiratory Center**  
Opioids, Anesthetics, Brain Injuries
- Cervical Nerves C3,4,5**  
Spinal Injuries
- Phrenic Nerves**  
Chest trauma, Surgery
- Neuromuscular Junction**  
Neuromuscular Blockers  
Myasthenia Gravis

### Muscular

- Mypoathy** Diaphragm  
Steroids  
Myasthenia Gravis  
Polyneuropathy/Polymyopathy  
of Critical Illness
- Intercostals

## Failure to Maintain Airway

### Failure of Gas Flow:

#### Airway Obstruction

- Upper: teeth, tongue
- Glottic:  
laryngeal edema  
laryngospasm
- Lower: bronchospasm  
Inhaled objects

#### Chest Wall

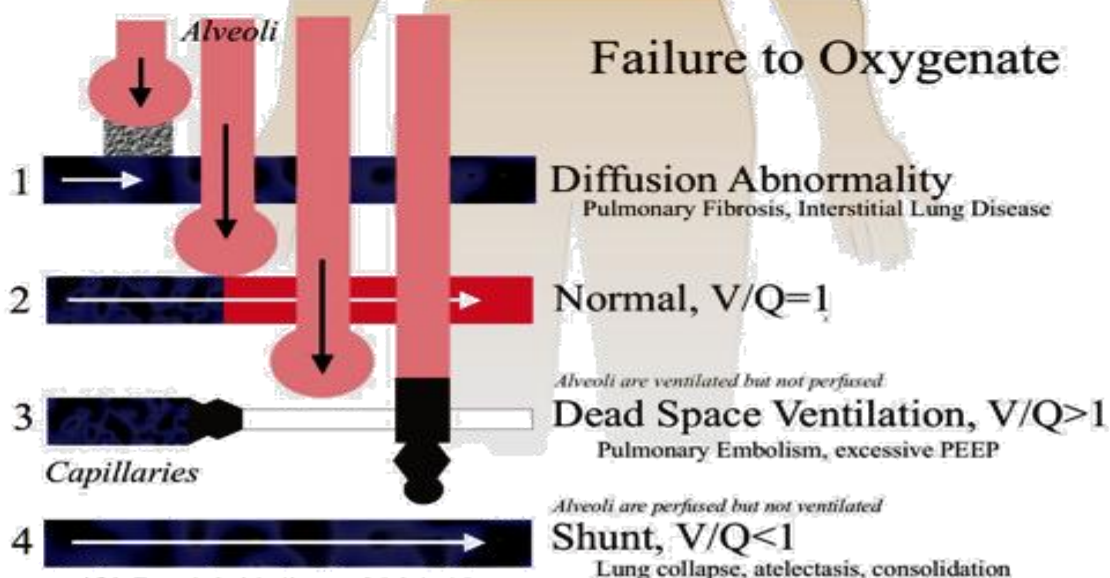
Flail Chest

#### Pleural Cavity

- Pneumothorax
- Hemothorax
- Pleural Effusion

#### Abdominal Compression

- Ascites/Hemoperitoneum
- Surgical Packs etc





# Manifestations of Respiratory Distress

- Altered mental status – especially anxiety!!!

Anxiety is a result of respiratory distress, almost NEVER the cause.

- Tachypnea, nasal flaring
- Accessory muscle use, retractions, paradoxical breathing pattern, respiratory alternans
- Increased work of breathing
- Catecholamine release
- Tachycardia, diaphoresis, hypertension
- Abnormal ABG .
- Neuromuscular failure **is different** from above – monitor vital capacity – intubate near 15cc/kg

# Diagnosis of RF

## 1 – Clinical (symptoms, signs)

- **Hypoxemia**
- Dyspnea, Cyanosis
- Confusion, somnolence, fits
- Tachycardia, arrhythmia
- Tachypnea .
- Use of accessory ms
- Nasal flaring
- Recession of intercostal ms
- Polycythemia
- Pulmonary HTN,  
Corpulmonale, Rt. HF
- **Hypercapnia**
- ↑Cerebral blood flow, and  
CSF Pressure
- Headache
- Asterixis
- Papilloedema
- Warm extremities,  
collapsing pulse
- Acidosis (respiratory)
- ↓pH.

# Diagnosis of RF

## 3 - Investigations

- ABG
- CBC, Hb
  - Polycythemia
  - Urea, Creatinine
- LFT → tissue hypoxemia
- Electrolytes (K, Mg) → Aggravate Resp F
- ↑ CPK, ↑ Troponin 1 → MI
- ↑CPK, normal Troponin 1 → Muscle dis myositis
- TSH → Hypothyroidism

# Diagnosis of Resp F

## 3 - Investigations

- Chest x ray
  - Pulmonary edema
  - ARDS
- Echocardiography
  - Cardiogenic pulmonary edema
  - ARDS
  - PAP, Rt ventricular hypertrophy
- PFT- (FEV1/ FVC ratio)
  - Decrease → Airflow obstruction
  - Increase → Restrictive lung disease

# Diagnosis of RF

## 3 - Investigations

- ECG
  - cardiac cause of RF
  - Arrhythmia due to hypoxemia and severe acidosis
  
- Pulmonary capillary wedge pressure (PCWP)
  - Normal → ARDS (<18 mmHg)
  - Increased → Cardiogenic pulmonary edema

# Management of ARF

- ICU admission
- 1 -Airway management
  - ▣ Endotracheal intubation:
    - Indications
      - Severe Hypoxemia
      - Altered mental status
  - ▣ Importance
    - precise O<sub>2</sub> delivery to the lungs
    - remove secretion
    - ensures adequate ventilation

# Management of ARF

- - Noninvasive Ventilatory support (IPPV)
- Mild to moderate RF
- Patient should have
  - ▣ Intact airway,
  - ▣ Alert, normal airway protective reflexes
- Nasal or full face mask
  - ▣ Improve oxygenation,
  - ▣ Reduce work of breathing
  - ▣ Increase cardiac output
- AECOPD, asthma, CHF

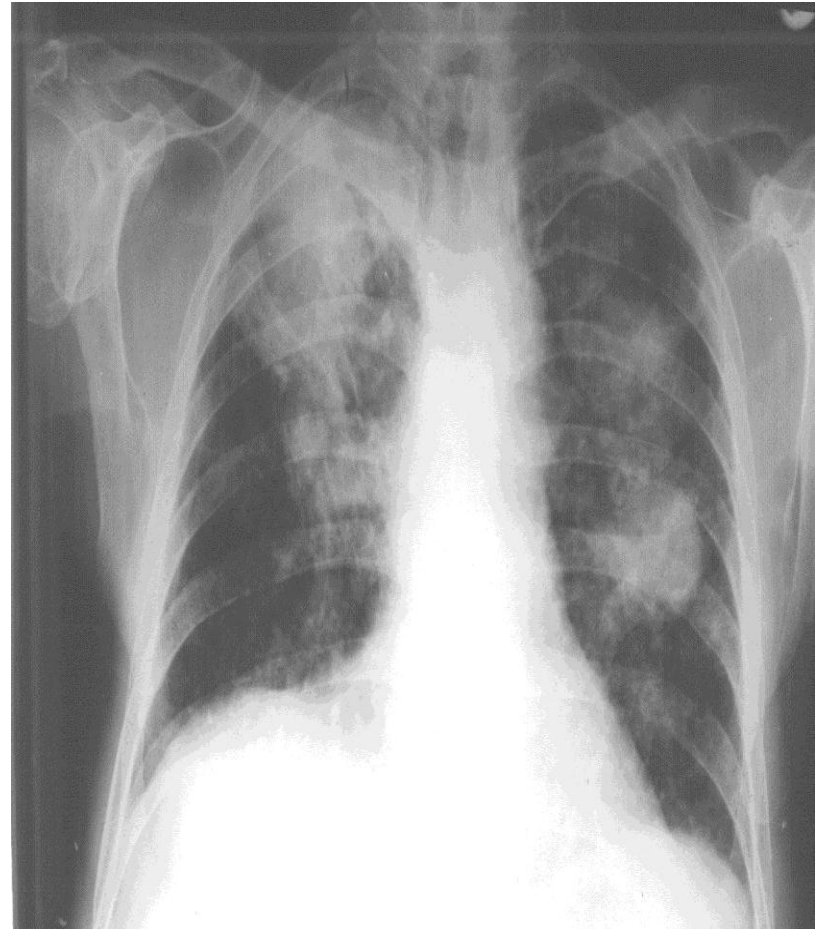






# Management of ARF

- - Treatment of the underlying causes
- After correction of hypoxemia, hemodynamic stability
- Antibiotics
  - ▣ Pneumonia
  - ▣ Infection
- Bronchodilators (COPD, BA)
  - ▣ Salbutamol
    - reduce bronchospasm
    - airway resistance



# Management of ARF

- - Treatment of the underlying causes
- Anticholinergics (COPD,BA)
- Diuretics (pulmonary edema)
  - ▣ Frusemide,

# Management of ARF

- Treatment of the underlying causes
- Methyl prednisone (COPD, BA)
- Fluids and electrolytes
  - ▣ Maintain fluid balance and avoid fluid overload
- IV nutritional support
  - ▣ To restore strength, loss of ms mass
  - ▣ Fat, carbohydrate, protein

# Management of ARF



- Treatment of the underlying causes
- Physiotherapy
  - ▣ Chest percussion to loosen secretion
  - ▣ Suction of airways
  - ▣ Help to drain secretion
  - ▣ Maintain alveolar inflation
  - ▣ Prevent atelectasis, help lung expansion



# Indications for Endotracheal Intubation

- Airway protection (outside ICU?)
- Relief of airway obstruction
- Respiratory failure or impending respiratory failure .
- Need for hyperventilation – increase ICP
- Unsustainable work of breathing
- Facilitate suctioning/pulmonary toilet
- Shock .

# Decision to intubate

- Clinical decision-not based on ABG
- Error on the side of patient safety

Think ahead- if need to intubation is expected in next 24hr, intubate now

- Endotracheal tubes are not a disease and ventilators are not an addiction i.e. Intubation does not cause ventilator dependence

# Continuous Positive Airway Pressure (CPAP)

- No machine breaths delivered
- Allows spontaneous breathing at elevated baseline pressure
- Patient controls rate and tidal volume

# Assist-Control Ventilation

---

- You set tidal volume and minimum rate
- Additional breaths delivered with minimal inspiratory effort - pt sets actual rate
- Advantages: reduced work of breathing;



# Synchronized Intermittent Mandatory Ventilation (SIMV)


---

- Volume cycled breaths at a preset rate

# Pressure-Support Ventilation

---

- Pressure assist during spontaneous inspiration with flow-cycled breath

- 
- Weaning from mechanical ventilation
    - ▣ Stable underlying respiratory status
    - ▣ Adequate oxygenation
    - ▣ Intact respiratory drive
    - ▣ Stable cardiovascular status
    - ▣ Patient is a wake, has good nutrition, able to cough and breath deeply

# Complications of Acute resp F

- **Pulmonary**
  - Pulmonary embolism
  - barotrauma
  - pulmonary fibrosis (ARDS)
  - Nosocomial pneumonia
- **Cardiovascular**
  - Hypotension, ↓COP
  - Arrhythmia
  - MI.
- **GIT**
  - Stress ulcer.
- **Infections**
  - Nosocomial infection
  - Pneumonia, UTI, catheter related sepsis
- **Renal**
  - ARF (hypoperfusion, nephrotoxic drugs)
  - Poor prognosis
- **Nutritional**
  - Malnutrition, hypoglycemia, electrolyte disturbances



- Thank u