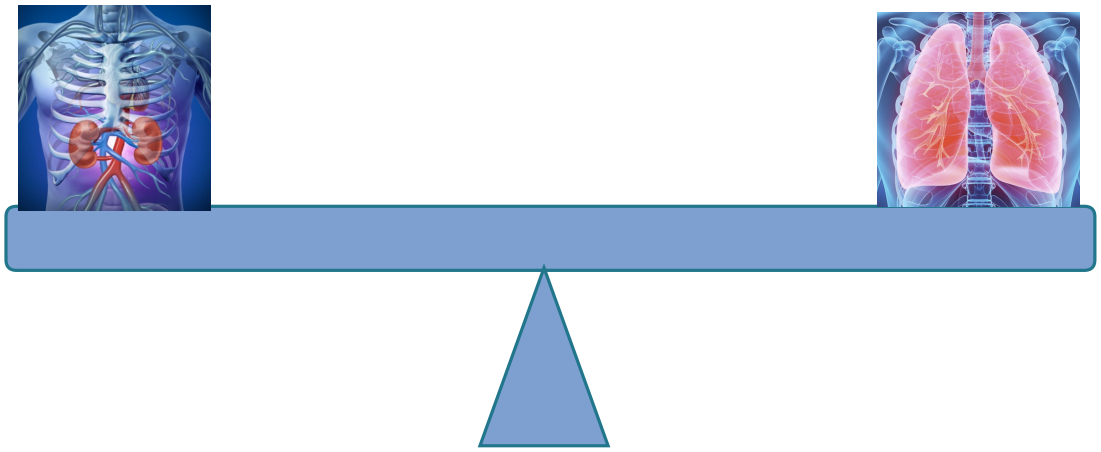
دانشگاه علوم پزشکی و خدمات بهداشتی، درمانی ایران

BLOOD GAS IN RESPIRATORY DISORDERS

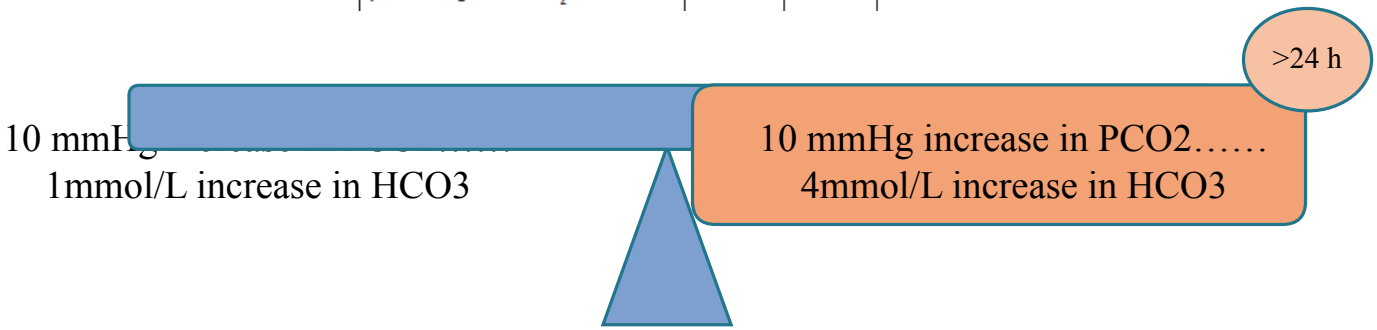
Dr.Hale Afshar. Pulmonologist. Assistant Professor of IUMS.

RESPIRATORY ACIDOSIS

- Primary respiratory disturbances (primary changes in Paco2)invoke compensatory metabolic responses (secondary changes in[HCO3−]).



DISORDER	PREDICTION OF COMPENSATION	RANGE OF VALUES		
		pH	HCO_3^-	$Paco_2$
Respiratory acidosis		Low	High	High
Acute	$[HCO_3^-]$ will ↑ 0.1 mmol/L per mmHg ↑ in $Paco_2$			
Chronic	$[HCO_3^-]$ will ↑ 0.4 mmol/L per mmHg ↑ in $Paco_2$			

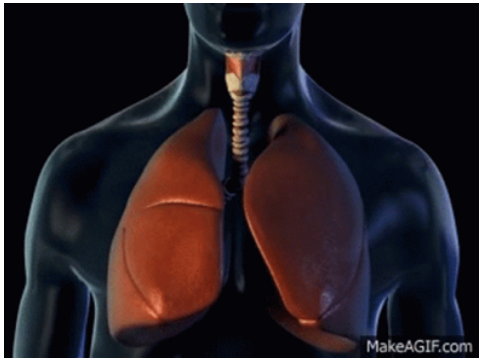


Causes:

- Any process interfering with ventilation can lead to respiratory acidosis.

CNS

NMJ Disorders



Airway disorders

Severe parenchymal disorders

Chest wall disorders

Table 12.5 Causes of Respiratory Disorders

RESPIRATORY ACIDOSIS

Central Nervous System Depression

Drugs: opiates, sedatives, anesthetics
Excessive administration of oxygen in COPD
Obesity-hypoventilation syndrome
Central nervous system disorders

Neuromuscular Disorders

Neurologic: multiple sclerosis, poliomyelitis, phrenic nerve injuries, high spinal cord lesions, Guillain-Barré syndrome, botulism, tetanus, amyotrophic
End plate cinylcholine chloride, curare, amin rus
Muscl temia, muscular dystrophy, polio

Airway

COPD
Acute aspiration,

Chest Wall Restriction

Pleural: effusions, empyema, pneumothorax, fibrothorax
Chest wall: kyphoscoliosis, scleroderma, ankylosing spondylitis, extreme obesity

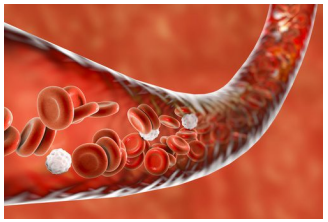
Severe Pulmonary Restrictive Disorders

Pulmonary fibrosis
Parenchymal infiltration: pneumonia, edema

Abnormalities in Blood Carbon Dioxide Transport

Decreased perfusion: heart failure, cardiac arrest with cardiopulmonary resuscitation, extensive pulmonary embolism, severe anemia
Carbonic anhydrase inhibition—high-dose acetazolamide

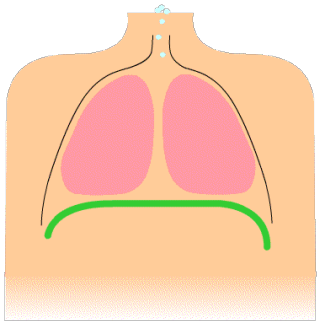
Clinical features:



- Elevations in Pco2 cause **systemic vasodilation** that is particularly evident in the cerebral circulation.
- Increase of cerebral blood flow……. increase intracerebral pressures……..may lead to a picture of pseudotumor cerebri (papilledema, retinal venous distention, and retinal hemorrhages)
- Dyspnea
- Myoclonic jerks, asterixis, tremor, restlessness and confusion.
- Coma may be observed at Pco2 values of 70 to 100 mm Hg (abrupt onset) Significantly higher levels may be well tolerated in patients with chronic onset.

- Peripheral vasodilation and increased cardiac output promote warm, flushed skin and a bounding pulse.
- Arrhythmias
- Reduced cardiac contractility (especially in the presence of β-adrenergic blocking therapy)
- Pulmonary arterial vasoconstriction (possible worsening of right heart failure)

Treatment:



Restoration of “Adequate ventilation”

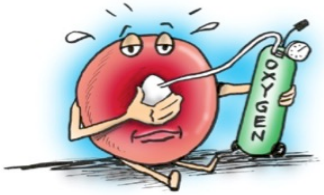
- Treatment of underlying disorder.
- Usage of antidotes for drug toxicities.
- Bronchodilators, antibiotics, steroids, chest physiotherapy.
- Aminophylline ??
- NIV (BIPAP/CPAP) vs IV(mechanical ventilation)
- Bicarbonate is generally contraindicated because it tends to decrease respiratory drive and increases CO2 levels in the tissues.

- Progesterone
- Acetazolamide

Some golden points about treatment:

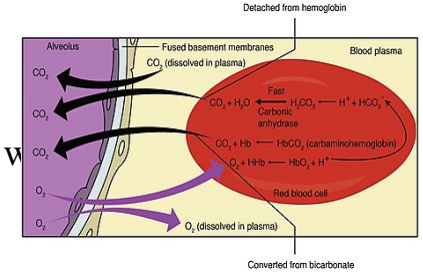
- <u>If hypoxemia is present, Oxygen administration should be titrated carefully. Especially in patients with chronic hypercapnia.</u>
- Low-flow oxygen generally suffices to increase Po2 to satisfactory levels (60 mm Hg and SO2 approximately 90%); greater elevations are neither needed nor advisable.

- Care must be taken that Pco2 is not decrease[d] [more than] 10 mm Hg/h to avoid life-threatening metabolic alkalosis. In add[ition], [a] rapid fall of Paco2 may provoke the same complications note[d] [in] [respi]ratory alkalosis (i.e., cardiac arrhythmias, reduced cerebral perfu[sion]s).



- Oxygen-induced hypercapnia:

- (1) by relief of hypoxic pulmonary vasoconstriction in poorly ventilated lung regions that further reduces the ability of the lung to eliminate CO2 because local perfusion to poorly ventilated regions increases.



- (2) by saturation of hemoglobin with oxygen that causes previously buffered protons on deoxyhemoglobin to be released w generation of new CO2 from $HCO3^-$ stores t).

- (3) by depression of the hypoxia-driven p eceptor drive that causes more hypoventilation.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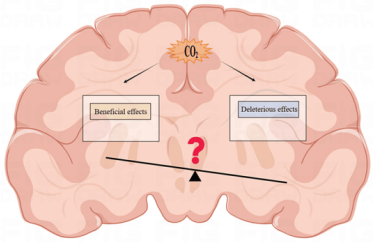
“Permissive hypercapnia”



- Lung-protective ventilation: “low Vt” ± low RR
- Reduce peak and plateau pressure
- Reduce the risk of barotrauma

- ARDS/ Airway diseases (COPD/Asthma)/ Thoracic surgery

- Allowing the CO2 to rise, up to more than 100 mm Hg.(Bicarbonate can be administered if the pH drops too low: PH< 7.2)
- It should be avoided in those with head trauma, increased intracerebral pressure, acute renal insufficiency, or cardiac dysfunction.

Base Excess(BE) / Base Deficit

- $HCO3^{-}$ is the most commonly used metabolic parameter in assessing acid/ base status.
- It underestimates the amount of acid (or base) that must be used to titrate samples of blood, plasma, or the body as a whole to a pH of 7.4.
- This reflects the presence of other buffer pairs that are titrated by the addition of strong acids and bases
- BE estimates how much strong acid or alkali must be added to titrate fully oxygenated blood to a pH of 7.4 at 37°C.
- -2 __ +2

RESPIRATORY ALKALOSIS

- Respiratory alkalosis is a common disorder, but it seldom has a significant impact on the clinical status of patients.

- Hypocapnia develops when a sufficiently strong ventilatory stimulus causes CO2 output in the lungs to exceed its metabolic production by tissues.

- $HCO3^{-}$ concentrations do not usually fall below 18 mEq/L acutely. A $HCO3^{-}$ concentration below 16 mEq/L should raise the possibility of an independent metabolic acidosis.

DISORDER	PREDICTION OF COMPENSATION	RANGE OF VALUES		
		pH	HCO_3^-	$Paco_2$
Respiratory alkalosis		High	Low	Low
Acute	$[HCO_3^-]$ will ↓ 0.2 mmol/L per mmHg ↓ in $Paco_2$			
Chronic	$[HCO_3^-]$ will ↓ 0.4 mmol/L per mmHg ↓ in $Paco_2$			

10 mmHg decrease in PCO2……
2mmol/L decrease in HCO3

>3-5 days

10 mmHg decrease in PCO2…..… 4-5 mmol/L decrease in HCO3

Causes :

RESPIRATORY ALKALOSIS

Central Nervous System Stimulation

Hyperventilation syndrome, anxiety
Pregnancy
Cerebrovascular disease, subarachnoid hemorrhage
Meningitis, encephalitis
Septicemia, hypotension
Hepatic failure
Drugs: salicylates, nicotine, xanthines, quetiapine, progestational hormones

Pulmonary Disease

Pneumonia, interstitial fibrosis, pulmonary fibrosis, embolism, edema
Right-to-left shunt

Hypoxia

High altitude
Severe anemia, hemoglobinopathy
Decreased cardiac output

Excess Carbon Dioxide Removal

Mechanical ventilation
Acetate hemodialysis, heart-lung machine, extracorporeal membrane oxygenation

Decreased Carbon Dioxide Production

Myxedema, hypothermia

- Sepsis: Respiratory alkalosis is often an early finding in gram-negative septicemia, before fever, hypoxemia, or hypotension develops.
- Drugs: Salicylates, Xanthins , Progesterone (5-10 mmHg)
- Chronic respiratory alkalosis is the most common acid-base disturbance in critically ill patients and, when severe, portends a poor prognosis.

Clinical features:

- Hypocapnic cerebral vasoconstriction leading to reduced blood flow and tissue hypoxia.

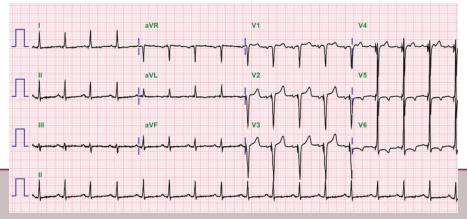
(Deliberate hyperventilation is used to reduce cerebral blood flow in states of impending brain herniation from high intracranial pressure; but just for a few hours)

- Panic, weakness, and a sense of impending doom, paresthesias and muscle weakness or cramping, impaired vision and speech, syncope.

- Trousseau and Chvostek signs can often be elicited, and overt tetany or seizu
ts with previous seizure diatheses.

(A fall in free serum Ca2+ due to increased calcium binding to serum proteins. P & K may also decline.)

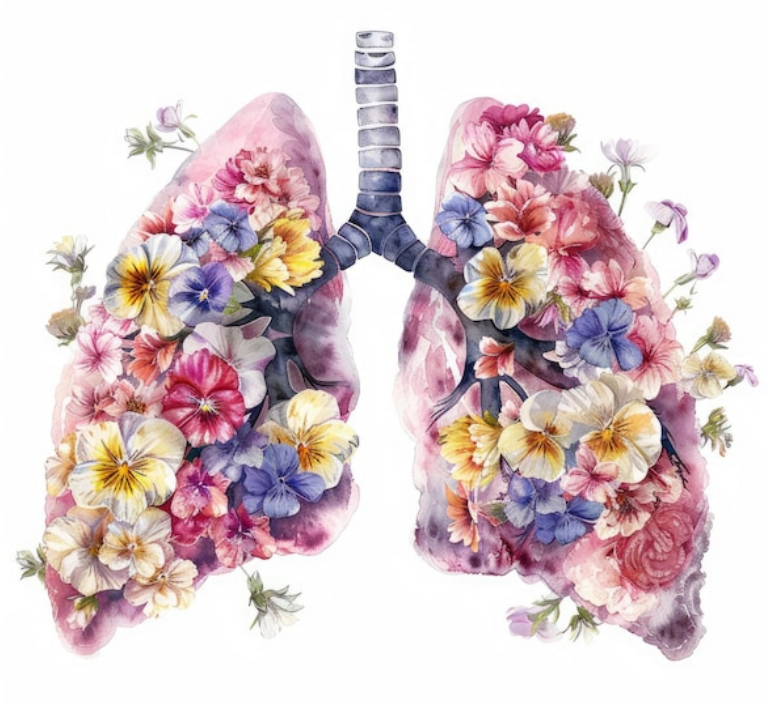
- Transient electrocardiographic changes can resemble those of myocardial ischemia; this finding can be particularly misleading because it is not uncommon for hyperventilating patients to complain of chest discomfort.
- Indeed, acute hypocapnia, for example with mechanical ventilation, can induce coronary artery vasospasm, angina, ominous cardiac arrhythmias, and ST elevations in patients with coronary artery disease.



Treatment:

- Alleviation of the underlying disorder.

- Reassurance and rebreathing in a small paper bag are frequently all that is needed to control hyperventilation associated with anxiety attacks.



Thank you for attention.