Acid-Base Balances

Introduction :

- Normal PH is : 7.35-7.45.
- Less than 7.35 is called Acidosis (May be metabolic or respiratory).
- More than 7.45 is called Alkalosis (May be metabolic or respiratory).

Metabolic Acidosis:

- Low PH and Low HCO3
- Occurs when PH is lower than 7.35.
- Vasodilation occurs (to remove protons) (Resistance ionotropic drugs).

Causes of metabolic acidosis:

***** High anion gap metabolic acidosis:***

1. Keto acidosis (DKA): prolonged period of starvation lead to lipolysis lead to beta oxidation of fat the end result will be ketone bodies.

- ❖Mitochondrial disorders (can't-metabolize glucose so can't get ATP)
- ❖Keto diet.
- ❖DM (lots of glucose but can't use it).

2. Lactic acidosis :

- ❖In malaria due anaerobic respiration——- glucose——— pyruvate——- lactate
- ❖Vigorous exercise

- MI
- Sepsis
- Reduced tissue perfusion
- Metformin (because it inhibits gluconeogenesis)
- Liver cirrhosis (lactate accumulate can’t make glucose)

3. Aspirin, methanol , ethylgycol.

***Normal anion gap :**

1. Proximal renal tubular acidosis (PRTA) (can't absorb bicarbonate)

Eg; 1- Wilson. 2- cystinosis. 3- Multiple myeloma.

2. Distal renal tubular acidosis (DRTA)

Eg, 1- SLE. 2- sjogren. 3- Amphotericin B (antifungal).

3. Carbonic anhydrase inhibitors (Acetazolamide).

4. GI loss (diarrhea , pancreatic fistula).

5. Addison (renal tubular acidosis type 4)

6. Spironolactone (causes hyperkalemia——- H follows k and sodium excretion).

Clinical features:

1) Acetone breath if Diabetic patient .
2) Hyperkalemia.
3) Hyperventilation (kussmal's breathing) deep breathing to wash out co2.

Lab investigation:

↓pH $\frac{\downarrow HCO_3 \ (24-28)}{\downarrow pCO_2 \ (35-45)}$ + measure anion gap

Treatment: treat the cause and avoid HCO3 (will lead to Respiratory Alk and Met Alk and acid)

Metabolic Alkalosis:

- Increase PH and Increase HCO3 if compensation started CO2 is also increase.
- Fixed by respiration (metabolic).

Causes:

1. Saline sensitive (dehydration patient) + low cl in urin :

- Vomiting
- NG tube
- Diuretics (all except acctazolamide (carbonic anhydrase inhibitor))
- Antacids
- ****** treated by saline.***

2.Saline resistant : (already have fluid expansion) + increase Cl

. Cushing syndrome (hyper aldosteronism) : patients have salt and water retention.

******* Don't give saline .***

Clinical features:

1) Increase total peripherals resistance——- vasoconstriction (unlike acidosis)
2) Decrease RR (retention of Co2).
3) Decrease k ,ca,Mg.
4) Altered mental status.
5) Excitation of neurons :seizure and convulsions.

Treatment :

- Saline sensetive——- saline.
- Saline resistance———- spironolactone and aldosterone reset or antagonist.

Respiratory Acidosis:

- Decrease PH , Increases CO_2 , if corrected increases HCO_3
- Total peripheral resistance decrease (resistant to ionotropic med)

Causes:

1. Upper airway obstruction by foreign body , epiglottis.
2. Sever asthma.
3. COPD.
4. Brain stem injury (inhibited Resp center in medulla).
5. Respiratory muscle: paralysis, bilateral phrenic injury.
6. Toxins causing neuromuscular junction blocking (eg.curare).
7. Anesthetic medication.
8. Morphine and heroin overdose.

Clinical features:

1) Somnolence
2) Confusion
3) AMS
4) Headache
5) Palpitations
6) Papilledema
7) Brain inhibited

Treatment:

1. **Fix airways obstruction (if it's there)**
2. **Asthma or COPD——- bronchodilator's**
3. **Treat underlying causes**
4. **Patient with neuromuscular injury or brain stem injury—— ventilation**
5. **Morphin and heparin—— naloxone**
6. **Barbiturates—— Dialysis**
7. **Benzodiazepines—— flumanzil (stimulate brain so keep patient in respiration)**

Respiration alkalosis

- Increase TRP
- Women are more affected
- Increase PH , decrease CO_2 , if correction started decreases HCO_3

Causes :

1. **Anxiety——- hyperventilation——— washing up Co2.**
2. **Hyperventilation**
3. **Aspirin——- stimulate respiratory center——- initially respiratory alkalosis——— then metabolic acidosis.**
4. **High attitude——— hypoxia——— hyperventilation.**
5. **Hypoxia of any cause**
6. **Pulmonary embolism——- closed artery——- decrease ventilation and perfusion**
7. **Pregnancy**
8. **Sepsis——— hypo ventilation**
9. **Fever**

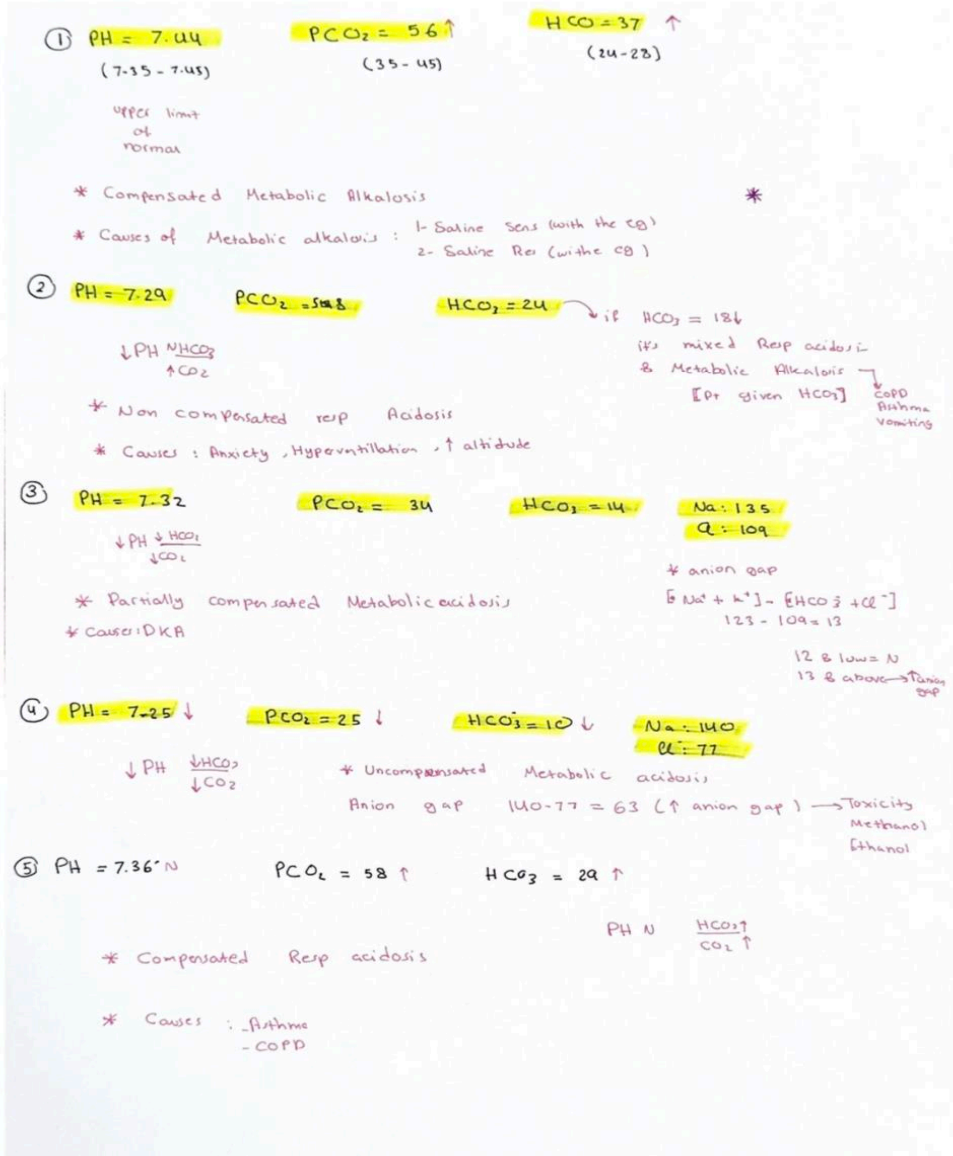
Clinical features:

1. Decrease blood flow to the cerebrum
2. Headache
3. Tetany
4. Excitation
5. Convulsions
6. Parasthesia (due to tetany) decrease ca
7. Chvosten sign
8. Trousseau sign
9. Increase tendon reflexes
10. Increase TPR : fetal arrhythmia.

Treatment:

1. Anxiety——— Breath into bag (increase co2 and breath it back.
2. Hyperventilation——- breath in a container
3. Aspirin——- dialysis
4. Increase altitude——- descend and give acetazolamide (metabolic acidosis)
5. PE——— tissue plasminogen gene activator (AE: bleeding) + not give in pregnancy (embolectomy).

Practice:


① PH = 7.44 (7.35 - 7.45) upper limit of normal
PCO2 = 56 ↑ (35 - 45)
HCO = 37 ↑ (24-28)
* Compensated Metabolic Alkalosis *
* Causes of Metabolic alkalosis : 1- Saline Sens (with the CB) 2- Saline Res (with the CB)
② PH = 7.29
PCO2 = 58
HCO3 = 24 → if HCO3 = 18 it's mixed Resp acidosis & Metabolic Alkalosis [Pt given HCO3] → COPD Asthma vomiting
↓PH ↑CO2 NHCO3
* Non compensated resp Acidosis
* Causes : Anxiety , Hyperventilation , ↑ altitude
③ PH = 7.32
PCO2 = 34
HCO3 = 14
Na: 135
Cl: 109
↓PH ↓HCO3 ↓CO2
* anion gap
[Na+ + K+] - [HCO3- + Cl-]
123 - 109 = 13
12 & low = N
13 & above → Anion gap
* Partially compensated Metabolic acidosis
* Cause: DKA
④ PH = 7.25 ↓
PCO2 = 25 ↓
HCO3 = 10 ↓
Na: 140
Cl: 77
↓PH ↓HCO3 ↓CO2
* Uncompensated Metabolic acidosis
Anion gap 140-77 = 63 (↑ anion gap) → Toxicity Methanol Ethanol
⑤ PH = 7.36 N
PCO2 = 58 ↑
HCO3 = 29 ↑
PH N HCO3↑ CO2↑
* Compensated Resp acidosis
* Causes : - Asthma - COPD