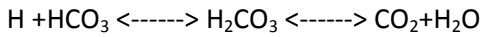


Acid Base Balance

Normal PH is 7.36-7.44



Metabolic alkalosis: This is either due to base excess or deficit of acid.

Causes:

1. Excessive injection of alkali
2. Loss of acid from stomach by repeated vomiting.
3. Cortisone excess : as a result of over administration of steroids or in case of Cushing syndrome

Clinical features:

- The commonest cause of alkalosis is due to loss of acid from the stomach.

Treatment:

- Metabolic alkalosis without hypokalemia needs no treatment. Only the cause should be removed.
- Metabolic alkalosis with hypokalemia due to repeated vomiting as in pyloric obstruction is treated by giving the patient intravenous normal saline with potassium supplement.

Respiratory alkalosis

Causes:

1. Excessive pulmonary ventilation carried out upon an anaesthetized patient.
2. Hyperpyrexia causing hyperventilation.
3. Hysteria.
4. Lesion in the hypothalamus.

These conditions may be corrected by increase renal excretion of bicarbonate (compensated Respiratory alkalosis)

Treatment:

- Respiratory suppression by insufflation of CO₂

Metabolic acidosis

A condition where there is a deficit of base or an excess of acid.

Causes:

1. Increase of fixed acids
 - Due to formation of ketone bodies as in diabetes or starvation
 - Retention of metabolites in renal insufficiency
 - Rapid increase of lactic acid & pyruvic acid by anaerobic metabolism
2. Loss of bases
 - Severe diarrhea
 - Intestinal fistula

Clinical features:

- In severe acidosis the leading sign is rapid, deep, noisy breathing due to overstimulation of the respiratory center and to eliminate as much as H_2CO_3 .

Treatment:

3. Give $NaHCO_3$ which correct acidosis but not treat the problem (each condition needs special treatment according to the underlying cause)
4. Restore adequate tissue perfusion

Respiratory acidosis

- This occurs as a result of chronic CO_2 retention. e.g.: inadequate ventilation during anesthesia.
- Also it occurs in case of acute respiratory failure (e.g.: pneumonia) or chronic respiratory failure as in case of (chronic bronchitis & emphysema). In the blood there will be raised PCO_2

Calcium

It is an extra cellular cation. The plasma level is 8-12mg/dl.

It exists in three forms:

- Bound to protein
- Free non-ionized
- Free ionized: this is important for both neuromuscular excitability and the blood coagulation.

The serum level is likely to be modified by any factor promoting or inhibiting:

- Its absorption from the bowel.
- Its storage in the bone
- Its elimination by the kidney

Factors that promote or inhibit such as vitamin D, parathormone, calcitonin, state of renal and bowel function.

Hypercalcemia

Causes:

1. Primary hyperparathyroidism
2. Sarcoidosis
3. Multiple Myeloma
4. Hyperthyroidism
5. Milk-alkali syndrome.
6. Hypervitaminosis D
7. Immobilization with Paget's diseases
8. Malignant diseases with endocrine function e.g.: carcinoma of bronchus or kidney

Clinical features:

- Anorexia, nausea, vomiting, constipation, muscle weakness with decreased tendon reflexes, thirst, polyuria, nocturia.

Treatment of hypercalcemia

1. **Rehydration:** 4-6 liters of fluid should be given in the first 24 hours.
2. **Diuresis:** with furosemide to decrease tubular reabsorption of calcium.
3. **Corticosteroid:** this decreases bone resorption.
4. **Calcitonin:** this decreases bone resorption.
5. **Mithramycin:** This is a cytotoxic antibiotic with specific toxic action against osteoclasts.
6. **Diphosphonate:** is an inhibitor of calcification.
7. **Treatment of the cause:** e.g.: if the cause is parathyroid adenoma then Parathyroidectomy should be done.

Hypocalcemia

The commonest cause in surgical practice is due to hypoparathyroidism after surgery on thyroid or parathyroid glands.

Clinical features:

- Tingling and numbness of face, fingers and toes.
- Carpopedal spasm: flexion at metacarpophalangeal joint, extension of interphalangeal joints and adduction of the thumb.
- Spasm of muscle of respiration.

Latent tetany is demonstrated by:

1. Chvostek's sign: tapping over branches of facial nerve at angle of the jaw causes twitching at corners of the mouth.
2. Trousseau's sign: a sphygmomanometer cuff is applied to the arm & inflated above the systolic pressure not more than two minutes, this produces carpopedal spasm.

Treatment:

1. Intravenous calcium gluconate (10-20ml) of 10% in a period not less than 10 minutes.(rule of 10 s). This can be repeated.
2. For longer term the absorption of calcium is enhanced by oral administration of vitamin D

Potassium (K): More than 98% of potassium is intracellular, only 2% is extracellular. Normal serum K is 3.5-5.3 mEq/l.

Hypokalemia

Causes:

1. Loss of potassium from GIT in cases of prolonged vomiting, diarrhea and from intestinal fistula.
2. Loss in the urine as in case of hyperaldosteronism in which there is increase sodium reabsorption and potassium excretion in the urine.
3. Drugs: like diuretics e.g. furosemide (Lasix).
4. Decrease potassium intake as in chronic starvation.

Clinical features:

- Asymptomatic
- Cardiac arrhythmia
- Muscle weakness, slurred speech
- Abdominal distention due to paralytic ileus

Investigations:

- Serum potassium is low (below 3.5meq/l)
- ECG changes

Treatment:

1. Oral potassium (in form of milk, meat, fruit, juice) or in form of tablets
2. Intravenous potassium: It should be given slowly in a drip because it carries risk of cardiac dysrhythmia and cardiac arrest

Sodium (Na): Sodium is the principle cation in the ECF (extra cellular fluid). Normal serum sodium level is 135-145 mEq/l

Sodium depletion (hyponatremia)

Causes:

1. Obstruction of small intestine with rapid loss of gastric, biliary, pancreatic and intestinal secretions with vomiting.
2. Intestinal fistula.
3. Severe diarrhea.
4. Adrenocortical insufficiency.

Clinical features:

- Hyponatremia with severe water depletion are due to ECF dehydration.
- Sunken eyes, in infants the anterior fontanel is depressed. the tongue is dry & coated.
- The skin is dry & wrinkled. the blood pressure is below normal. the urine is scanty & has high specific gravity.
- Lab investigations: low serum sodium .low urine sodium

Sodium excess (hypernatremia): this occurs in patient given excessive amount of IV normal saline postoperatively.

Clinical features:

- Puffiness of the face.
- Pitting edema especially in sacral area.
- Increased body weight of the patient.
- In infants there is sign of over hydration & increase tension in anterior fontanel and increased body weight.