

Electrolytic disorder

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Electrolyte

Some substances when dissolved in a solution dissociate into charged particles or ions are called electrolytes.

Some important electrolyte & their normal value

	Plasma (mOsm/litre of H ₂ O)	
Na ⁺	142	135 - 145
Cl ⁻	108	95 - 105
HCO ₃ ⁻	24	22 - 28
Ca ⁺⁺	1.3	Total- 2.4 & Free-1.2
K ⁺	4.2	3.5 - 5
Mg ⁺⁺	0.8	1.8 - 3.6

Electrolyte Contd.

Function of electrolyte

1. Maintenance of water volume in the different body compartment by exerting osmotic pressure.
2. Help in the acid base balance within the body compartment.
3. Essential for neuromuscular activities.

Sodium Metabolism

- Most of the body sodium is in the extracellular fluid (145mmol/l).
- Intra cellular fluid (10 mmol/L).
- About 100-150 mmol of sodium is consumed per day.
- About 80% is excreted through the kidneys.
- Rest through the gastro-intestinal secretion & sweats.

Sodium Metabolism Contd.

Hypernatraemia

- Increase in the sodium concentration in the plasma,
- Mainly from water loss from the body.

A. Main cause is water depletion:

- Reduced intake- inability to swallow, starvation.
- Increased loss through skin-fever , hot environment.
- Increased loss through lung- hyperventilation.
- Increased loss through kidneys- diabetes insipidus, diabetes mellitus, nephrotic syndrome, chronic renal failure (some cases).
- Increased loss through the gastro-intestinal tract- watery diarrhoea.

B. Hypernatraemia can also result from:

- Primary aldosteronism.
- Cushing syndrome.

Clinical features:

- Cellular dehydration
- Excessive thirst
- Oliguria
- Giddiness
- Confusion
- Muscle weakness
- Dry skin
- Coma (severe cases)

Hyponatraemia

- Decrease in the sodium concentration in the plasma,
- Mainly from water retention.
- It may also result from sodium loss from the body.

Causes of Hyponatraemia

- Main cause is water retention.
- Syndrome of inappropriate secretion of ADH.
- Psychogenic polydipsia.
- Uncontrolled diabetes mellitus.
- Vomiting, Diarrhoea, Dysentery
- Diuretics
- Fever
- Burns
- Congestive cardiac failure
- Cirrhosis of liver
- Nephrotic syndrome

Clinical features:

- Lassitude, muscle weakness.
- Sleepiness, confusion.
- Neurological damage

Potassium metabolism

- Most of the body potassium is in the cells (160mmol/L).
- ECF contains less than 2% of the body potassium.
- Dietary potassium intake is about 5-6 gm/day.
- Over 85% is excreted through the kidneys.
- Rest excreted through gastro-intestinal tract.

- Increase potassium concentration in plasma (normal plasma-4.2mOsm/L)

Commonest cause is impaired excretion of potassium through the kidney tubules.

-Causes of impaired excretion of potassium through the kidney tubules

- Acute renal failure
- Chronic renal failure
- Acute circulatory failure
- Addison's disease, hypoaldosteronisms.
- acidosis, diabetes mellitus.

Clinical features

- Muscle weakness
- Bradycardia
- Sometime arrhythmia

Hypokalaemia

- Decrease potassium concentration in plasma (normal plasma-4.2mOsm/L)

Causes of hypokalaemia

- **Loss through gastro-intestinal tract**
 - Vomiting, gastric juice aspiration
 - Diarrhoea, fistula
 - Villous adenoma of large bowel
 - Regular use of laxatives.

Causes of hypokalaemia (Contd.)

➤ Loss through the kidney

- Primary aldosteronism
- Cushing's syndrome.
- Secondary aldosteronism (cardiac failure, cirrhosis of liver, nephrotic syndrome)

Clinical features

- Muscle weakness
- Tiredness
- Tachycardia
- Flattening of T wave in ECG

Acid base balance

Acid- a molecule or ion that can function as proton donor.

Base- a molecule or ion that can function as a proton acceptor.

Normal arterial pH 7.4 ± 0.02

Acidemia – pH falls below 7.35

Alkalemia – pH rises above 7.45

Metabolic acidosis

- When an acid other than carbonic acid (due to CO_2 retention) accumulates in the body, resulting in a fall in the plasma bicarbonate.
- There is compensatory reduced in pCO_2 .

Metabolic acidosis may result from

1. Addition of acid radicals (more than kidney can excrete):

- Excessive production of acid radicals due to metabolic disorders-i.e. diabetic ketosis, lactic acidosis, salicylates poisoning.

2. Failure of kidney to excrete acid radicals:

- Acute renal failure.
- Chronic renal failure.

3. Excessive loss of base from the body:

- Diarrhoea, dysentery, intestinal fistula.
- Renal tubular acidosis.

Clinical features

- Anorexia
- Nausea
- Vomiting
- Abdominal pain
- Low cardiac output
- Decreased heart rate

Metabolic alkalosis

- It is characterized by increase in plasma bicarbonate & plasma pH.
- There is small compensatory rise in $p\text{CO}_2$.

Metabolic alkalosis Contd.

Vomiting

Acid base balance Contd.

Gastric loss of

H^+Cl^-

Na^+Cl^-

K^+Cl^-

Hypovolaemia

↑ Proximal $Na^+HCO_3^-$ reabsorption

↑ Renin-angiotensin-aldosterone

Hypokalaemia

↑ Distal H^+ secretion

↑ Renal NH_3 synthesis

Metabolic alkalosis

↑ H^+ excretion

Causes of metabolic alkalosis

- Excess vomiting, which causes loss of electrolytes.
- Overdose of diuretics.
- Adrenal disease.
- Large dose of potassium or sodium in a short period of time.
- Antacids
- Accidental ingestion of bicarbonate which can be found in baking soda.
- Laxative.
- Alcohol abuse.

Clinical features

- Tetany may occur

Respiratory acidosis

Respiratory acidosis occurs when there is accumulation of CO_2 due to reduced effective alveolar ventilation (type II respiratory failure)

Causes of respiratory acidosis

1. Chronic airway condition, like asthma.
2. Injury to chest.
3. Obesity, which can make breathing difficult.
4. Sedative misuse.
5. Overuse of alcohol.
6. Muscle weakness in the chest.
7. Deformed chest structure.

Respiratory alkalosis

Respiratory alkalosis develops when there is a period of sustained hyperventilation resulting in a reduction of $p\text{CO}_2$ & increase in plasma pH.

Causes of respiratory alkalosis

1. Hyperventilation, which is commonly occurs with anxiety.
2. High fever.
3. Lack of oxygen.
4. Salicylate poisoning.
5. High altitudes.
6. Liver disease.
7. Lung disease.

SAQ of Electrolyte imbalance

1. Name the serum electrolytes with their normal values.
2. What are the electrolyte that are done to evaluate a patient? Give their normal levels.
3. Write the clinical importance of serum calcium.
4. A male of 55 years presents with excessive vomiting. He gives history of long peptic ulcer disease.
 - What is the likely diagnosis of his illness?
 - How will be his electrolytes & acid-base status?

SAQ of Electrolyte Imbalance Contd.

5. A 10 years old boy develops severe diarrhea.
 - What changes you expect in his electrolyte & acid-base status?
6. A 65 years male with long standing chronic duodenal ulcer has developed excessive vomiting.
 - What will be his electrolyte & acid-base status?
7. A man aged 25 years is in shock following a RTA. He passed 40ml urine during last 24 hours.
 - What will be his acid-base & electrolyte status.
8. A 10 years old developed severe diarrhea.
 - What changes you expect in his electrolyte & acid-base status?

SAQ of Acid-base imbalance

1. What is the normal pH of blood & urine?
2. What do you mean by metabolic acidosis?
3. What are the causes of metabolic acidosis?
4. Write the causes of metabolic alkalosis.
5. What are the conditions that may lead to metabolic alkalosis?
Give the biochemical changes in such patient.
6. Write short note on:
 - Metabolic alkalosis.
 - Metabolic acidosis.
 - Causes of metabolic acidosis.

Thank you