Pediatric Nursing

Electrolyte Imbalance

Lecture '6'
Electrolyte Imbalance

Electrolyte refer to the electrolytes that are presents in the body fluid (Extracellular or intracellular).

Serum electrolyte value which reported from laboratory; provides information about electrolyte concentration in the blood.

But not necessarily reflect concentration in the other body compartments.
Electrolyte Concentration in Body Compartments

<table>
<thead>
<tr>
<th>Components</th>
<th>Extracellular</th>
<th>Intracellular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>Interstitial</td>
<td>Low</td>
</tr>
<tr>
<td>Na⁺</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>K⁺</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Proteins</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>
Electrolyte Imbalances

Several types will be discussed which are:

1- Sodium imbalances.
   - Hyponatremia.
   - Hypernatremia.

2- Potassium imbalances:
   - Hypokalemia.
   - Hypercalcemia.

3- Calcium imbalances:
   - Hypercalcemia.
Sodium Imbalances

- Sodium is positively charged particles, that plays important role in blood pressure regulation & maintenance of fluid volume.
- Serum sodium reflects Na in ECF (high level).

Hypernatremia:
- Is a condition of increased blood osmolarity (No. of moles per liter), in which contains excess sodium relative to water.
  - Na > 148 mmol/L in children.
  - Na > 146 mmol/L in newborn.

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## Causes of Hypernatremia

<table>
<thead>
<tr>
<th>Loss of relatively more water than Sodium</th>
<th>Gain of relatively more Sodium than water</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Diabetes insipidus (not enough antidiuritic hormone).</td>
<td>• inability to communicate thirst.</td>
</tr>
<tr>
<td>• Diarrhea or vomiting without fluid replacement.</td>
<td>• limited or no access to water.</td>
</tr>
<tr>
<td>• Excessive sweating without fluid replacement.</td>
<td>• high solute intake without adequate water (tube feeding).</td>
</tr>
<tr>
<td></td>
<td>• intravenous hypertonic saline.</td>
</tr>
</tbody>
</table>
Clinical Manifestations

- Thirsty.
- Diminished urine output.
- Decrease level of consciousness.
- Confusion, lethargy, coma (shrinking of the brain cell).
- Seizures (in sever case).

- Increase Na serum.
- Increase urine specific gravity (> 1.030).
Treatment:
Administer isotonic solution then hypotonic solution.

Nursing interventions:

1- prevent hypernatremia by:

• Teaching breast feeding mother about signs of adequacy of feeding.
• Teaching mother how to calculate correct dose of formula.
• Instructing mother about normal urine output (4-6 wet diapers).
• Instructing the mother not to give concentrated formula.
Nursing interventions:

• Instructing parents to keep salt out of reach.
• Instructing the parents to offer extra fluid during hot weather.

2- During hospitalization:
• Monitor serum sodium level, urine specific gravity.
• Intake/output chart.
• Frequent check on responsiveness (to monitor effect on brain cells).
• Enhance oral intake.
Hyponatremia:

- Is a condition of decreased blood osmolarity, in which contains excess water relative to sodium.
- \( \text{Na} < 135 \text{ mmol/L} \) in children.
- \( \text{Na} < 133 \text{ mmol/L} \) in newborn.

- It results from conditions that cause gain relatively more water than sodium or loss sodium relatively than water.
Clinical Manifestations

- Decreased level of consciousness (from edema in brain cells).
- Vomiting, nausea
- Confusion.
- Headache.
- Respiratory distress.
- Muscle weakness.
- Decreased deep tendon reflex.

As the condition progresses to:
- Respiratory arrest.
- Dilated pupils.
- Coma.
- Seizures.

In severe cases: it can be fatal.
# Causes of Hyponatremia

<table>
<thead>
<tr>
<th>Gain relatively more water than Sodium</th>
<th>Loss of relatively more Sodium than water</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Excessive intravenous D5W (hypotonic) rather than isotonic fluid.</td>
<td>• Diarrhea or vomiting with replacement of tap water only instead of fluid containing sodium.</td>
</tr>
<tr>
<td>• Irrigation of body cavities with distilled water.</td>
<td>• Excessive sweating.</td>
</tr>
<tr>
<td>• Excessive antidiuritic hormone (concentrated urine).</td>
<td>• Diuretics.</td>
</tr>
<tr>
<td>• Excessive oral intake of tap water.</td>
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<tr>
<td>• CHF.</td>
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</tr>
</tbody>
</table>

- Gain relatively more water than Sodium
- Loss of relatively more Sodium than water
Treatment:

Administer hypertonic solution.

Nursing interventions:

- Teaching mother how to calculate correct dose of formula to prevent hyponatremia.
- Teaching mother to give the child the proper formula to prevent hyponatremia.
- Monitor the hospitalized child on I.V therapy to prevent hyponatremia.
- Administer hypertonic solution as doctor order, but monitor the child to prevent rebound hypernatremia.
Potassium Imbalances

- Potassium is an essential anion (negatively charged particle). Most of the potassium in the body is found inside the cells. It is excreted from the body through urine, feces & sweat.
- The aldosterone hormone increase potassium excretion in the urine.

- **Hyperkalemia:**
  - An excess of potassium in the blood, is reflected by levels above 5.8 mmol/L in children and 5.2 mmol/L in newborn.
Factors that shifts potassium in or out of cells

Hypokalemia:
- High insulin level
- Alkalosis
- Epinephrine
- Beta-adrenergic stimulation

Hyperkalemia:
- Crush injury
- Acidosis
- Burns, cancers

Factors that shifts potassium in or out of cells
Causes:

1- increase potassium intake:
   is due to intravenous potassium overload. Blood transfusion (multiple units).

2- shifting of potassium outside the cells:
   Due to massive cell death (e.g. crush injury, sickle cell anemia, chemotherapy use). Potassium also shifts during metabolic acidosis caused by diarrhea and diabetes mellitus when insulin levels are low.
Causes:

3- Decreased potassium excretion:

Occur with acute or chronic oligurea during renal failure, severe hypovolemia, and conditions that lead to decrease levels of aldosterone secretion from the adrenal cortex. Such as lead poisoning.
Clinical Manifestations

- All of the clinical manifestations of hyperkalemia are related to muscle dysfunction, because potassium plays an important role in muscle activity.
- Intestinal colic, cramping & diarrhea.
- Weak skeletal muscle (start with legs then arms).
- Lethargy.
- Arrhythmias (tachycardia) is due to weakness of the heart muscle.
- Prolonged QRS complex, Peak in T wave.
Treatment & nursing interventions:

- restrict potassium intake.
- administer diuretics as order (loop diuretics).
- monitor serum potassium.
- ECG daily to monitor arrhythmias.
- Peritoneal or hemo dialysis.
- administration of intravenous sodium bicarbonate, insulin, glucose and calcium gluconate: to drive potassium ions into the cells.
Hypokalemia:

Low potassium in the blood, is reflected by levels below 3.5 mmol/L in children and 3.7 mmol/L in newborn.
Causes:

1- increase potassium excretion:
Caused by increase excretion of potassium from the GIT (diarrhea). Or it could be due to self-inducing vomiting as in bulimia or nasogastric suctioning.

2- increase urinary potassium excretion:
Caused by osmotic diuretics (manitol), hypomagnesaemia, increased aldosterone.
Causes:

3- decreased potassium intake:
Caused by anorexia nervosa, bulimia nervosa.

4- shifts of potassium from the extracellular fluid into cells:
Occur in alkalosis & hypothermia or ingestion of medication such as insulin, systematic antifungal, laxatives, osmotic diuretics (manitol).
Manifestations

- As in hyperkalemia, the significant symptoms related to the muscle dysfunction.
- Decreased GI smooth muscle activity leads to diminished bowel movements, constipation, abdominal distention.
- Skeletal muscle are weak & unresponsive to stimuli.
- Deep tendon reflexes are diminished.
- Flaccid paralysis in severe cases.
- Cardiac arrhythmias occur: inverted or flat T wave.
- Decrease urine specific gravity due to kidney changes related to hypokalemia.
Medical & nursing managements:

- The medical managements is directed to replace the potassium while treating the underlying cause.

- Monitor potassium level.
- Observe muscle weakness.
- Assess respiratory rate (to check on respiratory muscles).
- Assess bowel movements (sounds).
- Increase intake of food rich in potassium such as banana, dates, figs, potatoes, strawberries, tomato juice & orange juice.
Calcium Imbalances

- Calcium is important for muscle and nerve function, secretion of hormones, bone formation and in clotting formation.
Causes of hypercalcemia

- Vitamin D overdose
- Bone tumors
- Thiazide diuretics
- Familial hypercalcemia

Causes of hypocalcaemia

- Low calcium intake.
- Chronic diarrhea.
- Laxative abuse.
- Malabsorption.
- Alkalosis.
Hypercalcemia

- It refers to plasma excess of calcium:
  above 2.7 mmol/L in children.
  above 2.5 mmol/L in newborns.
- Because calcium is stored in bone, the serum calcium may not reflect the body stores.

- **Causes:**

  1- consuming high amount of food rich in calcium.
  2- consuming overdose of vitamins (vitamin A, D).
  3- excessive amounts of parathyroid hormone → calcium withdrawal from bones.
4- prolonged immobilization leads calcium to shift from bone to extracellular fluid.
5- some diseases such as leukemia, bone tumor.
6- Thiazide diuretics that decrease calcium excretion in the urine.

**Manifestations:**

- Constipation, anorexia.
- Nausea, vomiting.
- Fatigue, muscle weakness, cardiac arrhythmias.
- Confusion, lethargy, polyuria,
Hypercalcemia is treated with administration of IVF and diuretics (lasix) to increase excretion in urine.

- Administration of glucocorticoids & calcitonin to decrease bone resorption.
- Treatment of the underlying cause.
- Administration of phosphate.
Hypocalcaemia

• Is a serum deficit of calcium below 2.2 mmol/L in children. below 2 mmol/L in newborns.

• **It caused by:**
  1- malnutrition.
  2- decrease consumption of calcium.
  3- vitamin D deficiency.
  4- no access to sun light.
  5- chronic diarrhea.

  6- impaired parathyroid hormone secretion.
  7- hypomagnesaemia.
  8- increase phosphate level.

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Clinical manifestations:

- Increased muscle tetany.
- Twisting, tingling around the mouth or in the fingers.
- Laryngospasm.
- Seizures.
- Cardiac arrhythmias.
- Spontaneous fractures.
Medical & nursing managements:

- Treat the underlying cause.
- Increase exposure to sun light.
- Administration of medication (oral or IV) to support calcium levels in serum.
- Correct hypomagnesaemia.
- Increase intake of food rich in calcium, Vit. D. such as (milk, cheese, chicken, figs, nuts, yogurt, egg yolks.