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COURSE TITLE: MEDICAL BIOCHEMISTRY II

1. OUTLINE THE TOXICITY VALUES AND DEFICIENCY MANIFESTATIONS OF THE FOLLOWING MINERALS

A. POTTASIUM

B. CALCIUM

C. MAGNESSIUM

D. CHLORIDE

E. IRON

POTASSIUM

TOXICITY VALUE

Potassium chloride and sodium chloride were infused into the reticulorumen of male Holstein calves, approximately 6 mo of age and 260 kg, at .29, .58, 1.15, 1.73, 2.31, or 2.88 g potassium per kilogram body weight or 1.35, 2.12, or 2.16 g sodium per kilogram in equal volumes of water. Paired controls were infused with water. Calves were monitored for physiological changes for 6 h at 15, 30, or 60-min intervals. Potassium and total solids of plasma and packed cell volume were increased at potassium doses greater than .29 g of potassium per kilogram body weight within 1 h after dosing. At the higher doses of potassium, sodium content of plasma increased about 1 h after the increase in plasma potassium. Respiration rates within a potassium treatment varied with respect to time after dosing, but generally they increased, and associated variables of carbon dioxide pressure, pH, and bicarbonate in blood were decreased accordingly.

Clinical toxicity signs, including excess salivation, muscular tremors of legs, and excitability were observed with potassium doses greater than .58 g of potassium per kilogram body weight. Three of five calves given 1.73 g of potassium per kilogram, three of four calves given 2.31 g of potassium per kilogram, and one calf given 2.88 g of potassium per kilogram body weight died.

DEFICIENCY MANIFESTATION

Hypokalemia is a low level of [potassium](https://en.wikipedia.org/wiki/Potassium) (K+) in the [blood serum](https://en.wikipedia.org/wiki/Blood_serum). Mild low potassium does not typically cause symptoms. Symptoms may include [feeling tired](https://en.wikipedia.org/wiki/Fatigue_%28medical%29), [leg cramps](https://en.wikipedia.org/wiki/Cramp), [weakness](https://en.wikipedia.org/wiki/Weakness), and [constipation](https://en.wikipedia.org/wiki/Constipation). Low potassium also increases the risk of an [abnormal heart rhythm](https://en.wikipedia.org/wiki/Heart_arrhythmia), which is often [too slow](https://en.wikipedia.org/wiki/Bradycardia) and can cause [cardiac arrest](https://en.wikipedia.org/wiki/Cardiac_arrest).

Causes of hypokalemia include vomiting, [diarrhea](https://en.wikipedia.org/wiki/Diarrhea), medications like [furosemide](https://en.wikipedia.org/wiki/Furosemide) and [steroids](https://en.wikipedia.org/wiki/Steroid), [dialysis](https://en.wikipedia.org/wiki/Dialysis), [diabetes,insipidus](https://en.wikipedia.org/wiki/Diabetes_insipidus), [hyperaldosteronism](https://en.wikipedia.org/wiki/Hyperaldosteronism), [hypomagnesemia](https://en.wikipedia.org/wiki/Hypomagnesemia), and not enough intake in the diet. Normal potassium levels are between 3.5 and 5.0 [mmol/L](https://en.wikipedia.org/wiki/Mmol/L) (3.5 and 5.0 [mEq/L](https://en.wikipedia.org/wiki/MEq/L)) with levels below 3.5 mmol/L defined as hypokalemia. It is classified as severe when levels are less than 2.5 mmol/L. Low levels may also be suspected based on an [electrocardiogram](https://en.wikipedia.org/wiki/Electrocardiogram) (ECG). [Hyperkalemia](https://en.wikipedia.org/wiki/Hyperkalemia) is a high level of potassium in the blood serum.

The speed at which potassium should be replaced depends on whether or not there are symptoms or abnormalities on an [electrocardiogram](https://en.wikipedia.org/wiki/Electrocardiography). Potassium levels that are only slightly below the normal range can be managed with changes in the diet.

CALCIUM

TOXICITY VALUE AND DEFICIENCY MANIFESTATION

[Hypercalcemia](https://www.ncbi.nlm.nih.gov/books/n/nap13050/appendixes.app1/def-item/appendixes.app1.gl2-d53/) occurs when serum calcium levels are 10.5 mg/dL (also expressed as 2.63 mmol/L) or greater depending on normative laboratory values. It can be induced by excess intake of calcium or vitamin D, but it is more commonly caused by conditions such as malignancy and primary hyperparathyroidism. Clinical signs and symptoms of hypercalcemia may vary depending on the magnitude of the hypercalcemia and the rapidity of its elevation; they often include anorexia, weight loss, polyuria, heart arrhythmias, fatigue, and soft tissue calcification. When serum calcium levels rise above 12 mg/dL, the kidney's ability to reabsorb calcium is often limited; in turn, hypercalciuria can occur, particularly with increased calcium or vitamin D intake. [Hypercalciuria](https://www.ncbi.nlm.nih.gov/books/n/nap13050/appendixes.app1/def-item/appendixes.app1.gl2-d54/) is present when urinary excretion of calcium exceeds 250 mg/day in women or 275-300 mg/day in men. Often, urinary calcium excretion is expressed as the ratio of calcium to creatinine excreted in 24 hours (milligrams of calcium per milligram of creatinine). Values above 0.3 mg/mg creatinine are considered to be within the hypercalcuric range.

[Hypercalcemia](https://www.ncbi.nlm.nih.gov/books/n/nap13050/appendixes.app1/def-item/appendixes.app1.gl2-d53/), in addition to leading to hypercalciuria, can cause renal insufficiency, vascular and soft tissue calcification including calcinosis leading to nephrocalcinosis, and nephrolithiasis. [Nephrolithiasis](https://www.ncbi.nlm.nih.gov/books/n/nap13050/appendixes.app1/def-item/appendixes.app1.gl2-d74/), often referred to as kidney stones, can also be caused by hypercalciuria. [Hypercalciuria](https://www.ncbi.nlm.nih.gov/books/n/nap13050/appendixes.app1/def-item/appendixes.app1.gl2-d54/) may occur in the absence of hypercalcemia and is related to either hyperabsorption of calcium in the gut or a renal leak whereby calcium excretion is enhanced. Both etiologies can lead to nephrocalcinosis.

MAGNESIUM

TOXICITY VALUE

The toxic effects of magnesium are inherently linked to the levels (mEq/liters) found in the serum. As the levels of magnesium rise, different symptoms start to manifest, and the fatality of those symptoms is proportional to the levels of magnesium found. Starting at 5 to 10 mEq/L, patients will begin to develop ECG changes (prolonged PR interval, widened QRS). At 10 mEq/L, there will be a loss of deep tendon reflexes and muscle weakness. At 15 mEq/L, signs of abnormal conductivity surface as SA/AV node block. Additionally, patients begin to experience respiratory paralysis. At 20 mEq/L or higher, the patient is likely to experience cardiac arrest

DEFICIENCY MANIFESTATION

A magnesium deficiency (hypomagnesaemia) can have many causes. They can range from insufficient absorption through our nutrition, disturbed magnesium absorption (resorption), increased excretion of magnesium or increased magnesium content in stress situations. The terms hypomagnesaemia and magnesium deficiency are commonly used interchangeably. However, total body magnesium depletion can be present with normal serum magnesium concentrations and there can be significant hypomagnesaemia without total body deficit.

Hypomagnesaemia is more prevalent than previously appreciated. Prevalence of hypomagnesaemia varies from 7% to 11% in hospital patients. In patients with other electrolyte abnormalities hypomagnesaemia is more frequent, 40% in hypokalaemic patients, 30% in hypophosphataemic patients, 23% in hyponatraemic patients and 22–32% in hypocalcaemia patients. The prevalence of hypomagnesaemia in critically ill patients is even higher, ranging from 20% to 65%. Hypomagnesaemia in intensive care patients is associated with increased mortality.

Hypomagnesaemia is frequently undetected. Measurement of serum magnesium concentration in 1,000 samples received for electrolyte determination showed that only 10% of the hypomagnesaemic patients had magnesium requested. Thus it has been suggested that magnesium should be determined routinely in all acutely ill patients especially in those with conditions, diseases or treatment that may predispose to magnesium deficiency

CHLORIDE

TOXICITY VALUE

Humans can smell chlorine gas at ranges from 0.1–0.3 ppm. According to a review from 2010: At 1–3 ppm, there is mild mucous membrane irritation that can usually be tolerated for about an hour. At 5–15 ppm, there is moderate mucous membrane irritation. At 30 ppm and beyond, there is immediate chest pain, shortness of breath, and cough. At approximately 40–60 ppm, a toxic pneumonitis and/or acute pulmonary edema can develop. Concentrations of about 400 ppm and beyond are generally fatal over 30 minutes, and at 1,000 ppm and above, fatality ensues within only a few minutes.

DEFICIENCY MANIFESTATION

Hypochloremia is an [electrolyte imbalance](http://chemocare.com/chemotherapy/side-effects/electrolyte-imbalance.aspx) and is indicated by a low level of chloride in the blood.  The normal adult value for chloride is 97-107 mEq/L. You often won’t notice symptoms of hypochloremia. Instead, you may have symptoms of other electrolyte imbalances or from a condition that’s causing hypochloremia. Symptoms include: fluid loss, dehydration, weakness or fatigue, difficulty breathing and diarrhea or vomiting, caused by fluid loss. Hypochloremia can also frequently accompany [hyponatremia](https://www.healthline.com/health/hyponatremia), a low amount of sodium in the blood. Hypochloremia can also be caused by any of the following conditions: [congestive heart failure](https://www.healthline.com/health/congestive-heart-failure), prolonged [diarrhea](https://www.healthline.com/symptom/diarrhea) or [vomiting](https://www.healthline.com/symptom/vomiting), chronic lung disease, such as [emphysema](https://www.healthline.com/health/emphysema) and metabolic [alkalosis](https://www.healthline.com/health/alkalosis), when your blood pH is higher than normal. Certain types of drugs, such as laxatives, [diuretics](https://www.healthline.com/health/diuretics), corticosteroids, and bicarbonates, can also cause hypochloremia.

IRON

TOXICITY VALUE

The amount of iron ingested may give a clue to potential toxicity. The therapeutic dose for iron deficiency anemia is 3–6 mg/kg/day. Toxic effects begin to occur at doses above 10–20 mg/kg of [elemental iron](https://en.wikipedia.org/w/index.php?title=Elemental_iron&action=edit&redlink=1). Ingestions of more than 50 mg/kg of elemental iron are associated with severe toxicity.

* A 325-mg tablet of ferrous sulfate heptahydrate has 65 mg (20%) of elemental iron
* A 325-mg tablet of ferrous gluconate has 39 mg (12%) of elemental iron
* A 325-mg tablet of ferrous fumarate has 107.25 mg (33%) of elemental iron
* 200 mg ferrous sulfate, dried, has 65 mg (33%) of elemental iron

In terms of [blood values](https://en.wikipedia.org/wiki/Blood_values), iron levels above 350–500 [μg](https://en.wikipedia.org/wiki/Microgram)/dL are considered toxic, and levels over 1000 μg/dL indicate severe iron poisoning

DEFICIENCY MANIFESTATION

Iron deficiency anemia is a common type of anemia — a condition in which blood lacks adequate healthy red blood cells. Red blood cells carry oxygen to the body's tissues.

As the name implies, iron deficiency anemia is due to insufficient iron. Without enough iron, your body can't produce enough of a substance in red blood cells that enables them to carry oxygen (hemoglobin). As a result, iron deficiency anemia may leave you tired and short of breath. Initially, iron deficiency anemia can be so mild that it goes unnoticed. But as the body becomes more deficient in iron and anemia worsens, the signs and symptoms intensify.

Iron deficiency anemia signs and symptoms may include:

* Extreme fatigue
* Weakness
* Pale skin
* Chest pain, fast heartbeat or shortness of breath
* Headache, dizziness or lightheadedness
* Cold hands and feet
* Inflammation or soreness of your tongue
* Brittle nails
* Unusual cravings for non-nutritive substances, such as ice, dirt or starch.