Anion Gap Metabolic Acidosis

Anion gap metabolic acidosis is a metabolic state in which the body's pH drops below its physiologic level. This is due to the addition of an acid to the blood. Recall from general chemistry that many acids have a low pKa, and therefore will largely exist in deprotonated or anionic form when in solution near body pH. The end result is the addition of an acid (H) to the blood, as well as its corresponding anion. This unmeasured anion makes the anion gap larger. The common causes of this abnormality are methanol, uremia, ketoacidosis, propylene glycol, iron toxicity, isoniazid, lactic acidosis, ethylene glycol, and salicylate (aspirin) toxicity.



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Increased Anion Gap

Up-arrow Anion Gap

When patients have an increased anion gap, there are a particular set of causes, which are classified as MUDPILES. The anion gap is calculated by serum ions and cations, and the equation is [Na+] − ([Cl−] + [HCO3−]) =12 mEq/L. The normal reference range is 8 to 16 mEq/L.

MUDPILES

Mudpile

MUDPILES is the acronym to help memorize the common causes of anion gap acidosis: Methanol, Uremia, Diabetic ketoacidosis, Propylene glycol, Isoniazid, Iron, Lactic acidosis, Ethylene glycol, Salicylates.

Methanol

Moth-alcohol bottle

Methanol, commonly found in commercial solvents or poorly made alcoholic beverages can cause an anion gap acidosis. In addition it is extremely toxic to the body, especially to the visual system. Methanol is metabolized to formic acid, which is mostly responsible for ocular toxicity, leading to blindness.

Uremia

U-rainbow

Uremia is a term used to describe the constellation of symptoms which accompany renal failure due to buildup of nitrogenous waste in the blood. Uremia can cause an anion gap metabolic acidosis.

Diabetic Ketoacidosis (DKA)

Dyed-beads-pancreas with Key-to-acidic-lemon

Diabetic ketoacidosis (DKA) is a life-threatening condition in patients with diabetes mellitus (DM). This condition occurs more in patients with Type I DM, but can sometimes occur in those with Type II DM. DKA is a result of insulin deficiency, which stimulates lipoprotein lipase resulting in the breakdown of adipose stores and increased levels of fatty acid oxidation. The oxidation of fatty acids in the hepatic mitochondria produces ketone bodies including acetoacetic acid and beta-hydroxybutyric acid. These ketone bodies can increase the anion gap.

Propylene Glycol

Purple Antifreeze

Propylene glycol is a food additive that is widely used in food and tobacco products, pharmaceuticals, and cosmetics. In certain medicines, cosmetics, and food products, propylene glycol acts as an emulsifying agent, industrial drying agent, surfactant, and solvent. Large amounts of ingestion can lead to metabolic acidosis with an anion gap.

Isoniazid or Iron

Iron with Ice-knight-zit

Iron can cause an acidosis when ingested in excess. It can also lead to stomach ulceration. Common symptoms of iron intoxication include nausea and vomiting. Isoniazid is a medication used for tuberculosis infection and can cause an anion gap acidosis.

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Lactic Acid

Lake Acidic-lemon

Lactic acidosis can cause an anion gap and usually results from dehydration with deficient nutritional resources forcing the body into anaerobic metabolism.

Ethylene Glycol

Antifreeze

Ethylene glycol can cause anion gap acidosis as well as kidney failure with calcium oxalate kidney stones. This is commonly found in patients who drink anti-freeze solvents.

Salicylates

Aspirin

Salicylates (aspirin) can cause acidosis by acting as an uncoupling agent often resulting in cellular damage. Salicylates also stimulate the brain stem to increase ventilation. Therefore, salicylate toxicity can present as a mixed acid base disorder because salicylates can cause an anion gap metabolic acidosis along with a respiratory alkalosis, creating a mixed acid base disturbance.

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