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## Volatile Poisoning

Volatile compounds are low molecular weight organic solvents such as methanol, isopropanol and acetone. Although ethylene glycol is not actually a volatile compound, ingestion results in a similar clinical presentation. These solvents may be ingested either intentionally by adults or unintentionally by infants. According to the 2005 annual report of the American Association of Poison Control Centers the most commonly reported exposures in order of decreasing frequency were isopropanol > ethylene glycol > acetone > methanol. Methanol and isopropanol are sometimes used as substitutes for ethanol by alcoholics. Methanol ingestions most frequently involve automotive products such as gasoline additives and de-icers, while isopropanol ingestions usually involve products labeled as rubbing alcohol. Acetone poisoning may result from either ingestion of solvents, such as nail polish remover, or glue sniffing. Ethylene glycol is the major constituent in automotive antifreeze, de-icers, hydraulic brake fluid and industrial drying agents.

Approximately 20% of a methanol dose is eliminated unchanged via the lungs and kidneys. The remainder is slowly metabolized by alcohol dehydrogenase to formaldehyde and then to formic acid. Although methanol itself produces inebriation, its toxic metabolites may cause more serious complications such as metabolic acidosis, blindness, coma and death after a latent period of 6 to 30 hours. Reported lethal doses of methanol have varied considerably from 40 mL of 15% methanol to as much as 500 mL with an overall average estimate of 1 mL/kg of body weight. The lethal blood level in an untreated victim has been estimated to be 80 mg/dL. The elimination half life varies between 2 and 24 hours.

Isopropanol is not metabolized to highly toxic organic acids and does not result in a profound anion gap acidosis. It is eliminated in breath and urine with a half life of 2.5 to 3 hours. Isopropanol is a more potent CNS depressant than ethanol and causes gastritis. Toxicity has been reported to

occur after consuming 0.5–1.0 mL/kg of 100% isopropanol or 2-4 mL/kg of rubbing alcohol, which is 70% isopropanol. Fatalities have been reported with ingestions of 240 mL.

Acetone is predominantly excreted unchanged in the breath and in the urine. A small fraction is metabolized to acetate and formate. Acetone is a central nervous system (CNS) depressant that may cause confusion, drowsiness and hyperventilation. Patients with diabetic ketoacidosis who present with these CNS symptoms usually have blood acetone levels of 15 – 75 mg/dL. CNS narcosis and coma have occurred after ingestion of 900 mL of acetone. The elimination half life is 3 to 6 hours.

Ethylene glycol itself is relatively nontoxic, but it is extensively metabolized to glycolic acid, glyoxylic acid and oxalic acid. Tissue injury is caused by widespread deposition of calcium oxalate crystals coupled with the toxicity of glycolic and glyoxylic acids. Ethylene glycol intoxication involves three phases:

1. CNS phase occurs one to 12 hours after ingestion and involves ataxia, nystagmus, myoclonus, coma and seizures.
2. Cardiovascular phase occurs 12-72 hours post ingestion and involves mild hypertension, tachycardia, tachypnea, and hyperthermia. Tetany may occur secondary to hypocalcemia.
3. Renal phase occurs 24 to 72 hours post ingestion and involves flank pain, oliguria and hyperkalemia.

The adult lethal dose of ethylene glycol has been reported to be 1.0-1.5 mL/kg of body weight. The elimination half life is 2-5 hours.

Patients with volatile ingestion typically present in the Emergency Department intoxicated or unconscious, with or without a history of ingestion of one of these substances. The laboratory test used to measure ethanol in most hospital laboratories, which is based on alcohol dehydrogenase, does not reliably detect these volatile compounds.

Diagnosis of poisoning by one of these compounds is dependent on calculation of the anion gap and osmolal gap. The most commonly used formula to measure the anion gap is:

**Sodium - (Chloride + Bicarbonate) = Anion Gap.**

In organic acidosis, the anion gap increases because bicarbonate decreases, chloride remains constant, and the unmeasured anion increases. An anion gap of >15 is considered elevated.

Osmolal gap is calculated by subtracting calculated osmolality from the measured osmolality. The classical formula for calculating serum osmolality is:

**Serum osmolality = 1.86 x sodium + Glucose/18 + BUN/2.8.**

A simplified formula with excellent clinical utility is:

**Serum osmolality = 2 x Sodium + Glucose/20 + BUN/3.**

BUN and glucose are reported in mg/dL for both of these formulas. Generally, the calculated and measured values are within 10 units of each other. If the measured value exceeds the calculated value by more than 10, other osmotically active substances are present.

The results of the two gap calculations can provide valuable information about the likelihood of ingestion of a volatile substance.

- If acidosis is low or nonexistent, but there is a significant ketosis and an increased osmolal gap, acetone or isopropanol are the most likely ingestants. Ketosis is due to acetone and both compounds contribute to the increased osmolality.
- A significant metabolic acidosis with increased anion gap not accounted for by lactate, and without ketosis, but accompanied by an increased osmolal gap, is consistent with methanol or ethylene glycol poisoning.

It is important to remember that co-ingestion of ethanol with methanol or ethylene glycol may inhibit the conversion of methanol or ethylene glycol to their acidic metabolites. In this situation, only the osmolal gap will be elevated. Combined elevation

of anion and osmolal gaps can also be seen with severe alcoholic ketoacidosis or diabetic ketoacidosis.

When ethylene glycol is suspected, examination of the urine may be helpful. Most antifreeze solutions have a fluorescein additive, which can be detected by examination of a urine sample under an ultraviolet lamp. Microscopic examination of urine for calcium oxalate crystals can also help make the diagnosis of ethylene glycol toxicity.

### **Improved Quantitation of HIV-1 Viral Load**

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Measurement of HIV-1 viral load is a critical tool for monitoring antiviral treatment response in infected individuals. Assays used to quantitate viral load in the United States are most accurate and sensitive for subtype B, the predominant strain in industrialized countries. Subtype B is far less prevalent in developing countries and dissemination of non-B subtypes is anticipated. Several studies have reported the failure of conventional assays to accurately detect and quantitate non-B subtypes.

Saint Luke's Regional Laboratories has implemented an improved assay for quantitation of HIV-1 viral load. The new assay was recently cleared by the FDA for diagnostic use. In addition to the *gag* region targeted previously, our new assay targets the *ltr* region. Specificity for both targets provides more stable detection and quantitation for all subtypes.

In addition, the new assay offers improved sensitivity. HIV-1 viral load can now be quantitated down to 20 copies/mL, versus the previous limit of 50 copies/mL.

### **Free T3 Reference Range Change**

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On October 18, Saint Luke's Regional Laboratories began performing free T3 measurements in house. The reference range has changed to 1.7-3.7 pg/mL from 2.0-3.5 pg/mL. Testing will be performed daily, Monday through Friday.