Medscape

Ethanol Level

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Reference Range

Ethanol level can be measured by blood, urine, saliva, or breath tests. Toxic concentration is dependent on individual tolerance and usage although levels greater than 300-400 mg/dL can be fatal due to respiratory depression. Conversion unit: one millimole of ethanol per liter of blood is equal to 4.61 milligrams of ethanol per 100 milliliters of blood. [1]

Serum ethanol levels are as follows:

- Negative: no alcohol detected
- Lower limit of detection [2] = 10 mg/dL
- >80 mg/dL (>17.4 mmol/L) is considered positive for driving under the influence in most states
- >300-400 mg/dL (65.1-86.8 mmol/L) potentially fatal

Blood alcohol concentration

To convert serum ethanol level to BAC, move the decimal point 3 places to the left. Example, a 100 mg/dL serum ethanol level is equivalent to a 0.10 (g/dL) BAC, or 0.10% (weight/volume). This means that one tenth of a percent of a person's blood volume is alcohol or that a person has 1 part alcohol per 1000 parts blood. [3, 4]

Urine ethanol level (similar to above)

Urine ethanol levels vary widely and do not correlate well with blood alcohol level (and according to Wallach cannot be used to determine level of intoxication; see more below). [2, 5]

Interpretation

The table below indicates the most common effects seen at different BAC levels, although a wide variation exists among individuals and symptoms overlap among different BAC levels.

Table. Effects of Alcohol by Blood Alcohol Concentration level* (Open Table in a new window)

BAC	Effects
0.01-0.05	No loss of coordination, slight euphoria, loss of shyness
0.04-0.06	Well-being feeling, relaxation, lower inhibitions, minor impairment of reasoning and memory, euphoria

0.07-0.09	Slight impairment of balance, speech, vision, reaction time, and hearing, euphoria. Judgment and self-control reduced. Caution, reasoning, and memory are impaired.
0.10-0.125	Significant impairment of motor coordination and loss of good judgment. Speech may be slurred; balance, vision, reaction time and hearing will be impaired. Euphoria.
0.13-0.15	Gross motor impairment and lack of physical control. Blurred vision and major loss of balance. Euphoria is reduced and dysphoria is beginning to appear.
0.16-0.20	Dysphoria (anxiety, restlessness) predominates, nausea may appear. The drinker has the appearance of a "sloppy drunk."
0.25	Needs assistance in walking; total mental confusion. Dysphoria with nausea and some vomiting.
0.30	Loss of consciousness
0.40 and up	Onset of coma, possible death due to respiratory depression/arrest.
*Effects are dependent on individual use, chronicity, and tolerance, and other factors.	

Blood ethanol levels are also useful in the diagnosis of alcoholism because individuals who habitually use this drug become tolerant. This diagnosis is suggested when a person can function in a relatively normal capacity (without evidence of intoxication) with a blood ethanol level greater than 150 mg/dL. [2]

Urine ethanol samples are known to be imprecise in estimating BAC and the degree of intoxication. However, it is adequate if the primary goal is to determine if alcohol has been consumed. Urine alcohol levels peak 45-60 minutes after ingestion and are considered approximately 1.3-1.5 times greater than blood levels.

This ratio, however, is for the elimination phase only (after the blood alcohol level has already peaked). Other issues to consider with urine testing: false negative tests can result from volatility of the alcohol, thus uncapped urine specimens lose 10-25% urine alcohol concentration per hour, and certain organisms such as Candida Albicans (if found in the urine) or high glucose content (as in uncontrolled diabetics) can cause a false positive test due to fermentation. Thus, urine samples should not be left at room temperature for prolonged periods of time. [6]

Breath samples can be affected by certain alcohol containing agents such as mouthwash or by ketone production. [7]

Collection and Panels

Serum ethanol [4, 8]

- Specimen: Blood
- Tube: Hospital dependent. Can use serum separator tube (contains clot activator and serum separator gel; also known as tiger-top tube), red tube, gray tube, or green tube (plasma). Please note that serum or plasma concentration is approximately 1.2 times higher than whole blood.
- Collection method: Routine venipuncture, but site should be cleansed with a nonalcohol solution such as benzalkonium chloride or aqueous povidone-iodine.
- Centrifugation: Serum should be immediately separated from the red blood cells and analyzed within 4 hours when collected without preservatives.
- Storage: Specimens should be kept sealed, because ethanol is volatile. Serum or plasma can be stored frozen.

Urine ethanol [6]

- Sample: Freshly voided random urine specimen of 25 mL
- This method is more precise if 2 specimens are collected 30 minutes apart. First specimen is discarded due to the uncertain timeframe in the bladder and second is used in BAC determination. Estimation ratio varies from 1.3:1 to 1.5:1.

Saliva ethanol [2]

- Enzymatic colored strip reacts and changes depending on concentration of alcohol in saliva. This is compared to a color scale. Detects greater than 0.02%.

Breathalyzer [9]

Indirect measure of BAC taken from expired air (alveoli). Ratio of breath alcohol to blood alcohol is 2100:1, meaning that 2100 mL of air will contain same amount of alcohol in 1 mL of blood.

Background

Description

Ethanol, or ethyl alcohol, is one of the most abused substances in the world. It is found in many recreational substances in varying concentrations, including beer, wine, and hard liquors: whisky, rum, vodka, etc. Unfortunately, to those desperate for alcohol and no access, methanol and ethylene glycol (found in antifreeze, windshield wiper fluid, etc) may be used as a surrogate with devastating consequences.

Ethanol, a water-soluble 2 carbon chain molecule (CH2CH3OH), is absorbed primarily in the small intestine and secondarily in the stomach. It is eliminated mostly by metabolism in the liver, with the remainder excreted through urine, exhaled breath, and sweat. The volume of distribution approximates total body water and accounts for rapid distribution. [10, 11]

More than 90% of ethanol is oxidized in the liver primarily by the enzymes alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH). Metabolism at high alcohol concentrations follows zero order kinetics (independent of time and concentration of the drug). In the initial metabolic pathway, ADH breaks down alcohol into the toxic metabolite acetaldehyde. Small amounts of ADH are also found in other organs such as the stomach. This metabolite is further broken down to acetate by ALDH. Acetate is fed into the Krebs cycle and eventually broken down to water and carbon dioxide. [10, 11, 12]

An estimate for blood alcohol level would be each ounce of whisky, 12 ounces of beer, or 5 ounces of wine raises blood alcohol level 15-25 mg/dL. Peak is reached anywhere between 30 minutes (if consumption in fasting state) to 3 hours after the last drink. Metabolism is anywhere from 10-30 mg/dL/hour and depends upon a multitude of factors, including liver size. [4] The level of intoxication (and peak) is affected by age, gender, weight, presence of food in the stomach, number of drinks per hour, percentage of alcohol in the drink (proof), and the presence of other drugs that interact with the alcohol. [9] In general, women have a higher peak than men partly due to the fact that women have a higher fat content (and lower total body water) than men. The smaller amount of ADH found in the stomach and, thus metabolism, may contribute to the sex-related differences in ethanol concentration as well. [10]

Indications/Applications

Measurement of ethanol levels may be done for medical or legal purposes. Blood testing is most common modality used for medical purposes. Serum ethanol levels may be ordered in suspected alcohol ingestion as well altered mental status of unknown etiology, coma, psychiatric emergencies, traumatic emergencies, and history of other ingestions (eg, toxic alcohol, salicylates). Because alcohol-intoxicated patients may have other concurrent disease processes, re-assessing these patients frequently and using the serum ethanol level within the complete context of the patient is imperative.

Considerations

In patients who are clinically intoxicated and have a negative alcohol level, other diagnoses must be considered such as toxic alcohol consumption (methanol, ethylene glycol, or isopropyl alcohol). While an in depth review cannot be covered here, other laboratory testing to consider include a basic metabolic panel for anion gap acidosis, arterial blood gas analysis, urinalysis for crystal evaluation, and osmolality level to calculate the osmolar gap, as well as serum toxic alcohol levels. While fomepizole is used commonly to treat toxic alcohol ingestions, ethanol is still considered a treatment option and will require serum ethanol level monitoring.

For children, blood glucose should be checked because ethanol can cause hypoglycemia. This is due to the smaller glycogen stores in children's livers, as well as inhibition of gluconeogenesis by ethanol. [11] Note that a positive alcohol level (especially in the altered mental status patient or possible psychiatric patient) does not preclude further workup because many organic disorders can mimic alcohol intoxication or be confounded by this diagnosis.

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Tables

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