- The *Dubowski Scale* is shown further down in this section. The problem is blackouts are not parallel to degrees of intoxication. Remember, it's not how much, it's how quickly.
- *Behavioral Tolerance*: Over time, alcoholics will tend to develop increasing tolerance and may show less effects. One study was conducted at an emergency room over a two-year period on individuals presenting for minor emergencies (lacerations, etc.) Of those who admitted to drinking alcohol <u>but appeared sober to medical staff</u>, researchers found men with an average of .272 BAC and women with an average of .260 BAC. (Urso, 1980)
- The *Mellanby effect* has been demonstrated for intoxication and willingness to drive. Objective measures of skills necessary for safe driving, such as response to inhibitory cues and skills measured on driving simulators, were generally worse on the descending part of the BAC-time curve for the same BAC. (Holland, 2017)

- Practical questions regarding the victim…
  - Behavioral tolerance?
  - How much did s/he have to drink? Too drunk to accurately remember events?
  - How much was eaten eight hours prior/during the instant event?
  - Were there medications / OTC / recreational drugs?
  - How much sleep had s/he gotten?
  - Has s/he had previous blackouts?
  - Was a BAC taken? How long after the last drink?
- A good expert knows his/her limits.

A. Alcohol Concentration (AC) Estimates

The prosecutor may need to establish an AC at time of driving, rather than at the time that the test sample was obtained. Sometimes a sample cannot be taken until several hours after the driving, requiring expert testimony to relate the AC to the time of driving. The estimate may be complicated by allegations that additional alcohol was consumed after the crash or traffic offense and prior to obtaining the sample. The defense may claim that the alcohol concentration at the time of the offense was lower than at the time of the test due to the consumption of alcohol just prior to the offense (the so-called rising curve defense). The defense may also use an AC estimate based on the drinking history in an attempt to discredit the test result (i.e. "I only had two beers"). Conversely, the prosecutor may wish to discredit the defendant's drinking history by using the test result. Other scenarios, some quite imaginative, may be posed as defenses. A basic understanding of the principles of alcohol pharmacokinetics will aid in effectively dealing with these issues in court.

> Note: By itself, the measured AC cannot be used to reliably estimate an AC at any other time, but the measured AC can be used as the foundation of an estimate when knowledge of how alcohol is absorbed, distributed and eliminated is combined with the facts surrounding the case.

B. Absorption

Absorption is the process of moving alcohol from outside the body into the bloodstream where it can be distributed throughout the body. As a small, completely water-soluble molecule, ethyl alcohol is readily absorbed into the mucous lining of the digestive tract. When it comes into contact with the digestive tract, alcohol is absorbed via simple diffusion into the mucous lining and then into the blood. The amount absorbed at any given site depends upon the surface area, the thickness of the lining and the blood supply. Unlike most other ingested substances, alcohol is not digested and can be absorbed unchanged directly through the stomach lining. Only about 20-25% of ingested alcohol is absorbed in

this manner because the stomach has a relatively small surface area and limited blood supply. The remaining 75-80% of the alcohol is rapidly and efficiently absorbed when it leaves the stomach and enters the small intestine, which has a large surface area and rich blood supply.

C. Rate of Absorption and Time to Peak

Because alcohol is rapidly absorbed once it reaches the small intestine, anything that delays the stomach from emptying its contents into the small intestine will slow the rate of alcohol absorption. The most rapid absorption takes place when a 20% solution of alcohol is consumed on an empty stomach. Diluted drinks take somewhat longer to absorb. In concentrated drinks (greater than 40% by volume) alcohol acts as an irritant to the gastric lining and will be retained in the stomach until it can be diluted. Alcoholic beverages containing ingredients that require digestion, such as carbonated beverages, may also slow absorption somewhat. Absorption may also be affected by emotional state, shock and medications that impact stomach function and the general condition of the gastrointestinal tract. **The most important factor affecting absorption is the presence of food in the stomach concurrent with alcohol.** Food requires digestion and any alcohol trapped in food particles will take longer to be absorbed. The extent of the effect depends on the amount and type of food. . . The delay in absorption causes a lower peak alcohol concentration that lasts longer compared to consumption on an empty stomach.

Absorption rates and times vary considerably between subjects - even within the same subject at different times under similar conditions. The rate of alcohol absorption is non-linear. An initial rapid rise in AC is followed by a gradual tapering off until a peak concentration is attained. Of greatest forensic use is the time it takes for alcohol to reach its peak concentration after consumption. Peak concentrations are generally attained within 30 - 60 minutes of the cessation of drinking. Because of the initial rapid rise of AC after drinking, most of the peak AC is reached within the first 30 minutes. This is true whether or not food is present, even though food can affect the magnitude of the peak concentration. When alcohol is consumed successively over time, as in social drinking situation, peak concentrations are generally attained within 30 minutes of the last drink and may even be attained before the last drink is finished. Pp. 11-14

Alcohol Toxicology for Prosecutors (July 2003). American Prosecutors Research Institute, pp. 11-14

D. Distribution

Once absorbed, alcohol is transported by the blood and distributed throughout the body. As blood flows to the body's organs and tissues, alcohol diffuses across membranes into all areas that contain water. Alcohol always moves by simple diffusion from a higher concentration to a lower concentration.

Because **alcohol is completely soluble in water**, the AC in the whole body is directly proportional to total body water content. Water content varies from person to person. Obese individuals have less water per pound of body weight than individuals of average build because fat cells contain little water. Females tend to have a higher proportion of body fat than males. **About 68% of an average male's body weight is due to body water, while the percentage is 55% for average females**. In general, the heavier a person is, the greater the amount of alcohol that must be consumed to reach a specific alcohol concentration in the body. The relative alcohol concentration in any fluid or tissue is also directly related to its water content. The higher the water content, the higher the relative alcohol concentration.

Alcohol Toxicology for Prosecutors (July 2003). American Prosecutors Research Institute, pp. 14-15

E. Elimination

Alcohol is eliminated from the body through metabolism, excretion and evaporation. **Metabolism accounts for approximately 95% of alcohol elimination**. Enzymes act on alcohol molecules to change them into other compounds; these by-products are further metabolized. Alcohol dehydrogenase (ADH) in the liver is the enzyme that is primarily responsible for alcohol metabolism. ADH is also located in the stomach lining, causing a small portion of an alcohol dose to be eliminated before it has a chance to be absorbed. Other enzyme systems also act on alcohol, coming into play especially at higher alcohol concentrations.

Alcohol is also excreted unchanged through urine, tears, sweat, semen and saliva. Each drop of urine that is produced and pooled in the bladder reflects the alcohol concentration of the circulating blood at that time. Because alcohol has a high vapor pressure at body temperatures, alcohol will evaporate from the blood into the lungs and be excreted in breath, allowing it to be measured in a breath sample.

Rate of elimination. The average rate of elimination (combining metabolism, excretion and evaporation) is between 0.015 to 0.018% per hour. Expressed in terms of common alcohol measurement units this is 0.015 - 0.018 g/100 mL or g/210 L per hour. Although the range of rates reported in the scientific literature can be quite large, as a practical matter you can expect a range of rates from 0.01 to 0.025% per hour in drinking drivers. Inexperienced drinkers tend to have a lower average rate than moderate drinkers, while chronic drinkers and alcoholics will have the highest average rates of elimination. Elimination rates do not vary significantly within the same person at different times, although alcohol will be eliminated more rapidly during periods of heavy drinking. At low AC's (0.02 and below), the rate of elimination slows considerably as the enzymes no longer have enough alcohol available to work at peak efficiency.

Because metabolism accounts for the vast majority of elimination, there is no practical way for a subject to alter it. As long as blood is flowing to the liver, alcohol will continue to be metabolized.

Alcohol Toxicology for Prosecutors (July 2003). American Prosecutors Research Institute, pp. 15-16

Research Abstracts on Alcohol Toxicology

Is Behavioral Tolerance Learned?

Muriel Vogel-Sprott

Alcohol Health & Research World, Vol. 21, No. 2, 1997

Abstract

Both scientific and anecdotal evidence indicates that social drinkers can develop resistance (i.e., behavioral tolerance) to alcohol's impairing effects over time. Although repeated exposure to alcohol is thought to explain tolerance development on a physiological level, the acquisition of behavioral tolerance appears to involve additional factors. In particular, learned associations between a drinker's behavior following alcohol consumption and the subsequent consequences may play an important role. When favorable consequences result from displaying unimpaired (i.e., tolerant) behavior after drinking, a drinker learns to develop behavioral strategies to compensate for alcohol's effects. In contrast, if a drinker does not receive a reward for unimpaired behavior—or finds that a more favorable outcome follows the display of intoxicated behavior—tolerance does not develop. Studies show that subjects also can develop behavioral tolerance to alcohol when they practice a task while

impaired by factors other than alcohol or when they mentally rehearse task performance while under the influence of alcohol.

Ethanol forensic toxicology.

Perry, Paul J., et al.
Clinical Sciences Department, Touro University California College of Pharmacy, Vallejo, CA,
Journal of the American Academy of Psychiatry and the Law, Vol 45(4), Dec 1, 2017. pp. 429-438.

Abstract:

Ethanol abuse can lead to negative consequences that oftentimes result in criminal charges and civil lawsuits. When an individual is suspected of driving under the influence, law enforcement agents can determine the extent of intoxication by measuring the blood alcohol concentration (BAC) and performing a standardized field sobriety test. The BAC is dependent on rates of absorption, distribution, and elimination, which are influenced mostly by the dose of ethanol ingested and rate of consumption. Other factors contributing to BAC are gender, body mass and composition, food effects, type of alcohol, and chronic alcohol exposure. Because of individual variability in ethanol pharmacology and toxicology, careful extrapolation and interpretation of the BAC is needed, to justify an arrest and assignment of criminal liability. This review provides a summary of the pharmacokinetic properties of ethanol and the clinical effects of acute intoxication as they relate to common forensic questions. Concerns regarding the extrapolation of BAC and the implications of impaired memory caused by alcohol-induced blackouts are discussed.

Stages of Acute Alcoholic Influence / Intoxication

BLOOD- ALCOHOL CONCENTRAT grams/100 mL	STAGE OF ALCOHOLIC INFLUENCE	CLINICAL SIGNS/SYMPTOMS
0.01-0.05	**Subclinical**	Influence/effects usually not apparent or obvious Behavior nearly normal by ordinary observation Impairment detectable by special tests
0.03-0.12	**Euphoria**	Mild euphoria, sociability, talkativeness Increased self-confidence; decreased inhibitions Diminished attention, judgment and control Some sensory-motor impairment Slowed information processing Loss of efficiency in critical performance tests
0.09-0.25	**Excitement**	Emotional instability; loss of critical judgment Impairment of perception, memory and comprehension Decreased sensitory response; increased reaction time Reduced visual acuity & peripheral vision; and slow glare recovery Sensory-motor incoordination; impaired balance; slurred speech; vomiting; drowsiness
0.18-0.30	**Confusion**	Disorientation, mental confusion; vertigo; dysphoria Exaggerated emotional states (fear, rage, grief, etc) Disturbances of vision (diplopia, etc.) and of perception of color, form, motion, dimensions Increased pain threshold Increased muscular incoordination; staggering gait; ataxia Apathy, lethargy
0.25-0.40	**Stupor**	General inertia; approaching loss of motor functions Markedly decreased response to stimuli Marked muscular incoordination; inability to stand or walk Vomiting; incontinence of urine and feces Impaired consciousness; sleep or stupor
0.35-0.50	**Coma**	Complete unconsciousness; coma; anesthesia Depressed or abolished reflexes Subnormal temperature Impairment of circulation and respiration Possible death
0.45+	**Death**	Death from respiratory arrest

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