EFFECTS OF ALCOHOL ON HUMAN PERFORMANCE

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Preparation of Ethanol

- **Drinking ethanol (grain neutral spirits/GNS).**
  - Yeast + glucose + water = ethanol + CO$_2$.
  - Bread – CO$_2$ is desired product.

- Can be synthesized (illegal to drink) – cheaper to ferment.
  - Denatured with gasoline (eutectic) if it is not taxed.

- If grains or cereals are used for fermentation, they are allowed to malt (rot)(complex CHO’s > glucose) so there is glucose available for the yeast. (Beer)

- Ethanol is concentrated by distillation up to 95% purity(eutectic with water).
Alcohol Beverages

- Alcoholic beverages are flavored dilutions that mask the acrid taste of ethanol.
- Aged whiskey is GNS stored in charred (by fire) white oaken barrels. Ethanol removes fusel oils from the charred wood that “improves” the flavor of ethanol.
- Beer is not distilled (3-6% EtOH)
- Wine is made from fruit and not distilled (4-20% EtOH (Brandy is distilled wine))
- Vodka is grain neutral spirits (sometimes aged whiskey is passed through activated charcoal to make vodka. Vodka may have a light flavoring from distilling over fruits or berries.)
Beverages with Ethanol

- **Proof strength**
  - $\text{Proof } \div 2 = \% \text{ ethanol} \ (80 \text{ proof } = 40\%)$

  - **100 Proof** = 50% ethanol (Everclear = 190 Proof)

  - In the old days – alcohol was mixed with gunpowder and if the mixture could be ignited, it was considered 100% proof it was good stuff. It had to be at least 50% ETOH to ignite

- 1 drink or “dose” usually contains 0.4-0.5 oz of pure (95%-190 Proof) Ethanol

- States and communities regulate the proof strength that can be sold. Beer %, proof of whiskey.
Expressing Concentrations (blood levels)

- Blood concentrations of ethanol are measured to determine its effects.

- Medical (serum/plasma)
  - mg/dl  milligrams per deciliter (100 ml)

- Legal (whole blood – 18% lower than serum)
  - Gm%  (grams/deciliter)
  - 0.08 Gm%  legal limit for adults  = 80 mg/dL
Summary of Ethanol Kinetics

- 1 “dose” produces a BAC of 15-20 mg/dl in an average person based on height.

- 1 “dose” is removed per hour by metabolism (population average metabolism is 17 mg/dl/hr).

- Drinking 1 “dose” per hour would produce a “safe” BAC in average person.

- 2-4 “doses” in < 1 hr will produce “legal intoxication” of 80 mg/dl.
Dosing with Ethanol

- **1 Dose of Ethanol**
  - 1 oz of 80 Proof Whiskey
    - 1 oz x 40% Ethanol = 0.4 oz ethanol
  - 12 oz of 3.5% Beer (7 proof)
    - 12 oz x 3.5% Ethanol = 0.42 oz ethanol
  - 4 oz of 10% Wine (20 proof)
    - 4 oz x 10% Ethanol = 0.4 oz Ethanol
Dosing with Ethanol

- Clinical studies indicate that an individual will drink to a desired Blood Alcohol Level (BAC) and maintain it.
  - Loading Dose usually 2 – 4 doses/1st hour
  - 1 or more doses each succeeding hour
- The loading dose increases as behavioral tolerance develops to ethanol.
Ethanol Distribution

- Distributed in body water, i.e. muscle, but not fat. (Female - $V_d$ 0.55L/Kg  Male - $V_d$ 0.68L/Kg)

- Ideal Body Weight (IBW) your weight without the excess fat.
  - ^ Muscle will ^ IBW

- Height is more important than weight
Ethanol Calculations

- **Dose** = grams/dL X 0.68L/Kg x Wgt in Kg X 10 dL/L = grams of ETOH

- **Example** = .118g/dL X 0.68L/Kg X 85Kg X 10dL/L = 68.2 grams

- **Grams ETOH in a drink** = Oz. x 29.6ml/Oz X %/(ml)ETOH/100ml X 0.789g/mlETOH

- **Example** = 12 Oz. X 29.6ml/Oz. X 4.2ml ETOH/100ml X 0.789 g/ml ETOH= 11.77 grams

- **Vd of ETOH** = 0.68L / Kg (male) 0.55L / Kg (female)

- **SpGr of ETOH** = 0.789g/ml

- **BAC in g/dL** = grams ETOH ingested divided by : 0.68L/Kg X Wgt in Kg X 10dL/L

- **Population average elimination of ETOH** = 0.017g/dL/hour (range 0.010-0.035)
Alcohol and Travel

- 40 percent of all traffic fatalities (the leading cause of accidental death) are alcohol related.
- Although alcohol has not been directly implicated in U.S. commercial airline crashes, typical estimates of alcohol involvement by pilots in fatal general aviation crashes range from 10 to 30 percent.
- A recent review of Coast Guard reports suggests alcohol involvement in 60 percent of boating fatalities (including persons who fell overboard).
- In post-accident testing of railroad employees in 1990, 3.2 percent tested positive for alcohol or other prohibited drugs.
Alcohol-Related Impairment

- Skills may be divided into **cognitive** (information processing) and **psychomotor** (those involving eye-brain-hand coordination).
- Impairment is related to alcohol in terms of its concentration in the bloodstream.
- The brain's control of **eye movements** is highly vulnerable to alcohol. In driving, the eyes must focus briefly on important objects in the visual field and track them as they (and the vehicle) move. Low to moderate BAC's (0.03 to 0.05%) interfere with voluntary eye movements, impairing the eye's ability to rapidly track a moving target.
- **Steering** is a complex psychomotor task in which alcohol effects on eye-to-hand reaction time are superimposed upon the visual effects described above. Significant impairment in steering ability may begin as low as approximately 0.035%.
- Alcohol-impaired drivers require more time to **read** a street sign or to **respond** to a traffic signal than unimpaired drivers.
Alcohol-Related Impairment

- The most sensitive aspect of driving performance is the division of attention among component skills. Alcohol-impaired subjects who are required to divide their attention between two tasks tend to favor one of them. Attention deficits occur as low as 0.02%.
  - Planning and performance errors, procedural errors, and failures of vigilance each increase significantly with increasing BAC. Serious errors increased significantly at the lowest BAC, 0.025% compared with performance at 0%.
  - Degree of impairment depends on the complexity of the task involved as well as the BAC.
  - Magnitude of alcohol-induced impairment rises as BAC increases.
  - Investigators have not found an absolute BAC threshold below which there is no impairment. Certain skills important for driving are impaired at 0.01 to 0.02% BAC, the lowest levels that can be reliably measured.
Predicted Alcohol Levels (approximate)

Legal Intoxication = 0.08%

<table>
<thead>
<tr>
<th>Height</th>
<th>Female</th>
<th>Male</th>
<th>BAC if consumed in 15 min**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IBW*/V_d</td>
<td></td>
<td>1 dose</td>
</tr>
<tr>
<td>5'2&quot;</td>
<td>V_d .55L/Kg</td>
<td>V_d .68L/Kg</td>
<td>.042%F</td>
</tr>
<tr>
<td>5'6&quot;</td>
<td>V_d 28L</td>
<td>V_d 37L</td>
<td>.036%F</td>
</tr>
<tr>
<td>5'10&quot;</td>
<td>V_d 33L</td>
<td>V_d 44L</td>
<td>.032%F</td>
</tr>
<tr>
<td>6'0&quot;</td>
<td>V_d 37L</td>
<td>V_d 50L</td>
<td>.030%F</td>
</tr>
</tbody>
</table>

* ^ Muscle Mass increases IBW

** Alcohol is lost at an approximate rate of 0.017 G%/hour
The Effects of Alcohol

Euphoria (BAC = 0.03 to 0.12 percent)

Excitement (BAC = 0.09 to 0.25 percent)

Confusion (BAC = 0.18 to 0.30 percent)

Stupor (BAC = 0.25 to 0.4 percent)

Coma (BAC = 0.35 to 0.50 percent)

Death (BAC more than 0.50 percent)
What are “Safe” levels of Alcohol

- **Medically Safe level:** 0.010Gm% - 10 mg/dL
  - Acute Life Threatening Level > 0.350Gm% - 350 mg/dl

- **Safe Level for Driving a car**
  - Daylight - 0.05Gm% - 50 mg/dL
  - Night – 0.02Gm% - 20 mg/dL

- **Safe Level for hazardous work conditions**
  - 0.02 Gm% - 20 mg/dl

- **Legally Safe Level (DWI) – 0.08Gm% - 80 mg/dl**

- **Financially Safe Level – < 0.02 Gm% - 20 mg/dL**
How Much Alcohol is “Normal”?

- Alcohol is a normal substrate in the body
  - Porphyrin Catabolism
  - Fermentation in the GI tract.
  - Normal levels are < 0.01Gm%

- Alcohol is metabolized by Alcohol Dehydrogenase (liver)
  - Alcohol Dehydrogenase is saturated at 0.01Gm%/10mg/dl leads to buildup of ethanol in blood (CNS depression)
  - Alcohol > acetaldehyde > acetate
  - Acetaldehyde dehydrogenase is also saturated
  - Acetaldehyde is responsible for the toxicity - hangover and many of the “un-pleasant” effects of drinking ethanol.
Variables with Ethanol Dosing

- Alcohol Absorption from the stomach is delayed because it takes from 15 minutes to several hours for gastric emptying to occur.

- Food in stomach delays gastric emptying about an hour
  - Fatty foods delay more than carbohydrates
  - Delayed (but not necessarily diminished) toxicity

- Beverage ethanol concentration affects absorption rate.
  - Whiskey vs Beer or Mixed drink

- Breath or blood tests are the only reliable indication of BAC.
- Horizontal gaze nystagmus occurs at BAC > 0.05%
Medical Treatment of Ethanol Poisoning

- **Supportive**
  - **Dehydration** – EtOH is Diuretic
    - Inhibits ADH
  - **Cutaneous vasodilatation** – heat loss
  - **Post absorptive increase in BAC**
  - **Monitor for Acid base balance disturbance**
    - Due to Acetaldehyde
  - **Monitor for electrolyte changes**
    - Vomiting
  - **Monitor Blood Glucose in diabetics and children.**
    - Can decrease or increase.
Medical Treatment of Ethanol Poisoning

- Serial blood ethanol levels to evaluate patient status if they are also traumatized or have ingested other drugs.
  - May have ethanol analgesia

- Do not release IF unaccompanied until
  - BAC is at a safe level (< 20mg/dl 0.02%).
  - Residual effects have dissipated.
  - Patient is stable.
Scope of Legal Consideration

- DWI/BWI/WWI  Driving/Boating/Walking while Impaired/Intoxicated
  - DUI/DUID/BUI/BUID/WUI/WUID
- Boating
- Workplace Alcohol/Drug Use
- Professional Licensure
- Professional Liability
- Impaired Professional
- Child Abuse/Custody
§98. Operating a vehicle while intoxicated
A.(1) The crime of operating a vehicle while intoxicated is the operating of any motor vehicle, aircraft, watercraft, vessel, or other means of conveyance when:
(a) The operator is under the influence of alcoholic beverages; or
(b) The operator's blood alcohol concentration is 0.08 percent or more by weight based on grams of alcohol per one hundred cubic centimeters of blood; or
(c) The operator is under the influence of any controlled dangerous substance listed in Schedule I, II, III, IV, or V as set forth in R.S. 40:964; or
(d)(i) The operator is under the influence of a combination of alcohol and one or more drugs which are not controlled dangerous substances and which are legally obtainable with or without a prescription.
(ii) It shall be an affirmative defense to any charge under this Subparagraph pursuant to this Section that the label on the container of the prescription drug or the manufacturer's package of the drug does not contain a warning against combining the medication with alcohol.
(e) The operator is under the influence of one or more drugs which are not controlled dangerous substances and which are legally obtainable with or without a prescription and the influence is caused by the operator knowingly consuming quantities of the drug or drugs which substantially exceed the dosage prescribed by the physician or the dosage recommended by the manufacturer of the drug.
Testing for Ethanol

- Evidentiary Breath Testing
  - Breath test presumes ratio of 2100:1 of blood/breath (alveolar air)
    - 15 minute wait until mouth alcohol is absorbed.
    - Ratio is variable, women have a lower ratio than men/higher BrAC.
    - Reflects arterial blood which is higher during absorption phase and lower after absorption.
  - Cutoff at 0.02% (reported as 0)
  - Law may stipulate Breath Alcohol Level so it does not have to be compared to blood.
Don’t Drink and drive

- Cannot calculate your BAC reliably
  - Short term memory loss at 0.05%
- Companions can’t evaluate since they may also be impaired.
- Variability in BAC with alcohol consumed
- Variability in alcohol content of drinks
- Significant penalty

Designated Driver – non drinking

- Non drinking = none…..not even a drop
Hospital testing.

- Post accident.
  - Workplace.
  - MVA.
  - Home

- Medical alcohol test/UDS is used in civil liability suit in accidents.
Drugs/Ethanol Overview

- CNS depression and psychomotor impairment proportional to blood level
- BAC correlated to dose, height and IBW
- Alcohol Elimination is 0 order (17 mg/dl/hr)
  - 1 dose/hour
- Can decrease glycogenolysis and interfere with gluconeogenesis (decrease blood sugar)
- Legal restrictions on use.
- UDS has legal significance.