Standardization of Alcohol Interpretation

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The Estimation of Blood Alcohol ' Concentration Widmark ' Revised.pdf '

Outline

- Retrograde vs. Anterograde Extrapolation and Why?
- What are the issues with using Widmark Formula?
- What Information is Needed? '
- Legal Expectations

Retrograde *vs* Anterograde Extrapolation

- Retrograde
  - A known BAC is used to estimate a BAC at an earlier time
  - Requires the determination of ' consumed ethanol '
- Anterograde
  - A known amount of consumed ethanol is used to estimate a BAC at a later time '

Why is alcohol extrapolation necessary?

- Texas Penal Code Chapter 49 Sec. 49.01 defines ' "intoxicated" as: '
  - "not having normal use of mental or physical faculties by reason of introduction of alcohol, a controlled substance, a drug, a dangerous drug, a combination of two or more of those substances…" **OR**
  - "having an alcohol concentration of 0.08 (g/100 mL) or more."

- Chapter 49 Sec. 49.04 states an offense is committed if the person is intoxicated **<u>while</u>** operating a motor vehicle.

Measuring the BAC

- Demonstrate that the method is accepted by the scientific community
  - Methods are published and subject to peer review '
  - Laboratory is accredited
  - Laboratory participates in proficiency tests
  - Show how your laboratory ensures accuracy and precision
    - Which controls and standards do you use and why?
    - How does your instrument tell one compound (i.e. ethanol) from similar compounds (i.e. acetone)?

Primary Contributors to the Calculation of BAC

- Rate of absorption of the alcohol
- Distribution of the alcohol in the body
- Rate of elimination from the body

$$c = A / rW - \beta t$$

Widmark Formula – Traditional formula used to estimate BAC

Blood Alcohol Concentration "C" =

A: Amount of alcohol ingested (grams)

W: Body weight

β = Elimination Rate

T= Time since start of drinking

R: Widmark "Factor"

0.55 ± 0.11 for women

0.68 ± 0.17 for men

"R" accounts for the volume distribution of alcohol in the human body which affects how much is in the blood v. tissues thus determining the degree of intoxication.

Absorption

- Widmark calculations are based on a rule stating that alcohol is completely absorbed between 30 minutes and 2 hours after ingestion
  - This assumption is little help for ingestions of alcohol within the past hour

Elimination

- Widmark measured the elimination rate (β) in a large ' number of individuals and found it to average about ' 0.018 g% per hour
- Elimination rate has been found to vary significantly ' among individuals '
- The average elimination rate is about 0.018 g% per hour, with the range between 0.009 and 0.035 g% per hour
- BAC calculations are frequently based on an estimated elimination rate between 0.017 and 0.020 g% per hour

Range of Elimination Rates

- For non-alcoholics being 0.010 to 0.025g/dl/hr
- For alcoholics the range extending up to 0.035g/dl/hr. '

- https://www.ncbi.nlm.nih.gov/pubmed/20304569

Jones, A.W. (2010) Evidence-Based Survey of the Elimination Rates of Ethanol From Blood With Applications in Forensic Casework. Forensic Science International. 200: 1-20.

Information Required to Perform Alcohol Extrapolation

- Time of first drink
- Time of last drink
- Time of last meal
- Time of incident/traffic stop/accident
- Type/ Number of beverages consumed
- Demographic information about the individual
  - Sex
  - Age
  - Weight
  - Height

Published Research since 1932

- **<u>Absorption</u>:**
- Uemura et al. (2005) → First order rate constant of 6.5 +/- 1.5

- **<u>Distribution</u>:**
- Widmark (1932)
  - Male → 0.68
  - Female → 0.55
- Watson et al. (1981)
  - Male → 0.39834 + (12.725*H/W) – (0.11275*A/W) + (2.8993/W)
  - Female → 0.29218 + (12.6665*H/W) – (2.4846/W)

Published Research since 1932

- **<u>Distribution</u>:**
- Forrest (1986)
  - Male → $1.0178 – (0.012127*W/H^2)$
  - Female → $0.8736 – (0.124*W/H^2)$
- Ulrich et al. (1987)
  - Male → $0.715 – (0.00462*W) + (0.22*H)$
- Seidl et al. (2000)
  - Male → $0.31608 – (0.004821*W) + (0.4632*H)$
  - Female → $0.31223 – (0.006446*W) + (0.4466*H)$

Widmark determined the "r" factor by evaluating a group of volunteers in 1932.

PROBLEM: The Widmark "r" values are outdated … …Refinements to Widmark's "r" factor published over the years, but are often ignored due to complexity in calculations

(1)Widmark (1932)

0.55 ± 0.11 R females

0.68 ± 0.17 R males

(2) Watson (1981)

$$r_{Watson}\,(\text{females}) = 0.29218 + \frac{12.666H}{W} - \frac{2.4846}{W}$$

$$r_{Watson}\,(\text{males}) = 0.39834 + \frac{12.725H}{W} - \frac{0.11275G}{W} + \frac{2.8993}{W}$$

(3) Forrest (1986)

$$r_{Forrest}\,(\text{females}) = 0.8736 - \frac{0.0124W}{H^2}$$

$$r_{Forrest}\,(\text{males}) = 1.0178 - \frac{0.012127W}{H^2}$$

(4) Seidl (2000)

$$r_{Seidl}\,(\text{female}) = 0.31223 - 0.006446W + 0.4466H$$

$$r_{Seidl}\,(\text{male}) = 0.31608 - 0.004821W + 0.4632H$$

Average r Value

- All of these methods ultimately arrive at an r value or a value that can easily be converted to r, therefore it is possible to calculate an average r value from the several different methods
- ravg(male) = 0.2(rWidmark + rWatson + rForrest + rSeidl + rUlrich) '
- ravg(female) = 0.25(rWidmark + rWatson + rForrest + rSeidl)

Legal Expectation

- Single BAC value, without considering the full range of possible values that could reasonably attributed as the actual BAC value, will be considered as an exact value to the trier of fact and therefore the prejudicial risk outweighs the probative value of the BAC results.

- In closing, one ruling (Snohomish Co) states "to allow the test value into evidence without stating a confidence interval violates ER 403. The probative value of this evidence is substantially outweighed by its prejudicial value."
- Snohomish-County-District-Court-Cascade-Decision-Moon-032710 (1).pdf '

- When a witness is sworn in, he or she most often swears to "tell the truth, the whole truth, and nothing but the truth." In other words, a witness may make a statement that is true, as far as it goes. Yet there is often more information known to the witness, which if provided, would tend to change the impact of the information already provided. Such is the case when the State presents a breath-alcohol reading without revealing the whole truth about it.
- final\Opinion_and_Order_5.10.11 - Suppression of BAC without Uncertainty (1).pdf
- final\KING County Washington RULING on UNCERTAINTY (1).pdf

Recommendation for Practicing Forensic Toxicologists

- Expert should ensure utilize all published methods for distribution and a reasonable range of absorption and elimination rates to ensure an appropriately account for the variations in alcohol metabolism, .

Extrapolation by merely assuming an average elimination rate is incomplete just as assuming Widmark distribution without including the other methods is incomplete.

Summary

- It is difficult to account for a confidence interval in extrapolation scenarios however experts should consider including the full range of estimated values using the range of input parameters that have been found to be reasonable to account for intra and inter-individual variations in alcohol metabolism, specifically related to distribution and elimination parameters.
- It is a legal obligation of experts to let the court know about the full range of possible values. '

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