E39 Widmark's Alcohol Equation: A Forensic Application for Litigation

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After attending this presentation, attendees will understand the simplified forensic application of conducting Widmark's Alcohol Equation in Driving Under the Influence (DUI) and other alcohol investigative-related litigation.

This presentation will impact the forensic science community by reinforcing the necessity of properly applying Widmark's formula to address assumptions and avoid false and misleading results in judicial proceedings.

Widmark's Equation is an algebraic formula first published by Dr. Eric M.P. Widmark in 1932.[1] The equation is frequently utilized in courtrooms to determine the total number of alcoholic drinks in the human body based upon a forensic breath, blood or urine alcohol sample.[2] The equation has also been used in an attempt to perform a retrograde extrapolation of a measured alcohol concentration to a different point in time, typically the drive time. The latter application has been called "forensically unreliable" due to the number of unknowns including: absorption vs. elimination phase; peak concentration; elimination and absorption rates; and, short-term fluctuations in concentration.[3]

Widmark's Equation is often expressed as follows:

$$AC = \frac{A \times 0.8}{W \times R} \times 100$$

A = Mls of pure ethanol, 200 proof
AC = Alcohol Concentration, Chemical Test
W = Body weight in grams
R = Water: tissue volume of distribution: 0.55 for females; 0.68 for males
0.8 = Specific gravity of ethanol

While many versions of Widmark's Equation are used in courtrooms and have undergone many updates, a simplified version that combines the constants and conversion factors is expressed as follows:[4,5]

$$AC = \frac{D \times 2.6}{P \times R}$$

Where:
P = Weight in pounds; 1 pound = 454 grams
D = Number of drinks; 1 drink = 1 oz. of 100 proof = 30 mls of 100 proof = 12 oz. of beer (~4.2% ABV) = 4 oz. wine (12.5% ABV)

For Alcohol Concentrations (AC) other than 100 proof, multiply the AC calculated for that drink (D) or portion of a beverage by the alcohol proof expressed as a percentage (e.g., for 80 proof alcohol, the user would multiply the AC by 0.80) Assumptions pertaining to the height/weight distribution and alcohol content of each drink need to be clearly stated.

This simplified version does not change Widmark's formula. It merely converts the formula into a manageable equation for the non-scientist by defining a "drink" as beer, wine, or spirts and incorporating U.S. Standard Units of pounds, alcohol proof, and fluid ounces into the formula.

Historically, Widmark's formula did not include an estimate of uncertainty. The equation includes at least seven random uncertain variables, thereby having significant uncertainty. Failure to address and report appropriate uncertainty estimates when applying Widmark's Equation decreases its confidence and acceptability in scientific and legal contexts.[6]

Calculations other than estimating alcohol concentration or number of drinks require additional information; for example, a person's absorption rate for each drink and elimination rate. These calculations introduce additional uncertainty to the estimates of drinks and alcohol content and must be taken into consideration.[6]

Commercial software is available for performing the Widmark Equation and calculating associated

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uncertainty with varying interpretations of case facts, including alcohol concentration throughout the drinking session and beyond.[7] Many of these programs will generate graphs and tables for use as demonstrative aids for litigation.

When relying on Widmark calculations, especially with commercial software, it is important to avoid expanding or embellishing facts and known constants simply because the program can incorporate varying scenarios. According to Dr. Kurt Dubowski, "No forensically valid forward or backward extrapolation of blood or breath alcohol concentrations is ordinarily possible in a given subject and occasion solely on the basis of time and individual analysis results."[8]

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