K3 Comparison of Blood Alcohol Drink- Equivalent From Models and Breath Measurements

Michael R. Corbett, PhD, and Brittney R. Henderson, BSc, 7309 Sandhurst Drive, Mississauga, Ontario L5N 7G8, CANADA*

After attending this presentation, attendees will learn about a comparison of blood alcohol drink-equivalent calculated from model equations of Widmark (1932), Watson et al. (1980), Forrest (1986), Urich et al. (1987) and Seidl et al. (2000) with that from breath alcohol testing.

This presentation will impact the forensic community by furthering validation of model calculations of alcohol concentrations applied to breath alcohol testing to assist qualifying some expert opinion that may utilize such calculations to assist in judicial processes.

Model calculations of alcohol concentration may have differing applicability to subjects within a demographic group involving gender, age, weight, height, and body mass index (BMI).

Test subjects (675 male and 100 female) were obtained from a forensic population of motor vehicle drivers under direction of their legal counsel. Informed consent excluded persons seeking, or having received, counseling and/or medical treatment concerning alcohol, and those with limiting physical or mental health. Some subjects consumed a light breakfast hours prior to their arrival for testing and initiating dosing from an alcohol-free state. After consumption of their commercial alcohol beverages (with identified concentration) over a median (with range) of 153 minutes (14–290), suitable breath samples from subjects in the elimination phase were analyzed about every 20 minutes for their alcohol concentration using either an Intoxilyzer 5000 (1 of 7 instruments; 622 subjects) or Breathalyzer 900/900A (1 of 10; 153 subjects). Volume and duration of subject breath samples were monitored concomitantly by spirometry for many cases with Intoxilyzer testing; duration was recorded for a Breathalyzer test and volume from another immediate sample. Instrument calibration was confirmed using forensic alcohol standards from different manufacturers with differing concentrations. Model calculations included weight per volume units using the density of blood (1.055 g/mL) for comparison with breath alcohol concentration (mg/210 dL). The “r” factor in Widmark for females (0.61) used combined results of Österlind et al. (1944). Separate analysis of Breathalyzer and Intoxilyzer data found no significant difference to their combination.

Subjects (male and female) had medians (with range) of: age (yr) 39 (17–77) and 37 (19–74); weight (kg) 81.6 (44.0–144.9) and 64.9 (41.0–
132.0); height (cm) 176.5 (155.7–203.2) and 163.8 (149.8–187.1); and
BMI of 26.3 (16.5–42.6) and 23.7 (16.2–48.4). Fifteen other persons were excluded for protocol non-compliance. The alcohol dose (g) per body weight (kg) had a median for males of 1.11 (0.58–2.24) and females of 0.98 (0.75–1.77) that generated maximum breath alcohol concentrations (mg/210 dL) with a median for males of 118 (46–216) and females of 124 (57–171). The median experimental alcohol drink-equivalent (mg/210 dL) for males was 24.8 (13.9–37.6) and females was 35.5 (17.8–59.2). Median variation in alcohol drink-equivalent (mg/210 dL) using equations of Widmark, Watson, Forrest, Ulrich and Seidl and breath alcohol testing were for males: 0.92 (-8.7–16.9), 0.30 (-7.7–9.1), 0.23 (-7.4–9.1), -0.64 (-8.7–7.3) and -1.1 (-9.4–7.6), and females: 0.89 (- 9.8–13.9), 0.57 (-16.0–13.3), -0.83 (-16.1–13.0), not available, and -0.48 (-16.7–31.4). If the relative factor for females from only Österlind et al. was used (0.637/0.697), then the median variation was 0.20 (-10.7–13.2). Also found were: (1) higher variation (mg/210 dL) for females than males with all models; (2) Widmark for low body weight or BMI tend to overestimate concentration, and (3) Seidl for females with high BMI tend to overestimate concentration. The best fit to breath alcohol testing were calculations for males by Forrest, and females by Seidl. Both gender combined were best fit by Watson, then Forrest, then slightly less by Seidl and Widmark: no model exists for females by Ulrich.

Calculations of alcohol drink-equivalent using models (Widmark, Watson, Forrest, Ulrich, Seidl) agreed with that from breath alcohol testing for mean proportions of subjects at limits (± mg/210 dL) for males: 66.8% (62.1–70.4) at ±2.5, 92.7% (91.0–94.7) at ±5.0, and 98.9% (97.9–99.7) at ±7.5, and females: 65.8% (59.0–69.0) at ±4.5, 93.5% (90.0–97.0) at ±9.0, and 98.3% (97.0–99.0) at ±13.5.

Alcohol, Model, Concentration

 ** Presenting Author*