K13 Comparison of Ethanol Concentrations in Blood and End-Expired Breath During a Controlled Drinking Study

Sean Bortz, BS, Chemical Testing Section, Tomah, WI 54660; Diane Kalscheur, BS, Wisconsin State Laboratory of Hygiene, Madison, WI 53707; Lindsey K. Skaggs, BS, University of Wisconsin Platteville, Platteville, WI 53818; Heather Barkholtz, PhD, Wisconsin Department of Transportation, Madison, WI 53704*

Learning Overview: After attending this presentation, attendees will understand how near-simultaneous Blood Alcohol Concentration (BAC) and Breath Alcohol Concentration (BrAC) quantification compares as ethanol is absorbed and metabolized during a controlled drinking study.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by comparing two popular methods of quantifying bodily ethanol concentration.

Ethanol consumption results in diverse outcomes, such as: intoxication, cognitive impairment, motor incoordination, and dependence.[1] These effects are likely due to ethanol's action on multiple brain proteins, specifically $GABA_A$ receptors in the central nervous system.[2] Although ethanol's mechanism of action in the brain has yet to be fully understood, ethanol's impairing effects are well documented and bodily alcohol concentration per se limits have been incorporated into various laws. BAC and end-expired BrAC are two popular surrogates to quantify ethanol impairment via ethanol concentration in the brain and are often cited in per se statutes. This study seeks to compare BAC (g/100ml) and end-expired BrAC (g/210L) techniques and results as performed in Wisconsin.

Measurements of ethanol concentration were determined from blood and end-expired breath during a controlled drinking study in which healthy men and women drank 0.55–1.04g ethanol per kg body weight in 60 minutes. Specimens of breath were obtained for analysis of ethanol starting at 30 minutes post-dosing, then every 15-20 minutes for two hours to obtain a curve. One of the BrAC samples in the series was accompanied by a BAC sample to determine measurement agreement throughout the curve. BAC was determined by headspace gas chromatography and BrAC was determined with an electrochemical fuel cell (Intoximeter's EC/IR II), reporting the lower of two correlating breath samples. Results of the two subject breath samples required in Wisconsin's evidential breath test sequence will be discussed as they were highly correlated (r=0.98). Additionally, breath alcohol curves will be presented with corresponding BACs, which were also highly correlated (r=0.94). Furthermore, comparison of measurement techniques revealed that BrAC results were generally less than the corresponding BAC by 11.8%.

When quantifying and discussing ethanol impairment, it is important to recall that both BAC and BrAC measurements are surrogates for the ethanol concentration in the brain. Results of this study demonstrate how sampling, measurement, and reporting variables impact the final ethanol concentration assessment. Both BAC and BrAC measurements are excellent proxies for ethanol concentration in the brain, and associated impairment at each concentration is well defined in other literature.[3] However, details of the measurement technique and any legally mandated reporting requirements should be considered and explicitly defined when describing ethanol concentration results, particularly while referencing per se limits.

Reference(s):

1. Lobo I.A., Harris A. $GABA_A$ receptors and alcohol. *Pharmacology, Biochemistry and Behavior*. 2008;90(1):90-94.
2. Davies M. The role of $GABA_A$ receptors in mediating the effects of alcohol in the central nervous system. *Journal of Psychiatry and Neuroscience*. 2003;28(4):263-274.
3. Masters S.B. The Alcohols. In: Katzung B.G., Masters S.B., Trevor A.J., editors. *Basic & Clinical Pharmacology*. 12th ed. San Francisco, CA: McGraw-Hill, 2012;389-401.

Impaired Driving, Breath Alcohol Concentration, Blood Alcohol Concentration

*Presenting Author