K33 New Criteria for Accepting Breath Alcohol Test Results Using Exhalation Profile Data

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After attending this presentation, attendees will understand new criteria for accepting breath alcohol concentration (BrAC) test results using exhalation data to determine breath alcohol sample irregularities.

This presentation will impact the forensic science community by providing changes to BrAC testing, through new parameters for sample acceptance, utilizing exhalation profile Phase III slope data.

A breath alcohol exhalation profile is the plot of BrAC as a function of time or volume during sample submission into a breath alcohol instrument utilizing infrared spectrometry for analysis. Breath alcohol exhalation profiles normally have three distinct phases.[1] Phase I is the initial emptying of the residual air from the instrument. Phase II is the rapid increase in BrAC as breath from the upper bronchial passages is analyzed. The nonlinear phase transitions into Phase III, with a linear increase of BrAC over time and volume of soluble gas exchange beginning with approximately 1.2 liters of lung air volume until expiration has ceased.

Older breath alcohol equipment do not retain all exhalation profile data and use moving point averages to minimize noise to detect mouth alcohol for a determination of BrAC. Recent breath alcohol instruments preserve all BrAC and flow rate data. This data may be used to redefine sample acceptance through additional criteria.

BrAC as a function of Phase III volume slope is a consideration. Phase III slope should correlate to the BrAC sample at a fixed volume under normal breathing conditions. In addition, subjects undergoing hypoventilation prior to breath alcohol testing achieve significantly higher BrAC test results and exhibit distinctive exhalation profiles.[2] Hypoventilation samples are characterized by a rapid Phase II rise in BrAC coupled with a lower Phase III slope. BrAC Phase III slope correlation redefines sample validity and identifies abnormal samples including hypoventilations.

The Missouri breath alcohol program conducted a small exhalation profile study between April 2009 and October 2010. It consisted of twenty-four subjects (20 men, 4 women) selected during law enforcement training programs. Each subject was dosed with ethyl-alcohol to achieve varying BrACs ranging from 0.03 to 0.15 g/210 L, mean and median 0.084 g/210 L. The subjects provided 69 breath samples including 10 hypoventilations. Samples were collected using a DataMaster DMT manufactured by National Patent Analytical Systems, Inc.(DMT).[3] The DMT was selected for retention of concentration data, mass flow rate at 0.25 second intervals per sample and ease of data exportation. Microsoft Excel® was used for data analysis.

A correlation between the Phase III linear slope as a function of volume and the BrAC at a fixed delivered volume (1.5 liters) was observed, although it exhibited inter-subject variability ($R2 = 0.70$). The ratio of the BrAC at 1.5 liters over the Phase III slope (BrAC/Phase III slope) was calculated for each sample (median 11.2 liters, s.d. 2.2 liters). No outliers appeared when the normal three standard deviation rule was applied; however, 8 of 10 hypoventilation tests were outliers using the normal sample data ratios as the standard.

Between October 2010, and May 2011, the BrAC/Phase III slope ratio was calculated for breath exhalation data collected from 504 DWI suspects using 27 DMTs. The DWI subject data was randomly selected from 11,834 breath samples and 152 instruments.[4] Subject BrACs ranged from 0.015 – 0.345 g/210 L, mean and median 0.14 g/210 L. The BrAC/Phase III slope ratios were significantly different than laboratory results (mean 13.5, median 13.2, s.d 3.1, $p<0.0001$). The basis for this difference is unclear. The same ±3 SD test was applied to the DWI subject data, and 17 of the 504 samples (3.4%) were determined to be statistical outliers. The outlying samples were plotted to assess causation and difference. The 17 samples yielded five hypoventilations with 12 samples exhibiting breath alcohol sample characteristics inconsistent with current exhalation profile models.[1]

Application of BrAC/Phase III slope ratios to breath alcohol exhalation data functions as a method to identify hypoventilation and other anomalies during subject exhalation. Other approaches to BrAC data interpretation including computation of the averaging value, Fourier transforms and integration for area under the curve, may increase quality control and reduce uncertainty for BrAC testing. Redefining parameters for sample validity through the exhalation profile is warranted. Additional criteria for sample acceptance and reporting should be incorporated in breath alcohol instrumentation for reliability of results.

References:

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3. Highway Safety Programs; Model Specifications for Devices To Measure Breath Alcohol, Federal Register, Sept. 29, 2006, vol. 71, no. 125, pp. 37159-162.
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