D11 An Investigation Into Volatile Organic Compounds That Have the Potential to Cause False Positives in Blood Alcohol Analysis

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After attending this presentation, attendees will understand how volatile organic compounds present in human blood can interfere with blood alcohol analysis, causing false positive results.

This presentation will impact the forensic science community by demonstrating the need for greater specificity in blood alcohol analysis.

The qualitative and quantitative analysis results of Volatile Organic Compounds (VOCs) in human blood and breath are used as biomarkers of human exposure for epidemiological monitoring and investigation, point of care testing for patient diagnosis and treatment, and as evidence in criminal cases in the forensic arena. Over 3,000 different VOCs have been identified in blood and breath samples of living people. These VOCs may be found in human blood and breath as a result of endogenous production or environmental exposure. Endogenous VOCs may be present as a result of normal metabolic activity, disease processes, or both. Exogenous VOCs detected in human blood and breath occur as a result of environmental exposure at the workplace, home, or other environments.

Some VOCs, generated as a result of normal metabolic activity, may have elevated due to metabolic diseases. For example, in diabetic patients, ketones and organic acids may be elevated in the blood during ketoacidosis. In addition, previous studies have identified key compounds, such as hydrocarbons, methylated hydrocarbons, sulfur containing compounds, nitrogen containing compounds, isoprene and acetone, as biomarkers for different systemic diseases. Also, research has shown that patients diagnosed with lung cancer, leukemia, bone cancer, and lymphoma have high levels of hexanal in their blood, while hexanal, 1-octen-3-ol, and octane were recognized as biomarkers for liver cancer. These VOCs have been detected in human blood using Solid Phase Microextraction-Gas Chromatography-Mass Spectrometry (SPME-GC/MS).

Volatile organic compounds may be released to the environment by both natural and industrial sources. Compounds such as benzene, toluene, ethylbenzene and xylenes are present in fuel emissions. All of these compounds have been analyzed quantitatively in human blood using headspace SPME-GC/MS.

Ethanol is the most widely abused drug in the world. As a result, the most commonly known forensic application of VOC analysis is the determination of the concentration of ethanol in blood and breath samples from automobile drivers charged with Driving Under the Influence (DUI). The current standard for the determination of blood ethanol concentration is static headspace dual capillary column Gas Chromatography coupled to a Flame Ionization Detector (GC-FID). Other variations include single column (capillary or packed), direct injection, and GC/MS. If any compound present in blood were to co-elute with ethanol on the GC-FID, it would lead to a false positive result. A GC/MS method should replace GC-FID as the standard method for blood alcohol analysis as it would improve specificity and decrease the possibility of false positive results due to interfering volatile organic compounds. Many forensic laboratories have not budgeted for the upgrade to GC/MS for this type of analysis, and as a result, the GC-FID is still the most widely used analytical technique for blood alcohol analysis.

In this experiment, 46 VOCs that have been previously identified in human blood and breath were analyzed using GC-FID to determine if any of these compounds may co-elute with ethanol or the internal standard n-propanol, thus interfering with blood alcohol analysis. Of these 46 compounds, 17 co-eluted or had retention times sufficiently similar to ethanol and n-propanol so that minor variations in stationary phase composition, flow rates or temperature would be expected to cause co-elution and thus interfere with blood alcohol analysis. These results demonstrate that many VOCs commonly present in the body can yield a false positive result for the analysis of alcohol in blood. Therefore, this work supports the idea that blood alcohol analysis is no different than blood drug analysis regarding the requirement to use the selective mass spectrometry detector for qualitative analysis instead of the non-selective FID detector.

Blood alcohol analysis should meet the same standards of scientific reliability as any other chemical test performed in the forensic toxicology laboratory.

Blood Alcohol Analysis, Gas Chromatography, Co-Elution

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