Jessica Flynn
Class of 2020
Forensic Science w/ Concentration in Biology

Evaluation of an Ethanol Blood Diffusion Model Apparatus

Mentor: Robert Powers, Ph.D., F-ABFT

SURF Project Description

In the State of Connecticut, and many other states using breath testing as part of DUI case investigation, two breath tests are administered some minutes apart (generally ~ 20). Testing is not commonly performed at the scene of arrest, rather breath testing instruments are maintained at police or troop headquarters. Therefore, breath testing is generally performed some significant interval after the time of driving. The second test may be artifactually low or high compared to the first, if the two tests are not corrected for blow time, or volume. The ultimate question of the experiment was to determine if breath alcohol test results could be corrected for volume variations. The purpose of this research became to determine the extent to which the slope in the latter part of the breath v. [EtOH] curve can be described by a linear equation, and further, the extent to which that slope is a function of individual variation.

The first part of exploration of these questions involved the development of a diffusion-based model that could be utilized to evaluate the linearity of the diffusion-based rise in [EtOH] after un-equilibrated air was removed from the system. The experiment evolved into using dialysis tubing to mimic the semi-permeable membrane in the lungs to diffuse an ethanol solution into a headspace standard of n-propanol solution in a 500mL glass container. The system was kept at either 20°C, 40°C, or 60°C during the experiment. Immediately after the dialysis tubing filled with ethanol was added to the system the first sample of air was extracted with a syringe. Samples were taken in 5 minute intervals over the course of an hour. The samples were then injected immediately into a Gas Chromatograph, equipped with a Flame Ionization detector (FID) and then run for 3.5 minutes. Instrumental chromatograms were analyzed and peaks corresponding to ethanol and internal standard (n-propanol) were measured to determine the magnitude of ethanol diffusion into the air inside the system as a function of equilibration time. Three runs were conducted at each temperature (20°C, 40°C, and 60°C) and graphs were created to show the diffusion of ethanol over time. Finally, the mean of those three runs and the standard deviation of the mean were calculated and analyzed to determine how well the curve could be explained by linear equations.

The data suggested that ethanol blood diffusion in our model system could be expressed linearly, with a reasonable regression coefficient. Though this ethanol blood diffusion apparatus model is not an extremely accurate representation of the way alcohol equilibrates with the blood and the air in the lungs, it does show the possibility that ethanol blood diffusion graphs can be explained linearly. The use of the FID worked well in detecting the amount of EtOH diffused into the headspace and would work well in future work. The test should be done in smaller intervals of time to minimize large amounts of variation between samples. Keeping the air inside the system moving or swirling would also be advantageous to ensure every sample is taken while the air inside the system is at equilibrium.