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Topic:
Medical Issues in DUI Defense

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Medical Issues in DUI Defense

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Introduction

Breath test results are predicated on the assumption that the test subject is an *average* person, with *average* physiological responses, providing an *average* breath sample. That **breath** sample is then reported as a **blood** alcohol concentration using *average* values in the basic assumption used for conversion. Underlying or pre-existing medical conditions can upset those assumptions. This paper will address some of the medical conditions that may impact the reliability of reported breath alcohol concentrations.

The Effects of Diabetes

Diabetes *(Diabetes Mellitus)* is a chronic metabolic disease that reduces or eliminates the body's natural production of **Insulin** in the pancreas. In general, this produces high blood sugar (glucose) levels, either through lower production of insulin, or because body cells do not respond effectively to the insulin that is produced. It is the high blood sugar that creates three classic symptoms of diabetes; frequent urination, increased thirst, and increased hunger. Since artificial insulin[1] therapy became available in 1921, diabetes has been manageable, although it remains a chronic condition that cannot be cured.

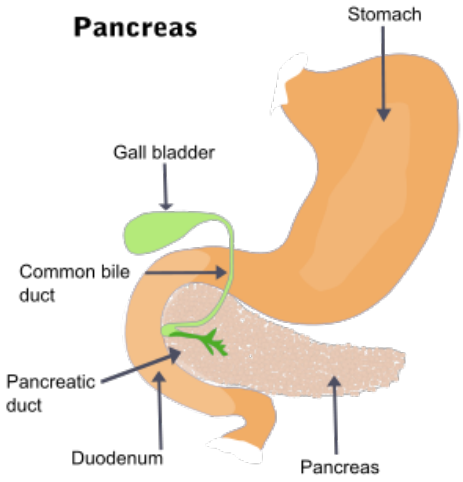
Diabetes is broadly classified into three main types: Type 1, Type 2, and Gestational Diabetes.

- **Type 1 Diabetes** results from the body's inability to produce adequate insulin levels. Persons with Type 1 diabetes require insulin injections to control their blood sugar levels. It accounts for about 10% of all diabetes cases. It was traditionally referred to as *juvenile diabetes*, due to its onset in children.
- **Type 2 Diabetes** is a product of insulin resistance. Body cells cannot use the naturally occurring insulin properly, resulting in insulin deficiency. This was formerly referred to as *non-inulin dependent diabetes*, or *adult-onset diabetes*. It is the most common type of diabetes.

[1] Insulin was developed in 1921 by Canadian physicians Sir Frederick Banting of Ontario and Dr. Charles Best, originally from Maine.

- **Gestational Diabetes** develops when pregnant women who have never had diabetes before have high blood-glucose levels during pregnancy. It occurs in 2-5% of all pregnancies. This may disappear following pregnancy, or be the pre-cursor for Type 2 diabetes after the pregnancy.

Pre-Diabetes is a condition that occurs when the person's blood glucose levels are higher than normal, but not high enough for a diagnosis of Type 2 diabetes.



Insulin is a hormone produced in the pancreas that is essential in regulating carbohydrate and fat metabolism in the body. Insulin acts in the body by taking up glucose from the blood in the liver, muscle and fat tissues, storing it as glycogen in the liver and muscles. In essence, insulin removes excess glucose from the blood. If not removed, the excess glucose would otherwise be toxic. Then, when blood sugar levels drop, the stored glycogen is broken down and used as an energy source through a process called glycogenolysis. When natural control of insulin levels fails, Diabetes Mellitus is the result.

Figure 1 – The Pancreas

Signs & Symptoms of Diabetes

The classic ***early*** **warning symptoms** of diabetes include frequent urination and increased hunger and thirst levels. In Type 1 Diabetes, these symptoms may develop rapidly over a few months or even a few weeks. In Type 2 Diabetes, the development of symptoms may be subtle, taking longer to develop, or absent altogether.

Diabetic emergencies are divided into two types: Hyperglycemia (Diabetic Ketoacidosis) and Hypoglycemia (Insulin Shock). Hyperglycemia, or too much sugar, is a life threatening complication that typically affects Type 1 diabetics, although Type 2 diabetics can suffer from this under certain circumstances. Without treatment, Hyperglycemia can lead to death. Before insulin therapy became available, it was almost always fatal.

In general, the signs and symptoms of **Hyperglycemia** (Diabetic Ketoacidosis) are similar to that of an impaired person. Levels of consciousness may be altered, and there may be a musty, alcohol odor on the breath. The ability to follow directions may be affected, as impaired cognitive function is typical.

Hypoglycemia (Insulin shock symptoms) also displays lowered levels of consciousness or confusion, heightened emotional states or violence, and a smell of an unusual odor on the breath.

First Responders are taught that the signs and symptoms of each, although initiated by very different root causes, may be difficult to differentiate. Indeed, a standard way of teaching how to identify diabetic disorders in first aid courses is to describe the individuals as having a "drunken appearance." The first aid strategy when one cannot differentiate the symptoms is to give sugar as a fall-back position, as it will immediately assist the hypoglycemic patient, and will not appreciably harm the hyperglycemic person. Symptomatic diagnosis is virtually impossible, with either blood glucose or blood ketone levels being the only accurate way to assess which condition is present. Ketone level measurement is emerging as the more accurate predictor of early-onset diabetic assessment.

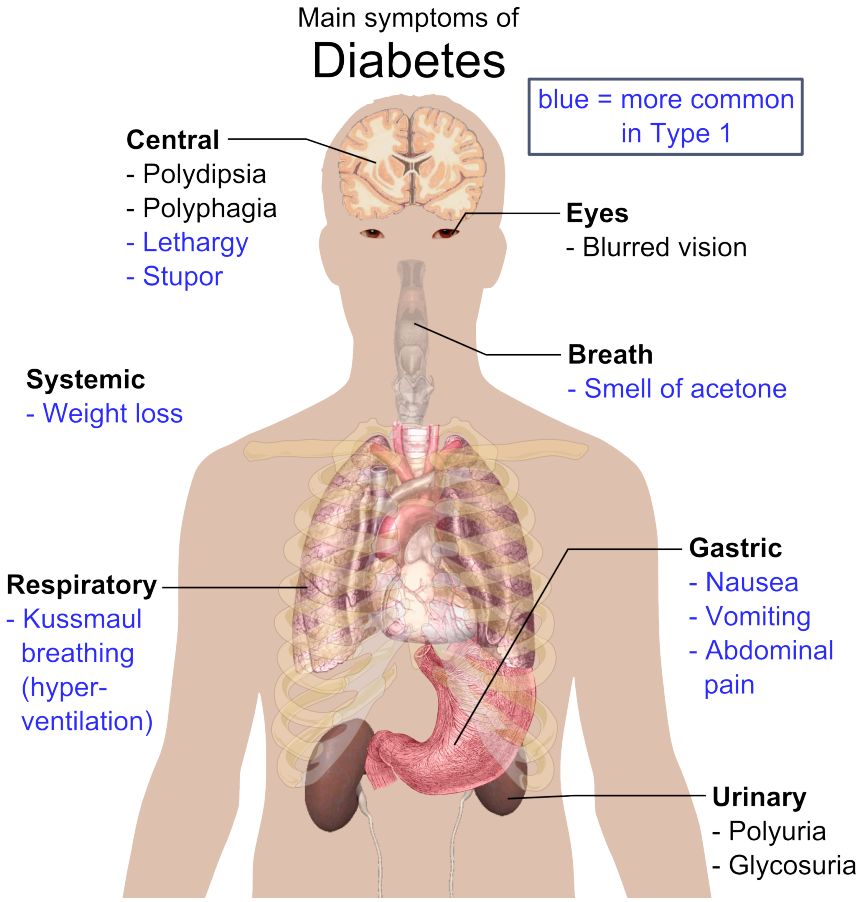


Figure 2 – The Main Symptoms of Diabetes Mellitus

The initial situation for a diabetic are rising levels of ketones (β-hydroxybutyrate in the blood that is first metabolized to form Acetoacetate, then Acetone which is ultimately reduced to increased levels of carbon dioxide). The infrared signature of β-hydroxybutyrate is similar to that of ethanol in the range read by infrared breath testing devices. There is quite a significant level of β-hydroxybutyrate in the blood before any acetone is produced. *It is only the later stage of acetone metabolism that is detected by infrared breath alcohol devices*. The β-hydroxybutyrate and Acetoacetate are found primarily in the blood and urine. Acetone is found primarily in the breath. Can β-hydroxybutyrate be found in the breath? If it is endogenous in the breath, the effect on an infrared device is shown in **Figure 3**.

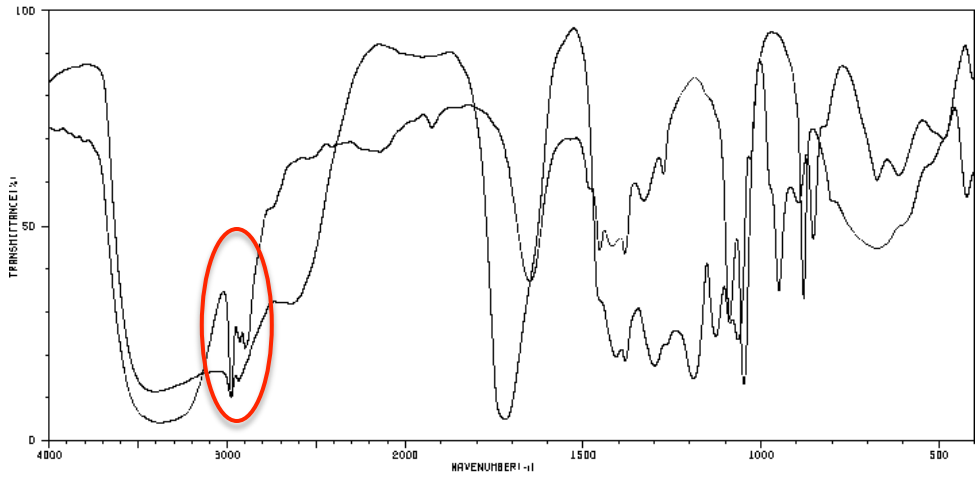


Figure 3 - The Infrared Overlap of Ethanol with β-hydroxybutyrate

Research since the 1960's indicates that more than 250 Volatile Organic Compounds (VOC's) can be measured on the human breath. Ketoacidosis can be smelled on a person's breath, and is commonly dismissed as alcohol consumption. The levels of exhaled ketones and acetone rise appreciably. It is this exhaled acetone that is designed to be detected by the acetone detectors in modern breath alcohol testing instruments. However, the level at which each detector system is set to trigger vary from jurisdiction to jurisdiction.

Acetone in and of itself is not very toxic to humans. For this reason, the levels of the detector are often set quite high. Many jurisdictions use a concentration of 1 milliliter of acetone in 100 milliliters of water as the threshold level. This may be higher than the level experienced by most uncontrolled diabetics experiencing an episode of severe diabetic ketoacidosis, and may therefore have little use in an evidentiary breath alcohol instrument. Also remember that acetone is only produced by the diabetic at the later stages of metabolism. It has also been demonstrated that the acetone is not a total waste product, being then converted into isopropanol by the diabetic. This is also an important step to consider.

Newer instruments such as the Intoxilyzer 8000 advertise, and this has been supported in various state training manuals, the notion that the 9.5-micron range is better suited in reading ethanol levels. Florida's state training manual says, as an example, that the 3.3 – 3.8 μ range (the range used in the older Intoxilyzer 5000EN to determine the presence and concentration of ethanol) is better suited to determine the presence of Interferents. The overlap of acetone, and its metabolite isopropanol, mimic that of ethanol in the 3.3 – 3.8 μ range.

It has been identified by various researchers that certain hydrocarbon compounds, in concert with low levels of ethanol cause inflated readings on the Intoxilyzer 5000 that are often not detected by its interferents-detect algorithm (Hak, 1995, Jones et al, 1996, Caldwell & Kim, 1997, Bell et al, 1992 and Memari, 1999). The Intoxilyzer 5000EN attempts to mitigate this tendency through the inclusion of two additional filter points (3.36μ and 3.52μ). However, these points will only assist in the detection of

toluene and acetaldehyde. Toluene was not present. Acetaldehyde is a naturally occurring by-product of ethanol consumption, and is expected to be produced by the body.

Modern infra-red breath alcohol devices are designed to identify the presence and concentration of ethanol. To these devices, all alcohols and many hydrocarbons produce an absorption pattern from the methyl group of the molecules between 3.2-3.5µ. To a certain extent, all alcohols, and many other hydrocarbons, therefore appear as ethanol to infrared instruments. However, the difference in the individual infrared signatures of these hydrocarbons as compared to ethanol, as interpreted by the devices, is supposed to "flag" the sample as containing an interfering compound. It has been my observation that this feature does not always function as designed, and can routinely report a falsely elevated BAC reading.

As an example, I have identified the tendency of the Intoxilyzer 5000EN to over-report the true BAC of a sample of ethanol in the presence of interferents such as isopropanol, methanol, D-limonene, Dimethyl Sulfone, Castor oil, Adipic acid and Methylsulfonylmethane. With a mixture of both ethanol and another infra-red hydrocarbon, the interferent detection algorithm fails.

Also, it should also be noted that the blood to air partition ratio for isopropanol has an accepted value of 1372:1. The partition ratio for acetone is about 300:1. The partition ratio for ethanol has been legislatively accepted at 2100:1. Therefore, any trace levels of isopropanol or acetone found within the body would have an exaggerated effect on the readings obtained on a device measuring at 2100:1. It has also been reported that blood levels of isopropanol have a tendency towards very low elimination rates in the body (Jones, 1996).

I have observed that, when confronted with a variety of potential interferents, the Intoxilyzer 5000EN and 8000 will report exaggerated BAC readings. The Intoxilyzer 5000, even the enhanced EN version, is just not sophisticated enough to discern the overlapping infrared signatures, and separate them from ethanol. I performed a series of simulations on an Intoxilyzer 5000 66-series and had a "true" ethanol level of 0.035 grams in a simulator elevated to an average of 0.072 grams with the inclusion of less than 1.0 ml of isopropanol and less than 1.0 ml of acetone (the expected metabolite of isopropanol). However, the unit only reported an interferent in 7 out of 15 samples. When the same 0.035 grams ethanol solution vapor was introduced into an Intoxilyzer 5000EN 68-series, the average reported BAC was inflated to .117 grams, yet the interferent detect circuitry only reported the interferent on 8 out of 15 occasions.

What is more alarming is the tendency of the units to report the BAC as a *subtracted*, or corrected, value on the occasions when the units did discover the interferent. In the simulations described above, during those times that the Intoxilyzer 5000 or 5000EN did determine the presence of the interferent isopropanol, they reported the *inflated* BAC value as being a *corrected* value, and apparently the product of subtraction of the false interferent value. However, these BAC values reported were still over-represented, often more than threefold.

See **Table 1** for these test results:

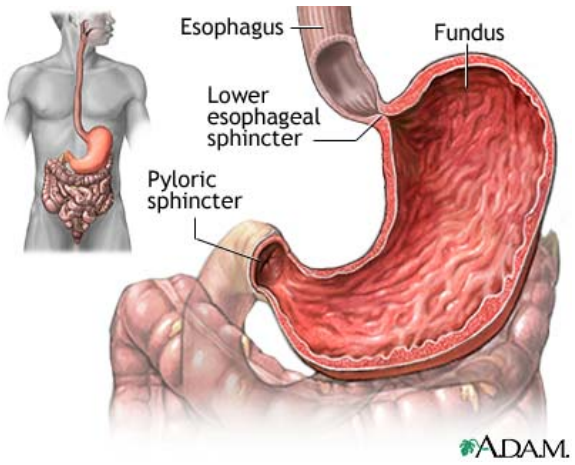
Test	Instrument	True BAC Ethanol	Average of 15 Tests with Isopropanol & Acetone
1	Intoxilyzer 5000EN Minnesota version & DOT version	.035 grams	.117 grams Interferent detected (8/15) but reported as *subtracted.*
2	Intoxilyzer 5000 66 Series	.035 grams	.072 grams Interferent detected (7/15) but reported as *subtracted.*

Table 1 – Test results using 1.0 ml isopropanol and 1.0 ml acetone in 500 ml water

I am left to reasonably conclude, as have other researchers, that a combination of infrared absorbing substances in the test chamber with levels of ethanol may falsely over-report the true BAC level, and may do so without triggering the interferent detector algorithm. The reported incidence of an interferent may vary among jurisdictions depending upon the threshold levels set in the acetone detect or subtract algorithm.

As such, persons routinely displaying symptoms caused by uncontrolled blood ketone or blood glucose levels are extremely poor candidates for breath alcohol testing.

Gastroesophageal Reflux Disorder (GERD)



Gastroesophageal Reflux Disorder (GERD) is a chronic condition that is believed to be caused by a partial weakening or failure of the Lower Esophageal Valve (LEV). This is a valve that separates the Esophagus from the Stomach. When stimulated, the LEV will open momentarily, allowing liquid consisting of acidic stomach contents to partially regurgitate, or reflux, back into the esophagus. This creates an uncomfortable burning sensation, often likened as severe heartburn.

Figure 4 - The anatomy of the stomach and esophagus

The condition is partially controllable through daily doses of medication, and alteration of the patient's diet. Increasing evidence indicates that smoking raises the risk for GERD. Studies suggest that smoking reduces LEV muscle function, increases acid secretion, impairs muscle reflexes in the throat, and damages protective mucous membranes. Asthmatic symptoms, such as coughing and wheezing, may occur. In fact, in one study, GERD alone accounted for 41% of cases of chronic cough in non-smoking persons.

GERD is a chronic condition. Once it begins, it is usually a life-long condition. If there is injury to the lining of the esophagus (esophagitis), this also is a chronic condition. Moreover, after the esophagus has healed with treatment and treatment is stopped, the injury will return in most patients within a few months. Once treatment for GERD is begun, therefore, it usually will need to be continued indefinitely. It is somewhat manageable by daily medication, and changes to the diet.

GERD can be stimulated by the consumption of alcoholic beverages. GERD has been associated with non-cardiac chest pain, ulcers, gastritis, asthma, hoarseness, and chronic cough. Symptoms such as chronic cough or chest pain can be caused by acid reflux into the esophagus, because they do not experience classic heartburn symptoms or acid regurgitation. It has been suggested in studies that the GERD is a pre-cursor to the chronic cough, creating its condition.

The Effect of GERD on Breath Test

A minority of patients with GERD, about 20%, has been found to have stomachs that empty abnormally slowly after a meal. With a known medical condition such as GERD, it is likely that the leakage in the LEV introduced a trace amount of alcohol remaining in the stomach into the esophagus. This would have the net effect of elevating the reading obtained. Dr. A.W. Jones *(DWI Journal – Law and Science, September 2005)* identified the presence of unabsorbed alcohol in the stomach among GERD patients several hours after drinking.

Kechagias et al (1999) reported no apparent correlation between GERD and increased BrAC readings while in the absorptive phase of alcohol ingestion. However, 50% of their tested subjects showed an elevated BrAC compared to their BAC's as tested by in vivo catheter. Their assertion that GERD does not elevate reported BrAC readings is not supported by their own data.

The Residual Alcohol Detection Algorithm

Due to the pattern of emanation of alcohol from both the upper digestive tract along with the normal pathway from the lungs in a GERD patient, the Residual Mouth Alcohol Detection systems of modern breath alcohol analyzers are incapable of distinctly separating readings of the two. In short, alcohol emanates from BOTH the lungs AND the upper GI Tract, at roughly the same rate. The residual alcohol detectors are designed to identify a sudden rise in measured BAC was a subsequent sharp drop in BAC from second to second during the breath test. False-positives associated with GERD do not follow this "rise and drop" pattern, and are not easily detected by the programmed algorithms.

The two breath tests were obtained only a few minutes apart. This is not enough time for the dissipation of alcohol from the mouth and oral mucosa, especially since it is possible that fresh alcohol was

introduced. As such, a condition where mouth alcohol can bias the true BAC reading of the test subject can occur. Under these conditions, it is known that the so-called “slope detectors” can falsely interpret this mouth alcohol bias and over-report the true BAC reading (Hlastala, 2006 and Gullberg, 2000).

It has been my experience that the slope detectors can, and often are, fooled under a variety of circumstances, most notably, recent consumption or regurgitation of an amount of alcohol, similar to what would occur during GERD emanation, which has a tendency to deposit alcohol-laden air in the oral cavity.

I have routinely observed the slope detector fail to register mouth alcohol that is as much as 12-15 minutes old, often allowing the unit to register an abnormally high reading given a simple swish of alcohol. Published studies indicate failure of the residual alcohol detection system to identify mouth alcohol bias between 37% (Harding et al, 1992) and 48 % failure (Simpson et al, 2004). Gullberg (2000) also reports on the inadequacy of the mouth alcohol detection systems. Harding reported that some of these failures occurred after more than 15 minutes of deprivation.

Elimination Rates

In cases where the state’s expert is using retrograde extrapolation to place your client at a particular BAC at a specific time, it may be helpful to have your client tested to determine their elimination rate. During the retrograde extrapolation, certain assumptions will be made regarding the elimination rate of your client. Often, the toxicologist will use the elimination rate they favour (i.e. - .017 grams per hour). Other toxicologists may use a range of elimination rates (i.e. -.01 - .02 grams per hour), and express the purported BAC as a range of values.

In any event, having your client tested to determine their specific elimination rate may be one avenue you have toward poking holes in the plethora of assumptions made during a back-track calculation. The procedure is fairly straightforward. You must retain the services of a private toxicologist, or expert who has access to a breath-testing device. Your client will be given a specific dose of ethanol to consume, and will have their peak BAC and elimination rate calculated. See Figure 1 for a sample, from a similar study I performed a few years ago.

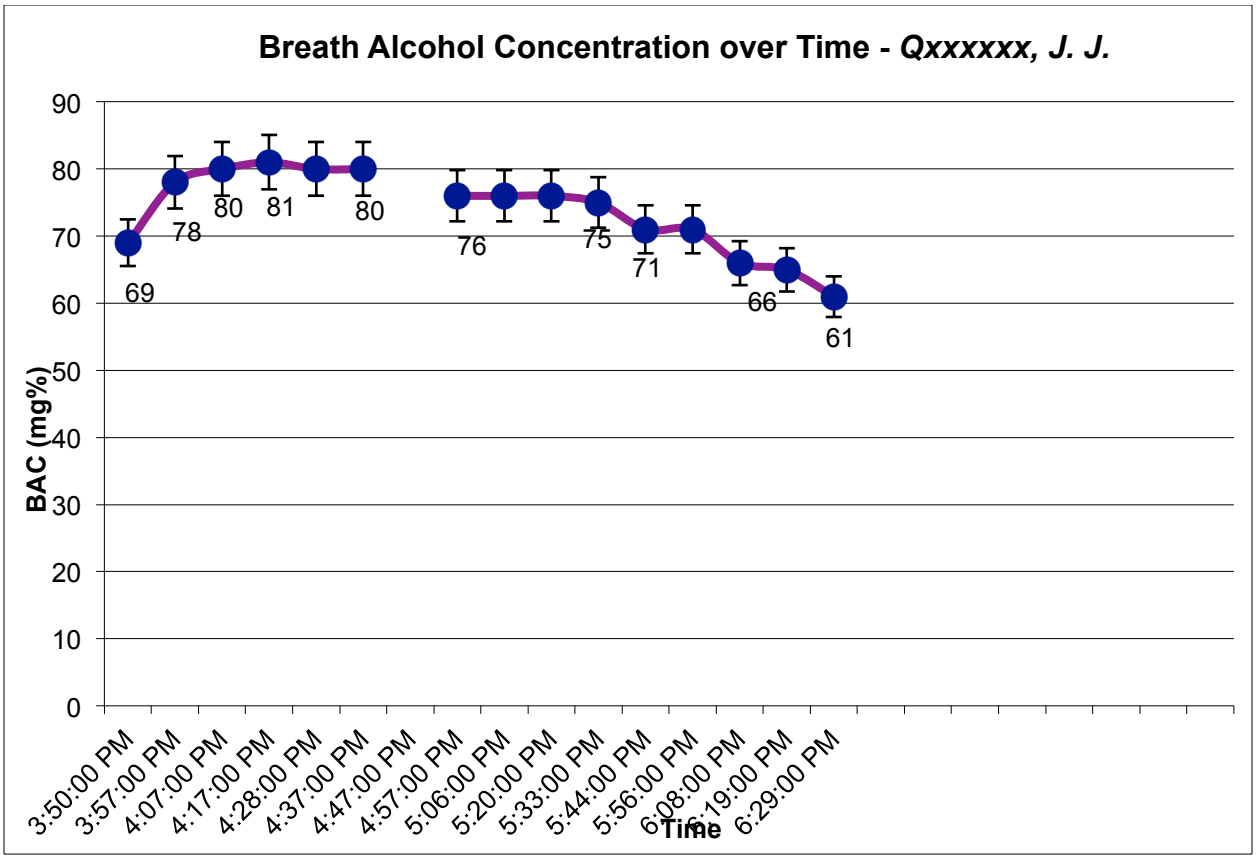


Figure 1 – Sample Elimination Rate Study

Note that is this sample, the elimination rate was shown to be - 0.009 grams per hour. While just below the range typically used, it shows the need to have specific values when performing retrograde extrapolation. I also did another similar study, and showed an elimination rate of – 0.027 per hour.

This technique is also useful in establishing *Partition Ratios* for your client. In addition to the breath test sequence, you will have to retain the services of someone capable of performing a series of blood draws that correspond to a number of times along your elimination sequence. They must be able to establish a chain of custody, and to have the blood samples analyzed, preferably using a Gas Chromatograph. The differences in values obtained can then be used by a toxicologist to calculate your client's specific partition ratio.

Simulation Studies

Differing from an Elimination Rate Study, the Simulation Study is useful when a known fact drinking pattern can be established. In these studies, we attempt to mimic the food and alcohol consumption as close as possible for the time in question. Then, the subject is tested repeatedly, ensuring that the data points correspond with the equivalent time of driving or accident, and times of breath testing. The results are often surprising. Even in cases where the consumption pattern on face value sounds too high to present as evidence to the contrary, the results of the breath tests for time of driving, and time of breath tests may raise sufficient doubt. Coupled with a failure in protocols on the part of the police breath test operator, or an instrument error, the testing may indicate an alternate fact pattern that can be seen as reasonable.

Here is a sample from a recent study:

(There was considerable alcohol consumption involving a 350 lb. man whose police breath test place him at .180 grams)

Test	Time	BAC	Remarks
	1856		Diagnostic - Passed
1	2131	.067	First test after consumption; 6 minute delay Equivalent to time of driving
2	2252	.057	Equivalent time to Test #1
3	2315	.049	Equivalent time to Test #2
4	2349	.043	Equivalent time to Test #3
	0039		Diagnostic - Passed

Table 1 – Data from a Simulation Study

We can also use the Simulation Study to show the effect of the drink AFTER the accident, as shown in Figure 2 on the next page. This case involved a 45-year-old male who had consumed 2 beers and 5 ounces of whiskey in a three-hour period. He went to an un-licensed restaurant and consumed a meal, then was involved in a car-motorcycle collision a number of hours later. After the accident, he immediately consumed about 8 ounces of rye, straight, prior to the arrival of the police. When tested after the accident, his BAC exceeded .120, and he was subsequently charged.

The simulation successfully demonstrated the results of his post-accident consumption of alcohol.

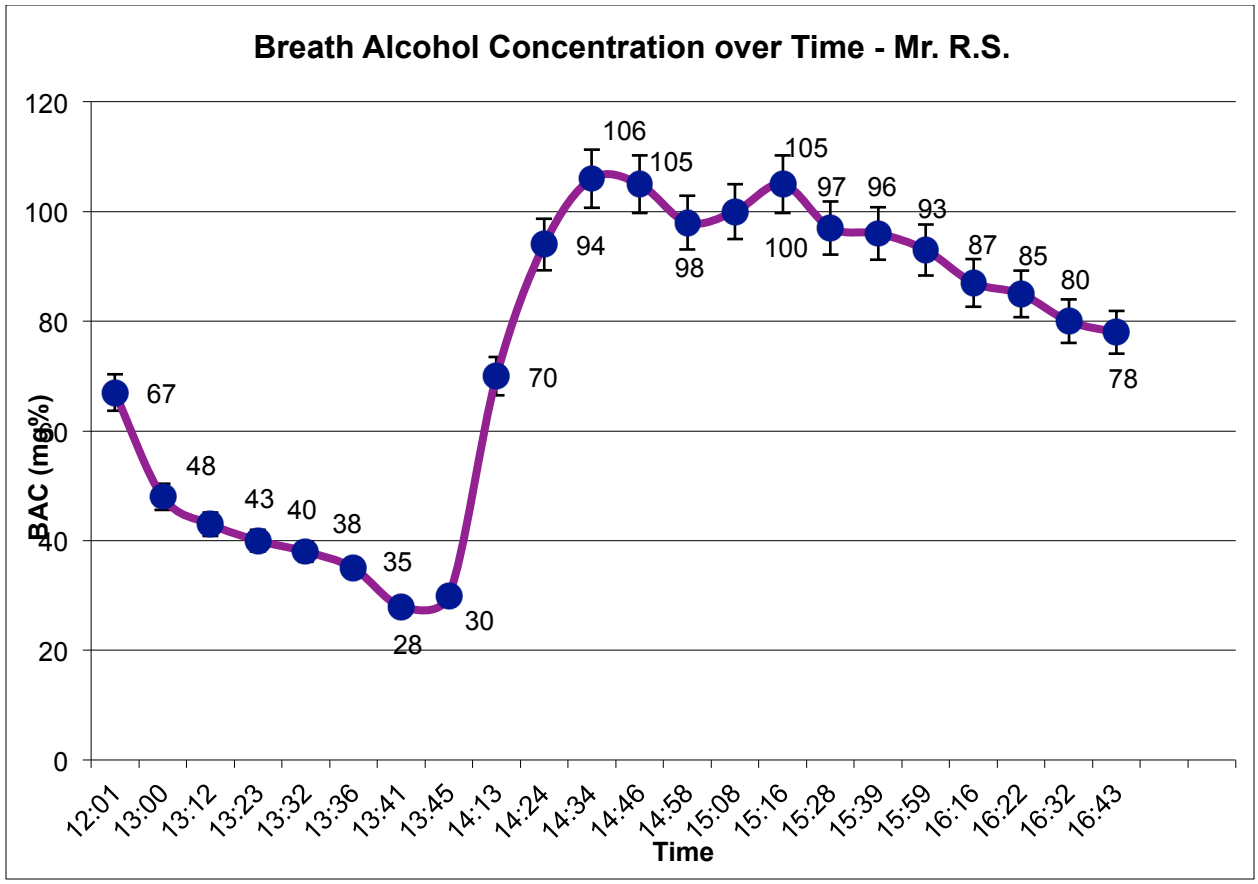


Figure 2 – Data Collected from Simulation Study

In order to be accepted in the courts, we have found the following most useful:

- The alcohol consumption should, if at all possible, be verifiable be some means.
- The alcohol consumed during the simulation study should be EXACTLY as outlined by the facts. Brands, glass sizes, drink times, mixes and rates of consumption should be firmly itemized and followed so that there is no variation by which reasonable doubt can be raised as to the testing process. You may have to retain the services of an investigator to get drink glasses and volumes or recipes from licensed establishments.
- The food consumption should be as exact as possible.
- The times should correspond as closely as possible with the actual time of day. In addition to the obvious concern about differences in circadian rhythm, it becomes confusing to the court to have different times quoted.
- The client needs to establish their specific consumption pattern; therefore, they may be needed to testify regarding their consumption in the absence of any third party or evidence, such as a restaurant receipt.

Occupational Exposure to Volatile Organic Hydrocarbons

Infra-red Interferents and Elevated Readings

The alcohol typically consumed is ethyl alcohol. The ideal evidentiary instrument should be able to discriminate between ethanol and other alcohol types. *Specificity* refers to the ability of breath testing devices to distinguish between ethanol, and other substances that might be found on the breath of the test subject. We need a reading of, for example, .120 grams to refer to a true B_rAC of 120 milligrams of ethanol dissolved in 100 millilitres of blood.

Anything else that may be on the breath of the test subject, and that either masks or enhances the reading of alcohol is referred to as an *interferent*. In practical applications, there are a few interferents that can adversely affect the outcome of a test.

In order to be considered an interfering substance to this true B_rAC reading, an interferent must have a few important characteristics:

- The substance must be **volatile**. Volatility refers to the ability of the substance to evaporate easily enough that it can be found on the breath of the test subject. Even if a compound is in the blood, and furthermore, even if it is capable of causing impairment, it won't be detected on the breath unless it is volatile. Most solid substances don't have volatile components, unless they contain alcohol. Gums, candies and most breath mints will not cause an interferent reading. Mouthwashes, candies with an alcoholic component, and some breath fresheners will cause a false positive reading. Usually, this is because they contain alcohol.
- The substance must be **non-toxic**, or no more toxic than ethanol. Any substance that is so toxic that it would provide a discernible reading must not be so toxic as to poison the test subject. In general terms, methanol (found in windshield washing fluid, cleaning products, and paints) falls into this category. However, people can build up chronic exposure doses that are considerable.
- The volatile and non-poisonous substance must be present in a **sufficient concentration** that it can provide a false-positive reading when compared to ethanol.
- It must have **chemical properties** that make it unlikely to be distinguished from ethanol by the breath testing instrument.

It has to have a reasonable and demonstrable **route of entry** into the human body, preferably not involving voluntary consumption. This is more of a practical consideration.

Hydrocarbons, the Alcohols and Organic Chemistry

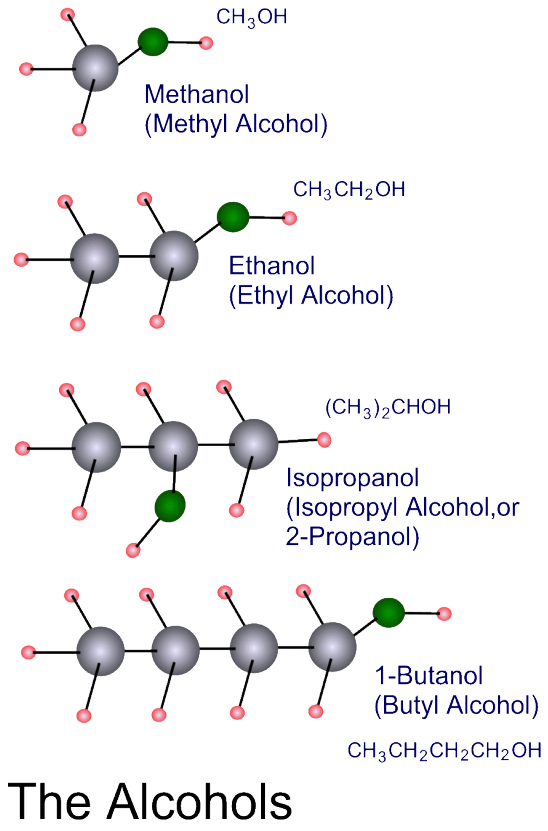


Figure 3 – Representative diagrams of the alcohol family

Organic chemistry deals with the bonds of carbon compounds. Alcohols have a chain of hydrogen-carbon bonds, called the alkyl group, (sometimes referred to as the methyl group), with a "tail" attached that is an oxygen-hydrogen pairing, called the hydroxyl group. Each of these is referred to as a functional group2. By adding more and more alkyl groups together in the chain, the alcohol molecule gets longer and more complex. In theory, the chain of hydrocarbons in an alcohol molecule could be infinitely long; however, we are concerned with only a few alcohol molecules. It is the difference in the alcohol's structure that creates different metabolites when they are broken down by the body, resulting in different levels of toxicity for each alcohol type. Alcohol is a hydrophilic compound, meaning that it is completely soluble in water. This solubility makes it easy for alcohol to be absorbed in the body.

Methanol exists as a "chain" of a single hydrocarbon group, Ethanol has two hydrocarbons in the chain, Isopropyl alcohol has three hydrocarbons, and Butyl alcohol has four, as shown in ***Figure 3***. Each one of these collections of carbon-carbon chains forms a marriage with the oxygen-hydrogen group, to form *an alcohol*. *The presence of the hydroxyl group makes the molecule an alcohol.* Because the alcohol molecules are similar in form, they behave similarly in function.

[2] A functional group in chemistry refers to a particular pattern of atoms that occurs time and time again in different molecules.

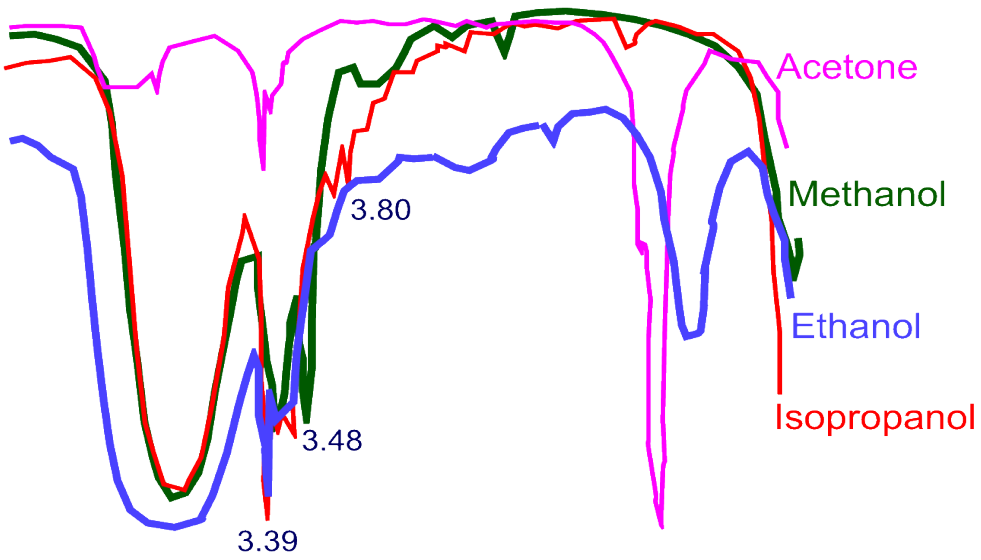


Figure 4 - Overview of the common interferents compared to the fingerprint of ethanol.

The bonds keeping those molecules bound together are continuously vibrating, even if the compound is in a solid or liquid state. Think of the bonds not as straight sticks, but as flexible springs. The bonds between two atoms in a molecule will vibrate perpetually at their own rate, or *frequency*. The bonds between hydrogen and oxygen atoms vibrate at different frequencies than between a pairing of hydrogen and carbon molecules. The bond energy is measurable, in the form of a *frequency rate*.

Occupational Exposure to Organic Hydrocarbons

Some workers are known to have been occupationally exposed to isopropanol or methanol. If tested while exposed to isopropanol or methanol alone the Intoxilyzer 5000EN would certainly be able to determine that the interferent did not produce the expected result as with ethanol and would therefore report an unknown interfering substance. However, in *combination* with ethanol, the Intoxilyzer has the tendency to over-report the BAC present in combination with a small concentration of isopropanol or methanol, and will not trigger the interferent detector. Hak (1995) reported that an isopropanol level will enhance a reported BAC while identified as an interferent less than half the time, depending upon the concentration of the interferent.

Ethanol is an organic hydrocarbon. The Intoxilyzer 5000EN reads the methyl (CH_3) portion of the ethanol molecule along the 3.36 – 3.80 micron range to determine the presence and concentration of ethanol in the test cylinder. The infra-red signature of isopropanol also includes a strong absorptance in this range, as outlined in Figure 1. The high degree of overlap in the 3.36 – 3.80 micron range is emphasized in red. This is due to the presence of the CH_3 molecules in both substances concerned. Note that this is the only infra-red range that is measured by the Intoxilyzer 5000EN.

It has been identified by various researchers that certain hydrocarbon compounds, in concert with low levels of ethanol cause inflated readings on the Intoxilyzer 5000 that are not always detected by its interferents-detect algorithm (Hak, 1995, Jones et al, 1996, Caldwell & Kim, 1997, and Memari, 1999). The Intoxilyzer 5000EN attempts to mitigate this tendency through the inclusion of two additional filter points (3.36µ and 3.52µ). However, these points will only assist in the detection of toluene and acetaldehyde.

I have identified the tendency of the Intoxilyzer 5000EN to over-report the true BAC of a sample of ethanol in the presence of interferents such as isopropanol, methanol, menthol, dimethyl sulfone and D-limonene. With a mixture of both ethanol and another infra-red absorbing hydrocarbon, the interferent detection algorithm often fails to report the presence of the interferent, while inflating the true concentration of ethanol reported as a BAC. I am concerned that a combination of hydrocarbons, as illustrated in Figure 5, falsely reports the BAC of ethanol in a test subject.

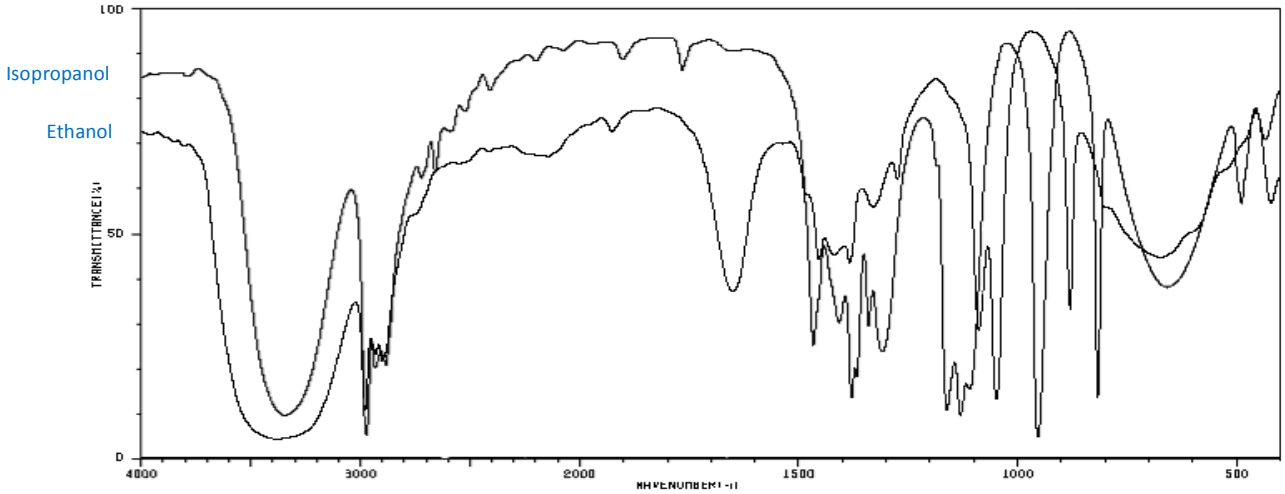


Figure 5 – A comparison of the fingerprints of isopropanol and ethanol.

The infra-red signature of Dimethyl Sulfone, Methyl Sulfonylmethane, and the organic volatile compound Biofreeze® (containing isopropanol and menthol) also includes a strong absorptance in this range, as outlined in Figure 6. The high degree of overlap in the 3.36 – 3.80 micron range is emphasized in red. This is due to the presence of the CH_3 molecules in all the substances concerned. *Note that this is the only infra-red range that is measured by the Intoxilyzer 5000EN.*

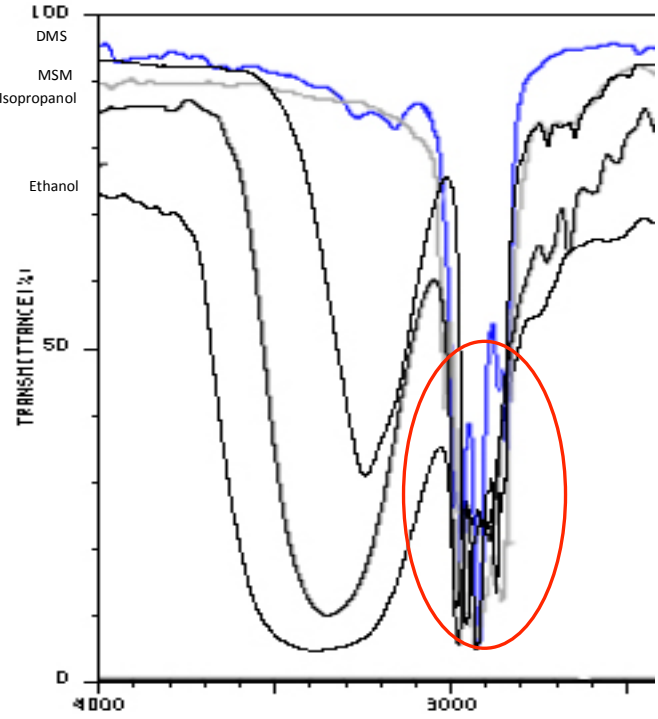


Figure 6 - Overlapping infrared detection points

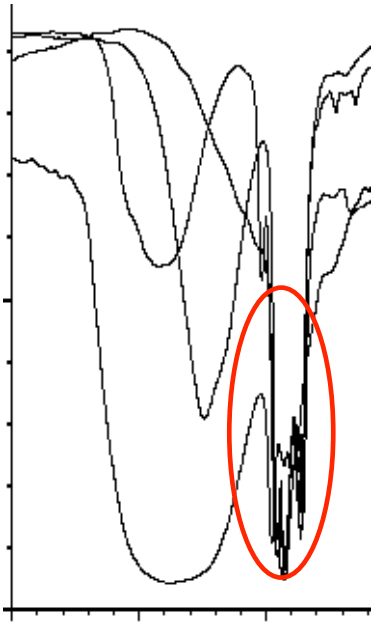


Figure 7 – The Over-lapping Infrared Signatures of
Castor oil, Adipic acid, Methanol and Ethanol (bottom)

I conducted a series of sample tests on an Intoxilyzer 5000EN with methanol in concert with ethanol as itemized in Table 2:

Phase	Test	Result - grams	Remarks
1	1	.058	*1.0 ml* ***ethanol*** *(50%) in 500 ml distilled water.* ***Average reported BAC .060 grams***
	2	.063	
	3	.060	
	4	.060	
	5	.060	
2	6	.154	*1.0 ml* ***ethanol*** *(50%) with 1.0 ml* ***methanol*** *dissolved in 500 ml distilled water.* ***No interferent detected.*** ***Average reported BAC .165 grams***
	7	.165	
	8	.166	
	9	.172	
	10	.170	

Table 2 – Abbreviated Test results using interferents with .06 ethanol solution
(More than these ten tests were performed).

Isopropanol and its Metabolite Acetone as Interferents

I have observed that, when confronted with a variety of potential interferents, the Intoxilyzer 5000 and 5000EN will report exaggerated BAC readings. The Intoxilyzer 5000, even the enhanced EN version, is just not sophisticated enough to discern the overlapping infra-red signatures, and separate them from ethanol. I performed a series of simulations on an Intoxilyzer 5000 66-series and had a "true" ethanol level of 0.035 grams in a simulator elevated to an average of 0.072 grams with the inclusion of less than 1.0 ml of isopropanol and less than 1.0 ml of acetone (the expected metabolite of isopropanol). However, the unit only reported an interferent in 7 out of 15 samples. When the same 0.035 grams ethanol solution vapor was introduced into an Intoxilyzer 5000EN 68-series, the average reported BAC was inflated to .117 grams, yet the interferent detect circuitry only reported the interferent on 8 out of 15 occasions.

What is more alarming is the tendency of the units to report the BAC as a *subtracted*, or corrected, value on the occasions when the units did discover the interferent. In the simulations described above, during those times that the Intoxilyzer 5000 or 5000EN did determine the presence of the interferent isopropanol, they reported the *inflated* BAC value as being a *corrected* value, and apparently the product of subtraction of the false interferent value. However, these BAC values reported were still over-represented, often more than threefold. *See* ***Table 1*** *on Page 7.*

I am left to reasonably conclude, as have other researchers, that a combination of infra-red absorbing substances in the test chamber with levels of ethanol may falsely over-report the true BAC level, and may do so without triggering the interferent detector algorithm. The reported incidence of an interferent may vary among jurisdictions depending upon the threshold levels set in the acetone detect or subtract algorithm.

Conclusion

Raising evidence to the contrary may be difficult in certain circumstances. Where a fact pattern exists, they have proven invaluable in establishing reasonable doubt. Establishing a rational medical defense requires one or more experts, supporting documentation and perhaps even testimony from the defendant.

This is an excerpt from my upcoming book, *"Fundamentals, Principles and Practices in Breath Alcohol Testing"*

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