DUI/DWI: Hospital Laboratory Testing Lacks Forensic Reliability

Joseph Citron

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DUI/DWI, Forensics

There are several scenarios where a hospital laboratory will be involved in determining alcohol concentration. It will be shown, however, that the hospital-determined alcohol concentration lacks the forensic reliability needed for courtroom settings. This article serves as a primer for the legal nurse consultant working with cases involving alleged driving under the influence or driving while impaired. Among other topics, collection of blood specimens, the chain of custody, storage, and blood alcohol concentration analysis are the critical concerns that are covered. This article has been selected for inclusion in the 2009 JLNC Nursing Contact Hour Program. Participants of the program will be able to earn CNE credits for completion of an online post-test on this article. Please see the conclusion of the article for more detailed instructions.

Cases of driving under the influence (DUI) or driving while impaired (DWI) can involve hospital laboratories. The usual circumstance occurs when an accident results and drawing a blood alcohol test is part of the emergency department protocol. Another possible involvement of the hospital lab is when an arrestee requests an independent blood test of his blood alcohol concentration (BAC) after submitting to the state-administered breath test or the arresting officer requests a blood test instead of the breath test. Such lab results, however, lack forensic reliability and therefore are not acceptable as legal evidence (Garriott, 1996).

Civil litigation attorneys are very interested in accurately identifying a party with an alcohol level at the time of incident. The value of settlements and verdicts are greatly enhanced when alcohol is shown to be a factor (Robinson, 2004). It is not enough to have a criminal conviction. Some states have a window of time following an arrest for DUI within which they can allege driver impairment (Georgia, 2006). Civil cases lack the burden of prescribed time in which a driver's alcohol level may be admissible in court. The alternative is to try to establish the alcohol concentration at the time of incident, known as retrograde extrapolation (Garriott 1996).

Erich Widmark, a Sweden-based physiologist, established a formula to determine blood alcohol levels when certain factors are known. These factors include gender, weight, amount of alcohol, drinking pattern, and drinking timeframe. This eponymous formula is still the benchmark by which other forms of BAC determinations are compared (Widmark, 1981).

A 1992 Texas case, *Mata v. State of Texas*, challenged retrograde determination of BAC by requiring testifying experts to possess sufficient information about the factors of the case, including gender, weight, drinking pattern, and timeframe. The expert must have the ability to apply the science of the retrograde extrapolation and an understanding of the difficulties associated with the process such as delayed alcohol absorption caused by the presence of food in the stomach and the competition for liver metabolism sites by drugs (Mehta, 1996). There is a 20% margin of error associated with the Widmark formula when used in retrograde extrapolations (Widmark, 1981).

In legal settings, BAC is expressed as grams of alcohol in deciliters of whole blood. Many hospital lab machines do not use these denominations, so there is a need to shift decimal points to conform with the legal formulation (Harding, 2008). For example, a BAC of .08% means that there is .08 grams of alcohol in a deciliter of whole blood; a hospital lab might report this as .80 gm/ml (grams/milliliter).

The United States and Western European communities of toxicologists agreed to maintain the metric units in regard to alcohol concentrations and not use the International System of Units (SI) that were adopted in 1986 by the *Journal of the American Medical Association* (Lundberg, 1988). As a result, metric units are currently used universally. Blood alcohol concentrations are typically reported to the second decimal point, and the remaining numbers are dropped. This is called truncation. For example, determinations of .081% and .087% are both reported as .08% (Gullberg 1991).

Collection

Venipuncture, the act of drawing blood from someone's veins, for a BAC specimen must be performed without any extraneous alcohol exposure from the skin prep. If isopropyl alcohol is used to clean the skin prior to venipuncture, it is possible to contaminate the vacutainer tube because of the vacuum within the blood tube. Alcohol on the skin may be pulled into the tube. It is recommended to use a non-alcohol skin cleanser for site preparation such as povidine iodine or zepharin. Depending on the technique used to measure alcohol concentration, contamination can be discovered and excluded in the final measurement, or the chemical measurement can be of the total of alcohol concentration that could include extraneous contaminants (Jain, 1971; Solon, 1972).

Depending on the hospital lab equipment, there are several, albeit very different, tubes for the blood collection. A whole blood specimen is collected in grey top tubes containing

anti-coagulants and preservative. Serum testing requires a clotted specimen and is collected in red top tubes. All tubes contain preservatives to prevent specimen degradation (BD, 2006).

Once collected, the specimen should be considered a forensic specimen and a proper chain of custody maintained. Chain of custody involves procedures that verify the transfer of evidence via date, time, and signatures of each person handling the evidence. The goal of chain of custody is to insure the integrity of the evidence, to prevent tampering, and to assure that the evidence admitted in a court proceeding is the original evidence in the original condition with which it was found or collected (Smith, 1990).

Transit and Storage

Specimens should be delivered to the lab directly after they are collected. The lab personnel receiving the specimen is a link in the chain of custody. While in transit, the specimens should be refrigerated as close to 4 degrees centigrade as possible. Hospital and state laboratories maintain policy procedures that require storage of specimens at 4 degrees centigrade for a certain time before discarding the specimens (Jones, 1999). Forensic specimens should be kept by the state laboratory for preservation of evidence.

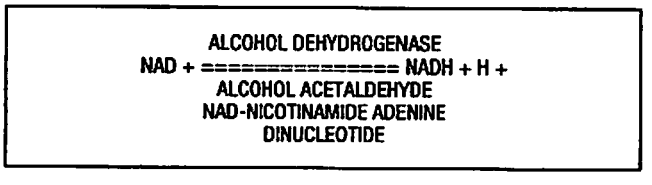
If specimen testing is not done immediately upon blood draw, the specimen should be secured in a locked refrigerator. The ideal temperature range should preclude any chemical reactions from occurring within the specimen and prevent freezing, and 4 degrees centigrade is considered appropriate to address these two concerns (Jones, 1990).

Testing

Enzymatic Immunoassays

Most hospitals use a variation of enzymatic assay testing (known as enzymatic immunoassays, or EIAs) of serum. This technique lacks the specificity to measure only ethanol (drinking alcohol). EIA is the most common chemical process in hospital laboratories (Whitehouse and Paul, 1979). For BAC measurement, a serum preparation is mixed with the enzymes alcohol dehydrogenase and nicotinamide adenine dinucleotide (NAD). First described by Bonnichsen and Theorell in 1951, it remains the basis for hospital laboratory blood alcohol level determinations today.

Figure 1. Enzymatic Assay Testing.



Alcohol dehydrogenase (ADH) is the primary enzyme in this reaction. It is not selective for ethanol and therefore will react with any alcohol present in the specimen. When a specimen is contaminated with isopropyl alcohol from the skin disinfectant, the ADH will react with the isopropyl and yield an alcohol concentration reading higher than that of the ethanol content alone.

EIA testing really measures the amount of NADH, one of the enzymes used in oxidizing the alcohol to acetaldehyde. NADH, the reduced form of NAD, is measured directly by a colorimetric device at 340 nm. This colorimetric device is part of the hospital laboratory machine. This is a purple hue, with the intensity of the color indicating the concentration of the NADH produced. NADH production is directly related to the amount of alcohol oxidized to acetaldehyde (Cobras, 2003).

Most laboratories have automated machines using a spectrophotometer calibrated to 340nm. The 340nm wavelength is used to measure various blood chemistries such as electrolytes, glucose, BUN, etc. The processes are automated and rapid. A BAC can be measured within 20 minutes of the specimen arriving at the lab (Young, 2006). The EIA measurement process is, however, considered an indirect alcohol concentration determination because the amount of alcohol is not really measured. Instead, the alcohol concentration is determined by the known relationship of how much NAD is needed to oxidize a known amount of alcohol (Solon, 1972).

A variant to this measurement system is an indirect colormetric system in which a dye is coupled to one of the enzymes and the amount of dye is measured indicating the amount of enzyme used. This adds an additional layer to this indirect measurement of alcohol concentration so that the alcohol concentration measurement is two stages away from the actual chemical being measured. Additional errors can occur with additional steps such as just described (Nine, 1995). For one, color contaminants to the serum can cause false readings. Hemolysis of the blood specimen adds color to the normally clear serum. Thus, hemolyzed specimens may cause false high readings of the EIA colormetric determinations. This occurs for any of the testing resultants, whether trying to measure alcohol, electrolytes, or other components (Cobras, 2003). Best practices would indicate that any result tested and determined to be hemolyzed is unreliable and should be redrawn before basing any treatment decisions or legal consequences on the result.

As reported by Nine (1995), false positives can occur in the presence of lactated ringer's IV solution because lactate is metabolized in the presence of NAD. This process produces NADH that is not related to any alcohol present or not present in the serum specimen. In emergency department settings, this is a common source of mistaken BAC levels. To avoid hemodiluted specimens, no blood specimens should be drawn from the same arm that has an IV line and certainly not above the IV site. Certain antibiotics can also give false positive or falsely elevated BAC measurements (Mehta, 1996). Each lab machine handbook has a list of the medications affecting the chemistry of the measuring process.

The EIA method has significant limitations. It cannot differentiate the quantities of ethanol (drinking alcohol) and isopropyl alcohol (Garriott, 1983). Additionally, EIA is a less

desirable method because it utilizes no individual internal quality controls. These deficits are countered by the ready availability of the machinery in every hospital lab and the rapidity of the measuring process.

Gas Chromatography

Gas chromatography (GC) is another technique used for determination of BAC. GC can measure each alcohol separately, and the results are graphed as individual quantities. The GC process involves using a vapor of the heated whole blood's volative content (alcohols) that is gas-propelled through a column packed with chemicals and resins. Each alcohol molecule travels through the column at a different rate of speed. This enables separation of the different blood volatives for identification and quantification. Additionally, propanol, an internal control substance, is added to each sample and measured at the end of the column run. This is an internal quality control feature that is not available in the EIA method (Jain, 1971).

GC measurements are considered the gold standard for BAC determinations. The specificity of the technique for measuring ethanol and the internal quality control in each test are the prime reasons for this recognition (Solon and Baird, 1972). The process is, however, slower and more labor-intensive than that seen with EIA testing. Most hospitals do not possess a GC machine. The specimen has to be sent to a reference lab for GC analysis. The results are usually available within 24 to 48 hours after collection.

Serum vs. Whole Blood

Serum is the liquid portion of the blood without the cells and clotting factors. Alcohol concentrations will be higher in serum than in whole blood because there is less volume in the serum specimen. Alcohol does not move into the intracellular areas and is not part of the clotting factors. The alcohol in the blood stays with the serum as the volume of the cells and clotting proteins are removed (Young, 2006).

Unfortunately, there is no formula to convert serum alcohol concentration into the whole blood concentration level (Charlebois, 1996). The difference between whole blood BAC and serum BAC ranges from 9-32%, with the serum BAC level higher. There is no agreement among alcohol physiologists for a conversion factor or formula to convert serum to whole blood BAC levels. The conversion factor varies between 1.13 and 1.18, as noted in papers by Dotzauer, et al (1972) and Payne, et al (1968).

Forensic BAC

There are several reasons that BACs determined via the EIA method should be disqualified as possessing forensic value. The legal definition of intoxication per se is a BAC of .08%, based upon a whole blood measurement. Whether the reason for testing blood alcohol is for a commercial driver's license (CDL), a per se level of .08%, or an under-age drinker, the laws are written in terms of alcohol concentration in whole blood (Georgia, 2006). The absence of a reliable conversion factor from serum to whole blood precludes the serum level as a forensic value.

All EIA process manufacturers have caveats in their handbooks that attempt to exclude the EIA-determined serum BAC value from being a forensic value. Some of the handbooks describe the EIA method as semi-quantitative and in need of clinical correlation. The intent is to have the physician interpret the numerical result in the context of the clinical findings (Cobras, 2003). As an illustration, a semi-comatose person with a low BAC needs further work-up to determine other factors, such as injuries or drugs, that account for the low level of consciousness. Similarly, a reported EIA-determined BAC of .60%, usually considered fatal, needs to be given little credibility when the patient is awake, oriented x3, and responsive to questions.

Roche Diagnostics, a manufacturer of blood analysis machines, states in the preamble of the operator's manual, 2003 version for their Cobras Integra models 400, 700 and 800, that the readings from this machine are not intended for forensic purposes.

EIA test results for BAC should not be used anywhere outside of the clinical setting. The values are out of context when not used in the presence of the patient symptomatology or when not used by the physician in determining treatment or diagnostics.

GC is a whole blood measuring test. This complies with the legal requirement for the type of specimen tested. As the gold standard in more than 35 years of use, the GC test is used by every state and federal crime lab in this country for measuring BACs (Garriott, 1996). The process was first reported in 1971 by Jain. The inclusion of an internal standard in each test sample, in conjunction with duplicated testing for each sample, amplifies the high level of esteem for this testing method. The GC measurement can, therefore, be recognized as a valid BAC determination. When done correctly, GC is valid forensically and valid as an accurate process (Garriott, 1996).

Summary

Enzymatic immunoassays are preliminary tests and should be considered presumptive. Confirmatory gas chromatography testing is required. Determining an accurate blood alcohol concentration requires adherence to correct procedures – from the technique for venipuncture, chain of custody, transport, and storage to the laboratory. When all procedures and protocols are properly followed, the BAC value should be accurate and forensically valuable.

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Joseph Citron, a Mayo Clinic-trained physician, has practiced medicine in Atlanta Georgia for more than 25 years. In 1989, Citron started and was an active participant in American Clinical Laboratory, a medical reference laboratory. In 1997, he graduated from the Georgia State University College of Law and is a member of the Georgia Bar Association. Citron has written several chapters for DUI/DWI law books and lectured at many legal symposia on topics related to medicine. He currently consults on medical-related legal issues and is of counsel to the Barnes Law Group. He can be reached at **joecitron@aol.com**.

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