HOSPITAL “BAC”: Anatomy of a Case

DCDLA Meeting
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Knowledge Can Take You Far

**Garriott’s Medicolegal Aspects of Alcohol, 5th edition**

**Understanding DUI Scientific Evidence**
(Aspatore Publ.)

**Phlebotomy Essentials, 5th ed.**
Plasma or Serum Tested in a Hospital Lab:

**NURSING PROGRESS NOTES**
03:53. Critical value relayed to ED and read back. Alcohol level: 266. ED physician and PA notified of critical value. --03:53 Skarsten, Cathy, R.N.

Alcohol level will be found somewhere in the medical records.

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
<th>Time</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>None (glass)</td>
<td>0</td>
<td>For serum determinations in chemistry. May be used for routine blood donor screening and diagnostic testing of serum for infectious disease. ** Tube inversions ensure mixing of clot activator with blood. Blood clotting time: 60 minutes.</td>
</tr>
<tr>
<td>Red</td>
<td>Clot activator (plastic)</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

| Green  | Sodium heparin                   | 8    | For plasma determinations in chemistry. Tube inversions prevent clotting. |
| Green  | Lithium heparin                  | 8    |                                                                      |
Serum/Plasma Testing Issues

- No chain of custody – sample results may belong to another patient
- No sample available for independent re-test
- Serum results always higher than whole blood
- Hospital may draw arterial blood instead of venous
- Arterial blood may have 40% higher ethanol concentration than venous blood
- Hospital protocols do not follow forensic quality control guidelines
- Hospital serum ethanol error is plus or minus 25%
- Serum ethanol enzyme assay method is prone to false positives
- Hospital serum ethanol testing is performed for medical, not legal purpose
- Substances found in the blood, such as lactic acid, can interfere with an enzymatic test and lead to a false high ethanol result
Hemolysis
What Are The Causes of Hemolysis?

Specimen Collection:

Evacuated Tubes
• An improper choice in the venipuncture site, such as drawing from a distal site to the antecubital region of the arm rather than drawing from an antecubital site, has been shown to result in more hemolysis.
• Prolonged tourniquet time causes the interstitial fluid to leak into the tissue and cause hemolysis.
• Cleansing the venipuncture site with alcohol and not allowing the site to dry may cause hemolysis.
• An improper venipuncture, indicated by a slow blood flow, may indicate occlusion due to the lumen of the needle being too close to the inner wall of the vein, causing hemolysis.
• The use of a small-bore needle, resulting in a large vacuum force applied to the blood, may cause shear stress on the red blood cells, causing them to rupture.
• The use of a large bore needle may result in a much faster and more forceful flow of blood through the needle, resulting in hemolysis.
Specimen Collection:
IV Catheters
• Several studies have noted that when blood is drawn from a peripheral IV catheter, a higher incidence of hemolysis occurs due to frothing of the blood from a loose connection of the blood collection assemblies.

Specimen Processing:
• Vigorous mixing or shaking of a specimen may cause hemolysis.
• Not allowing the serum specimen to clot for the recommended amount of time can result in fibrin formation in the serum. The use of applicator sticks to dislodge the fibrin may cause rupture of RBCs, resulting in hemolysis.
• Prolonged contact of serum or plasma with cells may result in hemolysis.
• Exposure to excessive heat or cold can cause RBC rupture and hemolysis.
Specimen Transport:
• Mechanical trauma during transport may occur with the use of a pneumatic tube system, resulting in hemolysis. Variable factors associated with the system are related to system differences such as length, speed, and number of times the specimen is transported, as well as the number of angles or turns the system uses.
Troubleshooting Hemolysis Issues in the Clinical Laboratory

Hemolysis causes a serum or plasma sample to take on a pink or red tinge, due to the presence of the heme from the red cell.

A hemolyzed sample can be a tremendous concern for the laboratory. The hemolysis can cause a false elevation in some analytes, such as potassium and lactate dehydrogenase (LD), due to their high concentration in the red cell. The red or pink color of a hemolyzed sample can also interfere with some test methodologies, such as spectrophotometric methods. The amount of analyte interference will depend on the degree of hemolysis and the methodology being used. Hemolysis can be a reason for specimen rejection, thus causing the patient sample to be redrawn.

Hemolysis can be caused by many variables, including a traumatic venipuncture, improper handling and processing of blood collection tubes, and adverse conditions when samples are being transported to a laboratory. In order to help you identify potential reasons that you may be getting hemolyzed samples, this issue of LabNotes will provide you with a Troubleshooting Hemolysis Issues [wall chart].
“In the forensic laboratory, biochemical methods are not usually utilized for determining blood alcohol concentration due to their lack of specificity. Isopropyl alcohol and butyl alcohol may interfere in the biochemical reaction. For forensic purposes, enzyme methods must be confirmed by an alternative technique.”
Background

• Client could not remember accident or what he had to drink
• Remembers leaving the bar and only thinks he had a few beers
• Remembers stumbling away from the car after the accident
• Accident occurred in 6 inches of snow
• Truck veered into a tree – airbag deployed
• Client not in car when cops arrived
• Cops followed blood in the snow
• Found Client huddled under a tree, covered in blood, many blocks away
- Client was incoherent
- Temp was 30 degrees & snowing
- Lots of wrecks that night
- Police smelled alcohol, found bar receipts in wrecked truck, “bloodshot eyes”
- Transported to ER
- “Snaps out of it” once he reaches ER
- Officer arrives and asks for blood
- Client refuses & cop leaves
- Client had emergency surgery for a ruptured bowel
- Hospital records report a “266” BAC
## Obtain & Review Medical Records

What were the clinical impressions of Client when he was in the hospital?

<table>
<thead>
<tr>
<th>ADMISSION DIAGNOSIS:</th>
<th>The patient is status post motor vehicle collision with:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Blunt abdominal trauma.</td>
</tr>
<tr>
<td></td>
<td>2. Intestinal injury.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISCHARGE DIAGNOSES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blunt abdominal trauma.</td>
</tr>
<tr>
<td>2. Intestinal injury.</td>
</tr>
<tr>
<td>3. Elevated blood pressure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCEDURES PERFORMED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient is status post exploratory laparotomy with small bowel resection of the ileum per Dr. Adam Alder on 03/21/10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOSPITAL COURSE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient is a 34-year-old male who presented to the Emergency Department after being involved in a motor vehicle collision. The patient states that he could not remember the events of the crash; however, he was able to be ambulatory at the scene. Patient believes the impact was on the driver's side. Patient was taken to the scanner. He had a CT of the abdomen and pelvis with contrast on 03/21/10 which showed free fluid in the right pelvis, the right pericolic gutter and surrounding the liver. There was also evidence of mesenteric stranding adjacent to several loops of bowel concerning for bowel injury. The patient was immediately taken to the operating room for exploratory laparotomy and subsequently had a small bowel resection. The patient tolerated the operation quite well and returned to PACU without any postoperative complications.</td>
</tr>
</tbody>
</table>
Under “Primary Survey”

So much for “bloodshot eyes”
Determine the Timeline

- 1:56 Officers dispatched to accident
- 2:52 Client arrives at ER
- 3:20 Blood drawn
- 5:30-6 am Doctor meets with Client
- 5:53 Client speaks to mom on the phone
- 5:54 Client signs consent for surgery
What Did the Lab Reports Reveal?

• No testing for lactic acid
• Myoglobin level at 415 (normal is up to 8)
• No drugs detected
• Alcohol level at 266
• Only 300 cc’s of urine from catheter
Shortly before 6 am the ER doctor meets with Client. These are excerpts from his notes:

HISTORY OF PRESENT ILLNESS: The patient is a 34-year-old male who presents to the Medical Center of Plano after being involved in a motor vehicle crash. He recalls going out drinking tonight, recalls having 3-4 beers, but does not recall any details regarding how he got into a vehicle and came home. He recalls no details of the events of the crash, remembers waking up, being dazed and walking. He thinks he might have been on the driver's side of the vehicle, but cannot recall if he was driving or not, does not recall the speed or any other details regarding the crash itself. He had no specific complaints at the time that he remembers waking up, just feeling dazed and getting into the ambulance. Currently, he has no specific complaints. He denies nausea, denies vomiting, denies chest pain, abdominal pain. He has no pain related to extremities or anything else related the crash. He has no past medical history except for some reflux that he takes over the counter Prilosec for. He takes no other medications and has NO ALLERGIES.
GENERAL: Awake and alert, responsive, unclear about the details of the event as noted above and did report to me that he would let the courts decide what actually occurred.

HEAD AND NECK: He has several small lacerations to the left side of his face.

IMPRESSION: The patient is a 34-year-old male involved in a motor vehicle crash of unknown details who presents with an equivocal abdominal exam and computed tomography findings concerning for mesenteric versus intestinal injury. My recommendation is to admit to my service to go to the operating room now for exploratory laparotomy to rule out and possibly treat any intestinal injuries. The risks, benefits and alternatives to this approach were discussed in history the patient who understood and agreed to proceed, provided written informed consent.

Client signs written consent.
How Was the Blood Tested?

- Subpoena Duces Tecum served on hospital lab
- Test was done on Siemens Dimension clinical chemistry analyzer
- SERUM was tested, not whole blood
- Obtained hospital’s SOP for blood draws
Drawing Blood to Test for ETOH

From the hospital’s blood draw policy:

“Once the site is selected, it should be rubbed vigorously with the alcohol sponge. Alcohol should be allowed to dry after preparing the site. When doing a fingerstick, if alcohol is not wiped dry with gauze, the blood will not form a round drop, therefore making micro-collection more difficult. Also, the specimen will be diluted with alcohol, possibly resulting in erroneous test results. Chloraprep preparations are used for drawing blood cultures. Betadine or soap and water should be used on patients being drawn for an alcohol test.”
Enzymatic Testing

- For medical purposes
- Fast, only need a ballpark figure
- Usually enzyme analysis which is less specific for ethanol (ie. a screening test) than GC analysis and needs to be confirmed
- Indirect method for alcohol analysis
- You need to find out what type of immunoassay kit was used
Q. Okay. Is gas chromatography considered to be a forensically reliable method of testing for substances such as ethyl alcohol?

A. Gas chromatography is considered the only reliable method for forensic testing. In the area of laboratory medicine, it's referred to as the gold standard. In other words, the standard by which all the other tests are rated or compared to because it will identify specifically the chemical that's being tested.

Q. In comparison or in contrast, when you do this kind of testing that's done in hospital laboratories, is the test actually measuring the alcohol in the serum or is it doing some sort of an indirect measurement?

A. The enzyme testing in the hospital setting or laboratory setting is designed for automation and for speed. You can run several hundred tests in an hour, which is what you want. You want to have results back quickly and you want to have them automated so that you have less human error. So that the testing is designed for the process of getting the results in very similar grouping.

Hospital enzyme testing is a photometric test. The results or the numerical value is dependant upon the color of the chemical reaction that's
produced. So the testing is designed so that most of the reactions will produce a color change at a certain wavelength of light. And you do chemical manipulations or equation manipulations so that you can get that reading.

In the case of ethanol testing or alcohol testing, you don't measure alcohol, you don't measure the byproduct -- or I'm sorry. You don't measure the end product of oxidizing the alcohol. You measure the coenzyme byproduct, which has a color change in the range of 340 nanogram wavelength. That's what you measure. Because that's -- the machines are set up so that they have a reader. It's called a photometric reader. It reads color changes at that wavelength whether it for sodium, glucose, cholesterol, ethanol, myoglobin, and other proteins. Most of those are read at 340 nanograms and that's why it's set up that way.
You must obtain the packaging insert from the test cartridge that is used in the hospital lab.

Results of this test should always be interpreted in conjunction with the patient's medical history, clinical presentation and other findings.

Interfering Substances
Isopropyl alcohol of 51 mg/dL [8.5 mmol/L] increases the ethyl alcohol by 11 mg/dL [2.4 mmol/L] at an ethyl alcohol concentration of 100 mg/dL [22.0 mmol/L]; Isopropyl alcohol of 254 mg/dL [42.3 mmol/L] increases the ethyl alcohol by 44 mg/dL [9.6 mmol/L] at an ethyl alcohol concentration of 100 mg/dL [22.0 mmol/L].

At ethyl alcohol concentration of 100 mg/dL [22 mmol/L], butanol at 250 mg/dL increases the ALC result by 26.5% and n-propanol at 500 mg/dL increases the ALC result by 57.7%.
Non-Interfering Substances

The following substances do not interfere with the ALC method when present in serum in the amounts indicated. Systematic inaccuracies (bias) due to these substances are less than 10% at ethyl alcohol concentration of 100 mg/dL (22.0 mmol/L).

<table>
<thead>
<tr>
<th>Substance</th>
<th>Test Concentration</th>
<th>SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>0.025 mg/dL</td>
<td>1.66 μmol/L</td>
</tr>
<tr>
<td>Acetone</td>
<td>100 mg/dL</td>
<td>17.2 mmol/L</td>
</tr>
<tr>
<td>Amikacin</td>
<td>15 mg/dL</td>
<td>256 μmol/L</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>5.3 mg/dL</td>
<td>152 μmol/L</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>5 mg/dL</td>
<td>227 μmol/L</td>
</tr>
<tr>
<td>Caffeine</td>
<td>10 mg/dL</td>
<td>51.5 μmol/L</td>
</tr>
<tr>
<td>Carbamazepine</td>
<td>3 mg/dL</td>
<td>127 μmol/L</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>5 mg/dL</td>
<td>155 μmol/L</td>
</tr>
<tr>
<td>Chloroformazide</td>
<td>1 mg/dL</td>
<td>33.3 μmol/L</td>
</tr>
<tr>
<td>Chlorpromazine</td>
<td>0.2 mg/dL</td>
<td>6.27 μmol/L</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>500 mg/dL</td>
<td>12.9 mmol/L</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>10 mg/dL</td>
<td>0.4 mmol/L</td>
</tr>
<tr>
<td>Creatinine</td>
<td>30 mg/dL</td>
<td>2652 μmol/L</td>
</tr>
<tr>
<td>Dextran 40</td>
<td>6000 mg/dL</td>
<td>1500 μmol/L</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.5 mg/dL</td>
<td>17.6 μmol/L</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>6 mg/dL</td>
<td>81.6 μmol/L</td>
</tr>
<tr>
<td>Ethanol</td>
<td>400 mg/dL</td>
<td>86.8 mmol/L</td>
</tr>
<tr>
<td>Ethosuximide</td>
<td>25 mg/dL</td>
<td>1770 μmol/L</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>250 mg/dL</td>
<td>40.3 mmol/L</td>
</tr>
<tr>
<td>Furosemide</td>
<td>6 mg/dL</td>
<td>161 μmol/L</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>12 μg/dL</td>
<td>25 μmol/L</td>
</tr>
<tr>
<td>Heparin</td>
<td>3 U/mL</td>
<td>30000 U/L</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>50 mg/dL</td>
<td>2425 μmol/L</td>
</tr>
<tr>
<td>Immunoglobulin G</td>
<td>5 g/L</td>
<td>60 g/L</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>100 mg/dL</td>
<td>11.1 mmol/L</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1.2 mg/dL</td>
<td>51.2 μmol/L</td>
</tr>
<tr>
<td>Lithium</td>
<td>2.3 mg/dL</td>
<td>3.2 mmol/L</td>
</tr>
<tr>
<td>Mannitol</td>
<td>500 mg/dL</td>
<td>27.4 mmol/L</td>
</tr>
<tr>
<td>Methanol</td>
<td>100 mg/dL</td>
<td>31.2 mmol/L</td>
</tr>
<tr>
<td>Nicotine</td>
<td>2 mg/dL</td>
<td>0.1 mmol/L</td>
</tr>
<tr>
<td>Penicillin G</td>
<td>25 U/mL</td>
<td>25000 U/L</td>
</tr>
<tr>
<td>Pentobarbital</td>
<td>8 mg/dL</td>
<td>354 μmol/L</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>10 mg/dL</td>
<td>421 μmol/L</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>10 mg/dL</td>
<td>421 μmol/L</td>
</tr>
<tr>
<td>Primidone</td>
<td>5 mg/dL</td>
<td>198 μmol/L</td>
</tr>
<tr>
<td>Propoxyphene</td>
<td>4 mg/dL</td>
<td>183 μmol/L</td>
</tr>
<tr>
<td>Protein, Albumin</td>
<td>0.2 mg/dL</td>
<td>4.91 μmol/L</td>
</tr>
<tr>
<td>Protein, Total</td>
<td>0.2 mg/dL</td>
<td>120 μg/L</td>
</tr>
<tr>
<td>Pyruvic Acid</td>
<td>0.2 mg/dL</td>
<td>4.91 μmol/L</td>
</tr>
<tr>
<td>Urea</td>
<td>60 mg/dL</td>
<td>3.3 mmol/L</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>60 mg/dL</td>
<td>4.34 mmol/L</td>
</tr>
<tr>
<td>Valproic Acid</td>
<td>20 mg/dL</td>
<td>1190 μmol/L</td>
</tr>
<tr>
<td>Valproic Acid</td>
<td>50 mg/dL</td>
<td>3467 μmol/L</td>
</tr>
</tbody>
</table>
Converting Serum/Plasma Result to Whole Blood Result

.10 serum blood test result

\[
\begin{align*}
.10 / 1.16 &= .086 \\
.10 / 1.18 &= .084 \\
.10 / 1.20 &= .083 \\
.10 / 1.25 &= .080
\end{align*}
\]

State’s expert converted .266 to .221 using a conversion factor of .20.

\[
.266/1.20 = .221
\]
Re-Visit the Timeline

- 3:20  Blood drawn
  .266 plasma = .221 whole blood according to State’s expert
- 5:30-6 am Doctor meets with Client
  Assuming a .015 elimination rate, BAC approximately .19-.18 during meeting
- 5:53  Client speaks to mom on the phone
- 5:54  Client signs consent for surgery
  Under State’s theory, .18 when signing consent form (9 beers on board)
What Won This Case for Us & Lost it for the State

• No driving facts
• No video
• No SFST’s
• Police did not arrest client at the hospital
• ER nurse spent over 4 hrs with Client, remembered him well and NEVER testified she thought he was intoxicated
• Medical records did not reflect intoxication
• Client “snapped out” of his daze which was not consistent with a black out
• Client’s injuries involved muscle damage which would release lactic acid into the blood as supported by the high myoglobin level

• The State’s expert (county medical examiner) admitted enzymatic testing is highly susceptible to interferents and is not forensically reliable

• The lab tech admitted the high myoglobin number would indicate muscle injury and a high lactic acid level

• The defense expert was untouchable by the State in cross and they called no rebuttal witness to disagree with his assessment of the case
• State did not really understand the subject matter
• State did not call the doctor as a witness
• State did not realize the accident occurred on my client’s birthday
• State did not have the witnesses there to prove up the receipts found in the car
• State did not really read and understand the medical records
• State did not understand that the nurse NOT testifying my client was intoxicated was a case-sinker
**Our Position**

Here are the facts. What conclusions can we draw from them?

**The Prosecution**

Here's the conclusion. What facts can we find to support it?
Attached Materials

• A Subpoena Duces Tecum for the hospital lab
• The direct examination of my expert, Dr. Joe Citron
• The closing argument from this case
• The 2 articles referenced in the materials
• Judge Edwards comments on the NAS report (which I give to judges who fight me on discovery)
Deandra M. Grant

AV-rated attorney Deandra Grant’s practice is focused on DWI defense in Dallas and Collin County, Texas. She is a national speaker on DWI law and science and is the co-author of *The Texas DWI Manual*, scheduled for re-release in 2012. She is also the author of the popular Texas DWI Gal blog and the founder of the Texas DWI Defenders list serve. Deandra has completed the SFST certification course, the SFST instructor course, a drug recognition course and is one of the few attorneys to pass the Forensic Sobriety Assessment Certification exam. In addition, she has completed coursework in DWI forensic blood and urine testing and was trained as an operator and maintenance technician of the Intoxilyzer 5000. In 2011 she received a certificate in *Forensic Chromatography: Theory & Practice*, issued by Axion Labs and the American Chemical Society. Deandra is a member of NCDD, NACDL, TCDLA, the Dallas Bar Association, the Collin County Criminal Defense Lawyers Association and has served on the Board of the Dallas Criminal Defense Lawyers Association since 2007. In 2012 she was admitted as a member of the American Chemical Society and the American Academy of Forensic Science. D Magazine named Deandra to its list of Best Women Lawyers in Dallas 2010 and Best Lawyers in Dallas 2011. She was also named a Texas Super Lawyer in 2011.