DWI Blood Cases: A Primer

AACDL’s Betting on Justice XII
June 2012
Tunica, MS

By Deandra Grant
Knowledge Can Take You Far

Garriott’s Medicolegal Aspects of Alcohol, 5th edition

Understanding DUI Scientific Evidence (Aspatore Publ.)

Phlebotomy Essentials, 5th ed.
Forced Blood Chair – Houston

“Old Sparky”
June 24, 2009

Deandra M. Grant
Law Office of Deandra M. Grant
1700 Alma Dr., Ste. 227
Plano, TX 75075

RE: Public Information Request for records pertaining to manufacturer of the blood testing kits and blood vials used by DPS; ORA No. 09-1215

Dear Ms. Grant:

The Department is in receipt of your request for the above referenced information. The manufacturer of the DPS blood testing kits used for DWI blood draws is Sirchie Fingerprint Laboratories. The manufacturer of the blood vials used for blood draws contained in the DPS blood testing kits is Coviden.

Should you have any questions regarding this matter, please contact me at (512) 424-2690.

Sincerely,

Michele Freeland
Legal Assistant
Office of General Counsel
DPS Blood Kit

It has the preservative sodium fluoride (100 mg) and the anti-coagulant potassium oxalate (20 mg).

- Potassium oxalate/sodium fluoride 8
- Sodium fluoride/Na₂EDTA 8
- Sodium fluoride (serum tube) 8

For glucose determinations. Oxalate and EDTA anticoagulants will give plasma samples. Sodium fluoride is the antilycolytic agent. Tube inversions ensure proper mixing of additive and blood.
Contents of the blood kit include:

- Pre-sealed **Blood Tube Mailer Box**
- **Kit Instruction Sheet** and **Subject Consent Form** (to be retained by officer)
- **Evidence Submission Form**
- 10 mL **Blood Collection Tube** (gray top) containing 100 mg of Sodium Fluoride and 20 mg of Potassium Oxalate
- **Absorbent material** to cushion the Blood Collection Tube
- **Foam padding** with space to hold plastic tube
- **Plastic bag** to hold Blood Collection Tube and tissue
- Tamper-evident **Blood Tube Seal** for Blood Collection Tube
- **Integrity Seal** to reseal box
- **Mailing Label**
- **Plastic Sleeve** to hold Evidence Submission Form
Follow these steps to assemble a blood collection kit:

**STEP 1:** After specimen has been collected, write the requested information on the tamper-evident Blood Tube Seal and seal the tube by placing it across the top of the stopper and down the sides of the tube.

**STEP 2:** Wrap the glass Blood Collection Tube with the absorbent material and place inside plastic bag.

**STEP 3:** Place the plastic bag inside the plastic tube.

**STEP 4:** Place the plastic tube in the foam padding inside the box.

**STEP 5:** Seal box with enclosed red Integrity Seal. Initial and date the seal so that the writing goes across the seal and the box. Fill out address label and place on top of sealed box.

**STEP 6:** Place the completed submission form inside the plastic sleeve attached to the outside of the box and seal.

**STEP 7:** Protect the specimen from extreme temperatures.

In the absence of a kit, have the medical personnel use a “gray top” tube. Submit with a current Laboratory Submission Form (Lab-06). Package so that tube will not break in transit.

If the expiration date on the Blood Collection Tube has passed, have the medical personnel use a new gray top tube and package in kit per the usual instructions.
BLOOD WITHDRAWAL PROCEDURE FORM

1. Officer placed suspect under arrest for a Chapter 49 offense involving operation of a motor vehicle.

2. Officer read DIC-24 to suspect and did provide suspect with written copy.

3. Suspect did consent / did refuse to give blood sample / unconscious or incapable of refusal.

4. Officer did remove vial from blood collection kit.

5. Expiration date on blood kit/vial is [Fill in or let blank]

6. Officer did fill cut label that came with kit completely except for the time blood was drawn.

7. Vial was closed when handed to the nurse.

8. Preservative/anti-coagulant powder was seen in vial.

9. Nurse/technician did the following in withdrawing blood from subject:
   - [ ] Used betadine (or other __________) solution to disinfect arm.
   - [ ] Officer should save swab packaging.
   - [ ] Rotated vial as directions indicated 5 times so as to mix blood with preservative anti-coagulant.

10. Vial (top never having been opened) was then delivered to officer and officer finished completing label by adding time blood was drawn and officer and nurse/technician initialed label which was used to seal vial top closed.

Signed by: [Signature]

[Printed Name]

[Title]

Nurse/Medical Technician

SUSPECT NAME [Printed Name]

DATE: [Date]

OFFENSE NO: [Offense Number]

TIME OF BLOOD DRAW: [Time]

[Contact Information]
Where Was the Draw Site?

- **Typical site** – cubital vein located inside the elbow

- **Hospital draw** – may use an artery due to convenience

- Why does this matter?
  - **Absorption phase** – Arterial blood has higher alcohol concentration

  **Elimination phase** – Venous blood has higher alcohol concentration
**Best Sites for Venipuncture**

Superficial veins of the upper limb

1. **Median cubital vein**
   A superficial vein, most commonly used for venipuncture, it lies over the cubital fossa and serves as an anastomosis between the cephalic and basilic veins.

2. **Cephalic vein**
   Shown in both forearm and arm, it can be followed proximally where it empties into the axillary vein.

3. **Basilic vein**
   Shown in the forearm and arm, it divides to join the brachial vein.

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**Troubleshooting Hints for Blood Collection**

Needle positioning and failure to draw blood

- **Correct insertion technique:** Blood flows freely into needle.
- **Incorrect insertion:**
  - Bevel on lower wall of vein does not allow blood to flow.
  - Bevel on upper wall of vein does not allow blood to flow.
  - Needle partially inserted into vein causes blood leakage into tissue.
  - Needle inserted through both vein walls.
  - Collapsed vein.

**BD Diagnostics**
Preanalytical Systems
BD Global Technical Services 1.800.631.0174
BD Customer Service 1.888.237.2762
www.bd.com/vacutainer
Troubleshooting Hints for Blood Collection
Proper insertion of evacuated tube

1. Correct
For proper insertion of tube, carefully center the tube in the holder.

2. Incorrect
Improper insertion resulting in an incompletely punctured stopper.

3. Incorrect
Partially punctured stopper.

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www.bd.com/vacutainer
Gray top tubes - It has the preservative sodium fluoride (should have 100 mg) and the anti-coagulant potassium oxalate (should have 20 mg).

Red top tubes are empty.

CHECK YOUR TUBE LABEL!
# BD Vacutainer® Venous Blood Collection Tube Guide

For a full line of BD Vacutainer® Specimen Collection Products, visit www.bd.com/vacutainer.

<table>
<thead>
<tr>
<th>Tube Color</th>
<th>Additive</th>
<th>Laboratory Use</th>
<th>Year Long Shelf Life/Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Gel, clot activator and gel for surface activation</td>
<td>for plasma determinations in chemistry. Gel for coagulation testing. May be used for calcium, copper, zinc, lead, and cadmium.</td>
<td>3 years</td>
</tr>
<tr>
<td>Light Green</td>
<td>Lithium heparin and clot activator</td>
<td>BD Vacutainer® EDTA® Tube for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Yellow</td>
<td>No additive</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Blue</td>
<td>Gel, clot activator (plastic)</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Orange</td>
<td>Thrombin</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Purple</td>
<td>Gel, clot activator, sodium citrate, anticoagulant, and preservative</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>White</td>
<td>Sodium heparin</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Maroon</td>
<td>K2 EDTA, sodium citrate, and heparin</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Clear</td>
<td>Sodium citrate, polyethylene glycol, and heparin</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Lavender</td>
<td>Sodium citrate</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Pink</td>
<td>K2 EDTA and glucose</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Mint</td>
<td>K2 EDTA with gel</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Magenta</td>
<td>Sodium citrate</td>
<td>for plasma determinations in chemistry. Tube maintains patient clotting.</td>
<td>3 years</td>
</tr>
<tr>
<td>Light Blue</td>
<td>K2 EDTA with gel</td>
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<td>3 years</td>
</tr>
<tr>
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<th>Red</th>
<th>None (glass)</th>
<th>Clot activator (plastic)</th>
<th>0</th>
<th>5</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>Potassium oxalate/sodium fluoride</td>
<td>8</td>
<td>For glucose determinations. Oxalate and EDTA anticoagulants will give plasma samples. Sodium fluoride is the antiglycolytic agent. Tube inversions ensure proper mixing of additive and blood.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium fluoride/Na₂EDTA</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium fluoride (serum tube)</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NOT SHAKING!

BD recommends **8-10 inversions** with a gray top tube to ensure proper mixture of blood and chemicals

What is an “inversion”? Why does it matter? Why is shaking bad?
See the unique additive
All BD Vacutainer plastic tubes have an additive or clot activator in the interior of the Vacutainer tube.

Draw correct volume of blood
Allowing the vacuum in the tube to be exhausted.

Gently invert
All BD Vacutainer plastic tubes require immediate mixing following collection. Please refer to the chart below for recommendations.

Process as usual

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### Processing (Mixing) of Tubes

**Why**
- Most tubes contain an additive or clot activator that needs to be mixed with the blood sample.
- Tubes with anticoagulants such as EDTA need to be mixed to ensure that the specimen does not clot.

**How**
- Holding tube upright, gently invert 180° and back.
- Repeat movement as prescribed for each tube.

**When**
- Immediately after drawing.

**Consequences if not mixed**
- Tubes with anticoagulants will clot.
- BD Vacutainer® SST™ Tubes may not clot completely.
- Specimen may need to be redrawn.

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<table>
<thead>
<tr>
<th>BD Vacutainer™ Tube Type</th>
<th>Closure Color</th>
<th>Number of Inversions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDTA</td>
<td>Lavender</td>
<td>9-10</td>
</tr>
<tr>
<td>*Citrate</td>
<td>Light Blue</td>
<td>3-4</td>
</tr>
<tr>
<td>SST with gel</td>
<td>Tiger-Red-Grey or Gold</td>
<td>5</td>
</tr>
<tr>
<td>Serum</td>
<td>Red</td>
<td>5</td>
</tr>
<tr>
<td>Sodium Fluoride</td>
<td>Grey</td>
<td>9-10</td>
</tr>
<tr>
<td>Heparin</td>
<td>Green</td>
<td>8-10</td>
</tr>
</tbody>
</table>

* BD Vacutainer Systems
  1 Boston Drive
  Franklin Lakes, NJ 07417
  www.bd.com
• What happened to the blood between the draw and analysis?

• Refrigeration only slows biological activity, it does not stop it – chicken salad in the refrigerator for a couple of weeks still goes bad – should be stored between 2 and 8 degrees **centigrade**

• Was blood frozen? Freezing breaks blood cells and can effect analytic results in whole blood.
What Was Tested?

- Whole blood?
- Serum/plasma?

Serum/plasma is a part of blood like your toe is a part of your foot.
**Methodology**

**Whole Blood-LEGAL**

**Components:**
- Circulating in whole blood is a mixture of:
  - Plasma (which contains fluid, proteins, and lipids),
  - Formed elements, consisting of red cells, white cells, and platelets.

**Plasma Blood**
- When centrifuged (or spun down), blood is separated into plasma, and formed elements including red blood cells. The plasma separator tube shown here has a barrier to maintain separation of plasma and cellular elements during centrifugation and storage.

**Serum Blood**
- Serum is the fluid that is left over the coagulum after the specimen is centrifuged (spun down).

- Serum contains all the same substances as plasma, except for the coagulation proteins, which are left behind in the blood clot.
Determine the Type of Testing in Your Case

- Was the blood tested in a forensic lab?  
  *(gas chromatography/whole blood)*

- Was the blood tested in a hospital lab?  
  *(enzymatic/plasma or serum)*
Imagine a pile of different types of balls resting at the bottom of an inclined, paved driveway. This pile includes ball bearings, marbles, ping pong balls, golf balls, wiffle balls, handballs, tennis balls, hockey pucks, baseballs, soccer balls, volleyball balls, basketballs, footballs, and bowling balls. Attempt to move this motley collection of balls up the driveway with a normal leafblower. Some of the pile will quickly move to the top of the driveway immediately, some balls will migrate at varying speeds, and some balls may take an eternity to reach the end of the driveway.
The difference in the time that each type of ball takes to travel to the top depends upon the characteristics of each ball. Obviously, the lighter balls travel more quickly. Also, some balls may take longer due to their shape, like the hockey puck or the football. The different balls interact with each other as the air from the leaf blower acts on the pile. This interaction may hinder or accelerate the ball’s travel as the balls strike each other. The surface characteristics of the ball may be important, as in the examples of the tennis ball and golf ball.
GC analysis depends on similar phenomena to separate chemical substances. A mixture of chemicals present in a specimen can be separated in the GC column. Some chemical and physical characteristics of the molecules cause them to travel through the column at different speeds. If the molecule has low mass it may travel more swiftly. Also, the molecule's shape may affect the time needed to exit the column. How the different substances relate to each other may cause the time needed to travel the column to increase or decrease. Interactions between the sample's molecule and the column surface may cause the molecule to be retained inside the column for a different amount of time than similar molecules that interact with the column differently.
Whole blood tested in a forensic lab:
Slide 3

Injector  Flow of Mobile Phase  Detector

\( T=0 \)

\( T=10' \)

\( T=20' \)

Most  Interaction with Stationary Phase  Least
Testing Errors in the Lab

• Cross contamination of sample
• Contamination of laboratory solutions
• Mislabeling of sample tubes
• Storage of samples in non-secure areas
• Using same source solution to calibrate that is used for quality control
Whole Blood Contamination Issues

Bacteria
To kill bacteria: heat, UV ray agents, antibiotics and chemicals

Betadine Solution contains 10% povidone-iodine and is the foremost documented, broad spectrum topical iodophor microbicide.
Fungus – tough to kill

ex. Candida Albicans -
(sometimes referred to as monilia) is a yeast-like fungus that is *normally present on the skin* and in mucous membranes. The fungus also can *travel through the blood stream* and affect the throat, intestines, and heart valves.
If *Candida Albicans* is present in the blood, it can produce ethanol even in the presence of sodium fluoridate (Yeast + Sugar = EtOH). Contamination can occur before, during or after blood collection.
So How Can the Sample Be Contaminated?

• Improper insertion of the needle into the vacutainer - Can allow outside air to be sucked into the tube

• Contaminated draw site
  o What was used to clean site? Alcohol free?
  o Poor swabbing technique – concentric circles away from puncture site is the proper protocol
• Piercing of sebaceous gland during draw - Can introduce bacteria into the blood

• Compromised tube top seal - Look for the expiration date on the tube which refers to the seal, not the chemicals in the tube
NOTE: Refrigeration only slows biological activity, it does not stop it – chicken salad in the refrigerator for a couple of weeks still goes bad – Blood should be stored between 2 and 8 degrees centigrade

NOTE: Check the amount of blood drawn (10 ml tube) - Short blood draw (9 ml or less) could indicate the vacuum was compromised allowing outside contaminants (bacteria or yeast) into the sample
Contamination of Blood Specimens for Alcohol Analysis During Collection

Kurt M. Dubowski, Ph.D., DABFT *
Natalie A. Essary, CLS **

On the contrary, we urge that three precautions be invariably used, in addition to other good practice requirements such as use of suitable anticoagulants and preservatives and adequate labeling, in collecting blood for alcohol determination: 1) Avoid use of ethanol, isopropanol, or other volatile organic substance for skin cleansing prior to venipuncture or capillary blood collection by skin puncture; 2) use only dry sterile gauze pads for covering the puncture site during needle removal; 3) when using evacuated collection tubes, remove the tube from the collection needle and holder before withdrawing the needle from the puncture site.
Blood starts to clot immediately after draw unless exposed to an anticoagulant.

- Clots within the specimen can yield inaccurate results, even if not evident to the naked eye.
- One cause of clotting is the inadequate mixing of blood and anticoagulant.
5. Inadequate Mixing – Leading to Clotting of Anticoagulated Specimens

As for hemolyzed specimens, overtly clotted specimens and those with micro-clots are, unfortunately, commonplace in the clinical laboratory. Again, this specimen quality issue is often disproportionately represented by specimens originating from the ED. Whilst anticoagulants differ in terms of their solubility in blood, all specimen tubes with anticoagulant additives require thorough mixing. This mixing must be performed by gentle inversion of the tube. Inversion should be slow enough to allow the air bubble in the tube to completely traverse the length of the tube.
Fermentation

**Makin' Bubbles**

Sugar → Yeast → Energy! → Carbon Dioxide → Alcohol
The alcohol you like to drink is yeast pee, a waste byproduct produced by yeast through the process of fermentation! The image shows a yeast cell budding off an "offspring," as well as the cells relieving themselves of their waste alcohol.
Plasma or Serum Tested in a Hospital Lab:

<table>
<thead>
<tr>
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<th>None (glass)</th>
<th>Clot activator (plastic)</th>
<th>Inversions</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Red</td>
<td>0</td>
<td>5</td>
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</tr>
<tr>
<td>Green</td>
<td>8</td>
<td>8</td>
<td></td>
<td>For plasma determinations in chemistry. Tube inversions prevent clotting.</td>
</tr>
</tbody>
</table>

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..
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
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.
Objections To Hospital Blood Testing Results

- Non-specific
- Non-selective
- Not direct
- One time testing, not duplicate, not replicate
- Not validated for its intended purpose
- High false-positive rates
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>Aminophyllin</td>
<td>15 mg/dL</td>
<td>256 μmol/L</td>
</tr>
<tr>
<td>Amphetamine</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>
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<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>Creatinine</td>
<td>10 mg/dL</td>
<td>0.4 mmol/L</td>
</tr>
<tr>
<td>Crystalline</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>
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<td>Ethromycin</td>
<td>6 mg/dL</td>
<td>81.6 μmol/L</td>
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<tr>
<td>Ethanol</td>
<td>400 mg/dL</td>
<td>86.8 mmol/L</td>
</tr>
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<td>Ethosuximide</td>
<td>25 mg/dL</td>
<td>1770 μmol/L</td>
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<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>181 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>3000 U/L</td>
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<tr>
<td>Ibuprofen</td>
<td>50 mg/dL</td>
<td>2425 μmol/L</td>
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<tr>
<td>Immunoglobulin G</td>
<td>5 g/dL</td>
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<tr>
<td>Lactic Acid</td>
<td>100 mg/dL</td>
<td>11.1 mmol/L</td>
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<tr>
<td>Lidocaine</td>
<td>1.2 mg/dL</td>
<td>51.2 μmol/L</td>
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<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>Phenobarbital</td>
<td>10 mg/dL</td>
<td>421 μmol/L</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>5 mg/dL</td>
<td>198 μmol/L</td>
</tr>
<tr>
<td>Primidone</td>
<td>4 mg/dL</td>
<td>183 μmol/L</td>
</tr>
<tr>
<td>Propoxyphene</td>
<td>0.2 mg/dL</td>
<td>4.91 μmol/L</td>
</tr>
<tr>
<td>Protein: Albumin</td>
<td>6 g/dL</td>
<td>60 g/L</td>
</tr>
<tr>
<td>Protein: Total</td>
<td>12 g/dL</td>
<td>120 g/L</td>
</tr>
<tr>
<td>Salicylic Acid</td>
<td>60 mg/dL</td>
<td>4.34 mmol/L</td>
</tr>
<tr>
<td>Thienphylamine</td>
<td>4 mg/dL</td>
<td>222 μmol/L</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>3000 mg/dL</td>
<td>33.9 mmol/L</td>
</tr>
<tr>
<td>Urea</td>
<td>500 mg/dL</td>
<td>83.3 mmol/L</td>
</tr>
<tr>
<td>Uric 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>
Ethyl Alcohol

**Intended Use:** The ETOH method is an *in vitro* diagnostic test for the quantitative measurement of ethyl alcohol (ethanol) in human serum, plasma, and urine on the Dimension® clinical chemistry system.

**Note:** Check state and local laws to determine whether the measurement of ethyl alcohol using this method can be accepted for establishing legal blood alcohol levels.

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

The following substances do not interfere with the ETOH method when present in serum at the concentrations indicated. Inaccuracies (biases) due to these substances are less than 10% at an ethyl alcohol concentration of 100 mg/dL (21.7 mmol/L).

<table>
<thead>
<tr>
<th>Substance</th>
<th>Test Concentration</th>
<th>SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>20.0 mg/dL</td>
<td>1324 μmol/L</td>
</tr>
<tr>
<td>Amikacin</td>
<td>8.0 mg/dL</td>
<td>137 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>6.0 mg/dL</td>
<td>342 μmol/L</td>
</tr>
<tr>
<td>Caffeine</td>
<td>6.0 mg/dL</td>
<td>308 μmol/L</td>
</tr>
<tr>
<td>Carbamazepine</td>
<td>3.0 mg/dL</td>
<td>127 μmol/L</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>5.0 mg/dL</td>
<td>155 μmol/L</td>
</tr>
<tr>
<td>Chlordiazepoxide</td>
<td>1.0 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>503 mg/dL</td>
<td>13 μmol/L</td>
</tr>
<tr>
<td>Cimetidine</td>
<td>2.0 mg/dL</td>
<td>79.2 μmol/L</td>
</tr>
<tr>
<td>Creatinine</td>
<td>30.0 mg/dL</td>
<td>2.7 mmol/L</td>
</tr>
<tr>
<td>Dextran 40</td>
<td>6000 mg/dL</td>
<td>1500 μmol/L</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.51 mg/dL</td>
<td>18.0 μmol/L</td>
</tr>
<tr>
<td>Digoxin</td>
<td>6.1 ng/dL</td>
<td>7.8 mmol/L</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>6.0 mg/dL</td>
<td>81.6 μmol/L</td>
</tr>
<tr>
<td>Ethosuximide</td>
<td>25.0 mg/dL</td>
<td>1770 μmol/L</td>
</tr>
<tr>
<td>Furosemide</td>
<td>6.0 mg/dL</td>
<td>181 μmol/L</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>1.0 mg/dL</td>
<td>21 μmol/L</td>
</tr>
<tr>
<td>Heparin</td>
<td>3.0 U/mL</td>
<td>3000 U/L</td>
</tr>
<tr>
<td>Ibsuprofen</td>
<td>50 g/dL</td>
<td>2425 μmol/L</td>
</tr>
<tr>
<td>Immunoglobulin G (IgG)</td>
<td>5.0 g/dL</td>
<td>50 g/L</td>
</tr>
<tr>
<td>Lactate</td>
<td>901 mg/dL</td>
<td>100 mmol/L</td>
</tr>
<tr>
<td>Lactate Dehydrogenase</td>
<td>237,500 U/L</td>
<td>237,500 U/L</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>12 mg/dL</td>
<td>51.2 μmol/L</td>
</tr>
<tr>
<td>Lithium</td>
<td>2.2 mg/dL</td>
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<td>198 μmol/L</td>
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<tr>
<td>Propoxyphene</td>
<td>4.0 mg/dL</td>
<td>183 μmol/L</td>
</tr>
<tr>
<td>Propoxyphene</td>
<td>0.16 mg/dL</td>
<td>4.91 μmol/L</td>
</tr>
<tr>
<td>Protein (Albumin)</td>
<td>6.0 g/dL</td>
<td>60 g/L</td>
</tr>
<tr>
<td>Protein (Total)</td>
<td>12.0 g/dL</td>
<td>120 g/L</td>
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<td>Salicylic Acid</td>
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</table>
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.
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.”
Blood/Serum Conversion

.10 serum blood test result

.10 / 1.16 = .086
.10 / 1.18 = .084
.10 / 1.20 = .083
.10 / 1.25 = .080
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?
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 she has passed 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*, from 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.