Blood Collection, Storage, and Transport Issues

Dr. Al Staubus and Ron Moore
Blood Collection, Storage, and Transport

- Where the blood is collected:
  - Site Selection Issues
- How the blood is collected:
  - Site Preparation, Collection Technique
- What the blood is collected into:
  - Vacutainer Selection, Identification of the Sample
- When the blood is collected:
  - AV Differences, Diffusion Anomalies, Extrapolations
- What happens to the blood on the way to the lab
  - Time, Temperature, Technique, Tracking
Where the Blood is Collected

Not Distal to IV site
Not after Lactate
Not Injured
Site Selection

Take pictures of the injection site and surrounding area.

Get the medical records
Differences Between Capillary and Venous Blood Alcohol Concentration as a Function of Time After Drinking with Emphasis on Sampling Variations in Left vs. Right Arm


35 (3) Clinical Chemistry 400 (1989)

Twelve healthy men drank 0.8 g of ethanol per kilogram of body weight during 30 min after an overnight (10 h) fast. At nine exactly timed intervals (30–390 min after the start of drinking), blood was sampled through indwelling catheters in cubital veins on the left and right arms. Immediately thereafter, capillary blood was sampled from fingertips on the left and right hands. The blood ethanol concentration (BAC) was determined by headspace gas chromatography. The SD for alcohol determinations in venous blood, including the left vs. right arm sampling variation, was 30 mg/L (range 8.3–83 mg/L), whereas for capillary blood the SD was 35 mg/L (range 11–60 mg/L). This difference much exceeded the purely analytical errors: SD = 2.67 mg/L for venous blood and 14.2 mg/L for fingertip blood. During the first 60 min after the subjects started to drink, capillary BAC exceeded venous BAC, the mean difference at 30 min being 136 mg/L (range 35–216 mg/L) in the postabsorptive state later than 60 min after drinking, venous BAC exceeded capillary BAC [mean difference 58 mg/L (range 0.0–170 mg/L)] for venous and capillary BAC crossing 37 min (range 6–77 min) after the end of drinking. Apparently, the source of blood analyzed, venous or capillary, must be considered in clinical pharmacokinetic studies of ethanol.

Materials and Methods

Subjects and Conditions

The 12 healthy men who took part in this study as paid volunteers were all medical students accustomed to moderate drinking; mean age 27.8 y (range 21–42), mean body weight 74.8 kg (range 71–81), and mean height 183 cm (range 180–193). The experiments started at about 0615 hours after an overnight fast (10 h). Indwelling catheters were inserted in a proximal direction into-medial cubital veins on the right and left arms. The catheters were kept patent by flushing with isotonic saline containing a few units of heparin. Specimens of venous blood were collected into 5-mL Vacutainer Tubes (Becton Dickinson, Rutherford, NJ 07070) containing 20 mg of NaF and 75 int. units of sodium heparin.

The subjects drank 0.6 g of ethanol per kilogram of body weight during 30 min. The drink was prepared from 950 mL ethanol reagent, which we diluted fourfold with an

BAC limits as evidence of impairment means that small increments in BAC make the difference between punishment or acquittal in borderline cases (6). The significance of variations in blood source and sampling site, in relation to the concentration of alcohol, must be carefully documented.

The aim of the present work was to establish the time course of alcohol concentrations in specimens of venous and capillary whole blood during absorption, distribution, and elimination stages of ethanol metabolism. We obtained near-simultaneous specimens of cubital-vein blood from both arms and capillary blood from fingertips on both hands. Thus we could resolve the magnitude of variation caused by the sampling procedure from that of the purely analytical errors.
How the Blood is Collected

- Site Preparation
- Withdrawal Technique
- Blood Volume Collected
Site Preparation

No Alcohol
In to Out Spiral
Site Preparation

The Effects of Swabbing the Skin on Apparent Blood Ethanol Concentration
25(6) Alcohol & Alcoholism 639 (1990)

A Comparison of Blood Alcohol Concentration Using Non-Alcohol and Alcohol
Containing Skin Swabs
T.M. Goldfinger and D. Schaber

Alcohol Swabs and Venipuncture
G.J. Peek, J. Keating, R.J. Ward, and T.J. Peters
The Lancet, June 17, 1989, p. 1388

Contamination of Blood Specimens for Alcohol Analysis during Collection
K.M. Dubowski and N. A. Essary
4 (3) Abstracts and Reviews in Alcohol and Driving, (1983)

A Source of Error in Blood Alcohol Analysis
P.V. Taberner
24 (5) Alcohol & Alcoholism 489 (1989)
Withdrawal Technique

Incomplete Draw
Early Withdrawal
Depleted Vacuum
Occluded Needle

Multiple Tube Order
Too Much Vacuum
Withdrawl Technique
Withdrawal Technique

Air & Contaminants
Withdrawl Technique
Blood Volume

Too low:
Becomes a blood slurry.
Salting out, Matrix effects

Too much:
Insufficient Preservative.
Ineffective Anticoagulant.
What the Blood is Collected into:
Container Selection

Different tops for different tests
<table>
<thead>
<tr>
<th>Catalogue Number</th>
<th>Colour Code</th>
<th>Tube Type</th>
<th>Determinations</th>
<th>Special Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Culture</td>
<td>Light Blue</td>
<td>Blood Culture</td>
<td>Aerobic followed by anaerobic - if insufficient blood for both culture bottles, use aerobic bottle only</td>
<td></td>
</tr>
<tr>
<td>Sodium Citrate</td>
<td>Red</td>
<td>Serotonin</td>
<td>Coagulation Testing, PT, INR, APTT, D-Dimer, etc</td>
<td></td>
</tr>
<tr>
<td>Serum</td>
<td>Gold</td>
<td>SST™ II</td>
<td>LDH, Ionised Ca, Drugs (Phenytoin, Theophylline, Methotrexate, Lithium), Vitamin D, Parathyroid Hormone, Osmolality, Bone Markers, Endocrine Testing (excluding Thyroid)</td>
<td></td>
</tr>
<tr>
<td>PST™ II</td>
<td>Light Green</td>
<td>PST™ II</td>
<td>TSH, FT4, T3, Cortisol, Digoxin, GH, ADNA, Gastrin, B12 Folate, Ferritin, PSA, CEA, AFP, HCG, CA125, CA19.9, CA15.3, Immunoglobulins (IgG, IgA, IgM, IgE), Electrophoresis, B2 Microglobulin, Caeruloplasmin, Infectious Mono, CRP, Thyroid Ab, Liver Ab, Rheumatology, Coeliac Ab</td>
<td>Please fill tubes to capacity, otherwise samples may not be accepted by the laboratory</td>
</tr>
<tr>
<td>EDTA</td>
<td>Lavender</td>
<td>EDTA</td>
<td>U/E, LFT, Cardiac Enzymes, Ca, Mg, Phosphate, Uric Acid, Total Protein, Amylase, Lipids, Bone Profile, Troponin, Iron Status, ACE</td>
<td>1 tube for FBC &amp; ESR, separate tubes for each of the other tests, Homocysteine (sent on ice &amp; state time taken)</td>
</tr>
<tr>
<td>Cross Match</td>
<td>Pink</td>
<td>Cross Match</td>
<td>Blood Transfusion Samples</td>
<td></td>
</tr>
<tr>
<td>Fluoride Oxalate</td>
<td>Gray</td>
<td>Fluoride Oxalate</td>
<td>Glucose</td>
<td>Please mix 8-10 times</td>
</tr>
<tr>
<td>Trace Element</td>
<td>Royal Blue</td>
<td>Trace Element</td>
<td>Trace Elements</td>
<td></td>
</tr>
</tbody>
</table>
Sample Inversion

- Necessary to mix preservative and anticoagulant
# Mixing Guidelines

All BD Vacutainer® tubes require immediate mixing following collection.

<table>
<thead>
<tr>
<th>Colour Code</th>
<th>Tube Type</th>
<th>Inversions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Blue</td>
<td>Sodium Citrate ESR</td>
<td>8-10 Times</td>
</tr>
<tr>
<td>Black</td>
<td>Fluoride Oxalate</td>
<td><strong>8-10 Times</strong></td>
</tr>
<tr>
<td>Grey</td>
<td>Trace Element</td>
<td><strong>8-10 Times</strong></td>
</tr>
<tr>
<td>Royal Blue</td>
<td>Trace Element</td>
<td><strong>8-10 Times</strong></td>
</tr>
</tbody>
</table>

Insufficient mixing can result in inaccurate test results and the need to re-draw.
When the Blood is Collected

- Arterio-Venous Differences
- Diffusion Anomalies
Arterio-Venous Differences

The Pharmacokinetics of Alcohol in Human Breath, Venous and Arterial Blood After Oral Ingestion

E. Martin¹, W. Moll², P. Schmid³, and L. Dettli²

A. W. Jones,¹ Ph.D., D.Sc; Å. Norberg,¹ M.D.; and R. G. Hahn,¹ M.D., Ph.D.

Concentration-Time Profiles of Ethanol in Arterial and Venous Blood and End-Expired Breath During and After Intravenous Infusion."
Timing of Draw Relative to Driving

It takes time to get from here... to here.
Short Time During Elimination

BAC

TIME
Back into Absorption Period
Too Low a BAC for Retrograde

Too late in BAC curve
What Happens on the way to the Lab
Initial Storage and Transport Issues

- Time
- Temperature
- Technique
- Tracking
Time from Collection to Lab

The longer it takes from collection to the lab, the more chance that something can happen to the sample that will alter the results:

More microbes can grow,
Technique of Transport
Technique of Transport
Storage Temperature
Tracking of Sample from Collection to Lab
Laboratory Handling Issues

- Receipt
- Storage
Receipt at the Lab

[Image of a computer setup on the left and an old refrigerator on the right]
Special Issues with Urine Analysis

- First versus Second Void
- Historical Sampling
- Residual Urine
- Blood to Urine Ratio
- Contamination
Urine as a Biological Specimen for Forensic Analysis of Alcohol and Variability in the Urine-to-Blood Relationship

Alan W. Jones

Department of Forensic Chemistry and Genetics, National Board of Forensic Medicine, and University Hospital, Linköping, Sweden
First or Second Void?

- First void urine alcohol results can be compromised by the presence of urine from before drinking began, and by the presence of urine collected when the blood alcohol level was significantly higher than when the specimen was collected.

- Second void urine can be compromised by the issues presented next:
Historical Sampling

- Urine alcohol levels are the result of the passive diffusion of ethanol from the renal artery into the urine as it is formed in the kidney. This is a continuous process. The UAC represents the result of the contributions of every moment over the entire collection period.
Residual Urine

- Residual urine ranged from 0 to 1178 milliliters.
  - Measurement of Residual Urine with $^{131}$I Labeled Diodrast.

Mulrow, P.J., Huvos, A., and Buchanon, D.L.
57 (1) Journal of Laboratory and Clinical Medicine 109 (1961)
THE UNRELIABILITY OF USING A URINE ETHANOL CONCENTRATION TO PREDICT A BLOOD ETHANOL CONCENTRATION

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Summary

Of approximately 5,000 forensic cases with a positive ethanol result, over 1,000 were available in which both blood and urine were present for comparison of ethanol content. Data were examined for calculation of the urine to blood ethanol concentration ratio, with the intent of evaluating the validity of predicting a blood ethanol level given a urine ethanol level. The overall urine to blood ethanol concentration ratio was 1.57:1 with a range of 0.7 to 21.0:1. The extremely wide range of values implies that a large degree of error would be introduced if a mean ratio was used when predicting a blood ethanol level from a urine ethanol level.
Unpreserved urine spiked with glucose and *Candida albicans* produced mean alcohol levels of 0.16 g%.

*Patricia Schechter Lough,¹ M.S. and Richard Fehn,² Ph.D.*

Efficacy of 1% Sodium Fluoride As a Preservative in Urine Samples Containing Glucose and *Candida albicans*

The End