Utah DUI Defense

The Law and Practice

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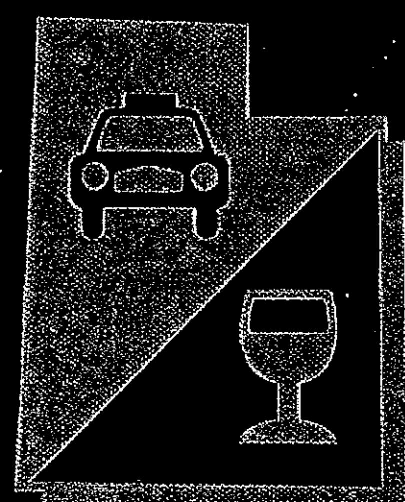

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(with essays by Mimi Coffey)

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Chapter 12

Blood Alcohol Calculations for Attorneys

Synopsis

12.1 Blood Alcohol Calculations for Attorneys

Entire books have been devoted to blood alcohol calculations in humans. This chapter is not designed as a treatise on the disposition of alcohol in humans or as a reference for expert witnesses. Many formulae exist for the determination of BAC in humans. Most require conversion of Metric to English measurements. Some require the Body Mass Index (BMI) of the subject. All are complex.

This chapter is designed for attorneys who simply need to know how to calculate quickly the BAC numbers for use in court and in the office. The one-drink potential calculation is based on the Widmark formula. Metric units of measurement have been converted to English. Certain operations have been combined which necessitated moving variables from the numerator to the denominator position and vice versa.

12.2 Determining the One-Drink Potential

A *one-drink potential* is the maximum BAC that a person will reach after one drink. Every defense attorney needs to know how to estimate the one-drink potential for any client who walks in through the door. Fortunately, it is very simple. You will need only the following four pieces of information and a calculator.

1. Client's gender (for males use .13; females use .11)
2. Client's body weight in pounds
3. Type of drink (or alcohol content)
4. Size of drink in ounces

For example, the calculation for a 180-pound male who drank one 12-oz., 4.16 percent alcohol beer (Bud Light) is as follows:

$$\frac{(12\text{ oz. beer}) \times (.0416\text{ alcohol content})}{(180\text{ lbs}) \times (.13\,♂)} = \frac{.499}{23.4} = 0.021\text{ per drink}$$

The man has a one-drink potential of .021. In other words, .021 is the maximum BAC that he would reach after consuming one 12-oz. beer that is 4.16 percent alcohol.

If this man has four Bud Lights, the maximum his BAC could be would be .021 × 4 or .084. This does not account for elimination.

Men and women are different in so many ways; it is not surprising that they are also different in their one-drink potential. This is due to the fact that, on average, women have a higher body fat to water ratio than men. Although on average most women are shorter and lighter than most men, women tend to carry more fat in their breasts, buttocks and thighs than men. Clearly this may be reversed in some instances such as when we compare a very physically fit woman with an obese man; but the generalizations made here hold true enough for the attorney estimations necessary to estimate a BAC in the office or in court.

Take the same facts as above, but change the gender from male to female and we find a different one-drink potential:

$$\frac{(12\text{ oz. beer}) \times (.0416\text{ alcohol content})}{(180\text{ lbs}) \times (.11\,♀)} = \frac{.499}{19.8} = .025\text{ per drink}$$

If this woman has four Bud Lights, the maximum her BAC could be would be .025 × 4 or .100. This, too, does not account for elimination.

The gender difference is embodied in Widmark's rho factor. Widmark's rho factor is a mathematical expression of the ratio of body fat to water in men and women. The rho factor has been moved from the numerator of Widmark's formula into the denominator of the formula above. For men, use .13 as the rho factor; for women, use .11 as the rho factor.

When figuring alcohol content for drinks that express alcohol content in terms of *proof*, simply divide the proof in half. Thus, 80-proof vodka has 40 percent alcohol. Sometimes proof is expressed as a small circle similar to a degree sign used for temperature. For example, "80 proof" can also be expressed as "80°."

Below is a quick reference chart for men and women from 100 to 240 lbs. It uses the formula above to calculate the one-drink potential BAC for a 12 oz., 4 percent beer, or a 4 oz., 12 percent glass of wine, or a 1 oz. shot of 96° distilled liquor. It does not account for elimination rates.

Weight	Male	Female
100 lbs	.037/drink	.044/drink
110 lbs	.034/drink	.040/drink
120 lbs	.031/drink	.036/drink
130 lbs	.028/drink	.034/drink
140 lbs	.026/drink	.031/drink
150 lbs	.025/drink	.029/drink
160 lbs	.023/drink	.027/drink
170 lbs	.022/drink	.026/drink
180 lbs	.021/drink	.024/drink
190 lbs	.019/drink	.023/drink
200 lbs	.018/drink	.022/drink
210 lbs	.018/drink	.021/drink
220 lbs	.017/drink	.020/drink
230 lbs	.016/drink	.019/drink
240 lbs	.015/drink	.018/drink

12.3 Elimination and Retrograde Extrapolation

When DUI attorneys discuss elimination, we are mainly discussing the metabolization of the alcohol by the body, rather than the actual elimination of alcohol from the body.

A very small amount of alcohol leaves the body in an unchanged state (less than 6 percent). Most of the alcohol ingested is metabolized by enzymes in the *alcohol dehydrogenase pathway*. Alcohol dehydrogenase, aldehyde dehydrogenase, acetaldehyde and other enzymes play a part in the biological oxidation of alcohol and its metabolites. One can trace the path of alcohol elimination on a molecular level in great detail. My belief is that juries are bored by this, judges are confused by it and prosecutors don't know what to do with it on cross-examination.

What we need to know is that after alcohol has been consumed, it is eliminated at a relatively steady rate; rates of elimination have been recorded as low as .008 per hour and as high as about .035 per hour. Generally, alcoholics and binge drinkers with high BACs eliminate alcohol faster than inexperienced drinkers. The average rate used in court by many (but not all) forensic toxicologists is .010 to .017 per hour, depending on whom you talk to. It is not gender dependent like one-drink potential calculations. Rather, it is dependent upon how "experienced" one's liver has become over time.

A man with a .100 BAC will be a .000 BAC in ten hours if the elimination rate is .010 per hour. Eliminating .010 per hour from his known BAC is called a *retrograde extrapolation* (sometimes known as *back extrapolation*). If the same man has an elimination rate of .015 per hour, he will be a .000 in less than seven hours. A retrograde extrapolation is nothing more than choosing an hourly elimination rate and subtracting that amount from the known BAC. The one caveat to a retrograde extrapolation is that the person must be in the elimination phase of alcohol consumption.

12.4 White's Retrograde Extrapolation

White's retrograde extrapolation calculates the number of drinks that need to be unabsorbed in the subject's stomach in order for the subject to be under the legal limit at the time of driving (this is also known as the *Rising BAC Defense* in many parts of the country).

In years past, before many state's legislatures eliminated the Affirmative Defense, White's retrograde extrapolations were the mainstay of the DUI defense bar. Virtually the most important question for the attorney was to ask the client how many drinks were consumed in the hour before being stopped by the police. This is because those drinks could remain wholly or partially unabsorbed in the stomach at the time of driving, but could be partially or completely absorbed at the time of the chemical test. Alcohol sitting unabsorbed in the stomach (not in the blood) does not contribute to impairment any more than alcohol that remained in the bottle. A driver's BAC could have been substantially lower at the time of driving than at the time of the chemical test. The converse is also true where the driver is in the elimination phase at the time of driving. In fact, the driver might also be in the absorptive phase when stopped, reach a peak during the investigation, and be in the elimination phase at the time of the chemical test. Thus, the driver could be higher, lower, or have the same BAC at the time of the chemical test as she did at the time of driving.

Now, the argument is virtually worthless where there is no Affirmative Defense because one has to start from the premise that the over-the-limit BAC was correct at the time of the chemical test but was under the limit at the time of driving. If you concede the first premise and have no Affirmative Defense, you have lost the *per se* BAC charge.

White's retrograde extrapolation is still important in the scenario, however, where your defense rests not on the particular BAC within a specified period of time from driving, but on lack of impairment at the time of driving, such as in an endangerment case.

Many people are charged with felony endangerment or worse, along with a misdemeanor DUI. Sometimes one has to sacrifice the misdemeanor BAC in order to have a chance of winning the felony charges.

Take, for example, the scenario where your client is charged with two counts of endangerment after rear-ending a car with two passengers at a stoplight. The accident was at 2:15 A.M. The driver's BAC was measured just a half hour after the accident at 2:45 A.M., and it was .090. If he downed his last drink when the bar closed at 2:00 A.M., some of the alcohol could have remained unabsorbed in his stomach at the time of the accident, but fully absorbed at the time of the breath test.

If he is the 180-pound man from the one-drink potential example, the value of the 12-ounce beer could be subtracted from his reported BAC. Thus, we subtract .021 from .090, and the result is a .069. Because we do not know how fast he actually absorbed that 12-ounce beer into his bloodstream, he could have been anywhere from a .069 to the reported result of .090. Under these facts, you will never prove that your client was under the limit, but the state will never prove that he was over the limit, either.

White's retrograde formula can be expressed as follows:

$$\frac{(\text{test result}) + \{[(\text{elapsed time*}) \times (\text{elimination rate } a)] - (.079)\}}{(\text{one-drink potential})}$$

$$= \#\text{ of drinks unabsorbed in stomach}$$

* = Elapsed time from time of last drink to time of chemical test.
a = Choose the elimination rate within human limitations that suits your purpose.

$$\frac{(.090) + \{[(.75\text{ hours})(.010/\text{hr})] - (.079)\}}{(.021)} = \frac{(.098) - (.079)}{(.021)} = \frac{.019}{.021}$$

$$= 0.88\text{ drinks}$$

$$(0.88\text{ drinks}) \times (12\text{ oz. drink size}) = 10.6\text{ oz.}$$

This means that if he had 0.88 drinks (or 10.6 oz.) unabsorbed in his stomach at the time of the accident, he was no higher than a .079.

For the most complete and thorough explanation of absorption, elimination, and retrograde extrapolations, refer to *Medicolegal Aspects of Alcohol, Fifth Edition*, edited by Dr. James C. Garroitt and available from Lawyers & Judges Publishing Company.

12.5 Partition Ratio Conversions

Conversion to different partition ratios is a simple mathematical formula. Take the breath test reading and divide it by 2100, then multiply by the new partition ratio number that you have chosen. This will give the corrected breath test value.

Example:
To convert a .100 BAC at 2100:1 to a new ratio of 1500:1 use the formula:

Step 1: (BAC Reading) ÷ 2100 = Y
Step 2: Y × (New Partition Ratio Value) = Corrected Breath Test Value

Step 1: .100 BAC ÷ 2100 = 0.00004762
Step 2: 0.00004762 × 1500 = .071 BAC
Thus a .080 BAC at 1100:1 could be corrected to .042 and, a .080 BAC at 2800:1 could be corrected to .107

Mean Specific Gravity of whole blood is assumed to be 1.055.
Whole blood is assumed to be 80 percent w/w water.
Plasma is assumed to be 92 percent w/w water.

12.6 Unit Conversions

Conversions from among commonly used units of measurement are as follows:

mg/100ml	g% w/v	mg/g	mmol/L	mg/L	µg/L
50	0.05	0.47	10.8	0.24	240
100	0.10	0.94	21.7	0.48	480
150	0.15	1.41	32.3	0.72	720
200	0.20	1.88	43.2	0.96	960

g = grams
mg = milligrams
µg = micrograms
w/v = weight per volume
w/w = weight per weight
mmol = millimoles
ml = milliliters
L = liters