Alcohol - A Review

P&A PAPE & ASSOCIATES

Specializing in Toxicology

TOXICOLOGY REPORTER

Premortem Alcohol Testing

Postmortem Alcohol Testing

Case Analysis

- **Statements and Testimony**
- **Case-relevant records**
- **Expert reports**

- **Test reliability**
- **Total alcohol consumption**
- **BAC at a time-of-interest**
- **Alcohol-related effects**
- **Risk of accident or incident**
- **Alcohol-Drug interaction**

- **Case-relevant comparisons**

Brian E. Pape, Ph.D.

Specializing in Toxicology

PAPE & ASSOCIATES

Phone: **800-736-0503**
Fax: **800-736-9096**

TOXICOLOGY REPORTER

Alcohol: Case Analysis

Premortem Alcohol Testing

Blood serum alcohol testing

Over 90 percent of the hospitals in the United States routinely test for alcohol in blood serum.

The usual SOP for hospital-based alcohol testing involves the following:

Drawing blood: After topical disinfection with a non-alcoholic preparation such a betadine, a venous blood sample is usually drawn from the anticubital area (opposite the elbow) using a sterile needle and glass evacuated blood tube. The blood collection tube does not contain anticoagulants, and the blood sample clots on standing.

Processing the blood specimen: The clot tube is allowed to sit for a period of time and then processed by centrifugation to separate the blood clot from the straw colored fluid called blood serum. The serum is tested.

BSAC testing: Most hospitals use a blood serum alcohol concentration (BSAC) test procedure that is based on an enzymatic method highly specific for ethyl alcohol (ethanol or beverage alcohol). Tests are usually run on an automated instrument and reliability is documented.

Results-reporting: Printed test results usually include the date and time of specimen collection, the test result, and the normal range. For alcohol, the normal range is none-detected or less than 10 mg/dl (< 0.01% BSAC). *Because of the physical difference between blood serum and whole blood, a blood serum alcohol concentration BSAC is usually about 15 percent greater than the equivalent whole blood alcohol concentration (BAC).*

To convert XXX mg/dl to percent BSAC, divide by 1000 (e.g. 100 mg/dl = 0.10%). To convert XXX mg/L (milligrams per liter) to percent BSAC, divide by 10,000 (e.g. 1000 mg/L = 0.10%). And remember … to convert the BSAC to a BAC, divide the BSAC by 1.15. Examples of the conversion of BSAC to BAC follow.

Conversion of BSAC to BAC

100 mg/dl BSAC is 0.100% BSAC
0.100% BSAC equals about 0.087% BAC

1500 mg/L BSAC is 0.150% BSAC
0.150% BSAC equals about 0.130% BAC

Postmortem Alcohol Testing

Blood alcohol concentration (BAC)
Brain alcohol concentration
Urine alcohol concentration
Vitreous alcohol concentration

It is generally recommended that more than one postmortem specimen should be obtained at autopsy.

Postmortem specimens include the following:

Blood from the femoral vein or a peripheral vein is preferred over blood from the heart or an artery. The least desirable specimen is "loose" blood from the abdominal cavity.

Other specimens include urine, vitreous humor from the eye, cerebral spinal fluid (CSF), brain tissue, and stomach contents. **Urine** can be used to estimate the minimum peak or highest BAC the subject must have experienced prior to the time of death. **Stomach content** volume and alcohol concentration can be used as one indicator of alcohol consumption near to the time of death and whether or not the person was in an absorptive state. Alcohol concentration(s) in **brain tissue** and/or **CSF** and/or **vitreous fluid** can be used to indirectly estimate BAC at the time of death. When different specimen types are tested, the alcohol concentration ratio(s) (i.e. ratios for specimen-to-specimen test results) can be compared to expected biological ratios and/or the results for different specimens such as CSF can be expressed as a roughly equivalent BAC.

When data are available, the interpretation of a set of postmortem alcohol test results should include the calculated between-specimen alcohol concentration ratio. *There are generally accepted relationships between the concentration of alcohol in femoral blood and vitreous humor and muscle tissue.*

See other newsletters relating to postmortem alcohol testing and the interpretation of test results.

Case Analysis

Case analysis usually focuses on five or six case-specific issues:

Alcohol Concentration Test Results
Total Alcohol Consumption
BAC at the Time-of-Interest
Expected Effects Based on BAC
Consistent/Inconsistent Statements
Case-related comparisons

Alcohol test results:

A premortem and postmortem alcohol test result is almost always a reliable measure of the alcohol concentration in the specimen tested. However, it is still important to consider the following:

Review of the testing process and procedure

This review should include the usual SOPs related to subject identification, preparation prior to obtaining a specimen, specimen transfer-and-processing, test instrumentation and method, standardization, and quality assurance.

Calculation of the equivalent or expected BAC

Examples include the conversion of a blood serum alcohol concentration (BSAC) to an expected or equivalent BAC, range estimates for BAC based on one or more urine alcohol concentration test result(s), and comparison of subject-specific alcohol test results for different biological specimens.

Comparison and/or consideration of case-specific features relating to evidence regarding the time-course and extent of the subject's alcohol consumption, the subject's appearance-behavior-demeanor, and the subject's alcohol history.

Do these comparisons raise questions regarding the reliability of an alcohol test result of the reliability of testimonial evidence? If there are differences, what are the most reliable inferences or conclusions?

The amount of alcohol consumed:

The estimation of a person's total alcohol consumption (TAC) should account for the total amount of alcohol distributed in the subject's body tissues and fluids (TBA) at the time of the collection of a premortem specimen or at the time of death plus the total alcohol elimination (TAE) due to the on-going metabolism and excretion of alcohol between the time alcohol was first consumed and the time the alcohol test specimen was drawn or the time of death.

TAC = TAE + TBA

when …

TBA is based on the subject's age-weight-height-sex and alcohol test result or equivalent BAC.

TAE is based on the assumed rate of alcohol elimination or a range for the rate of elimination and the time-period between the first relevant consumption of alcohol and specimen collection or death.

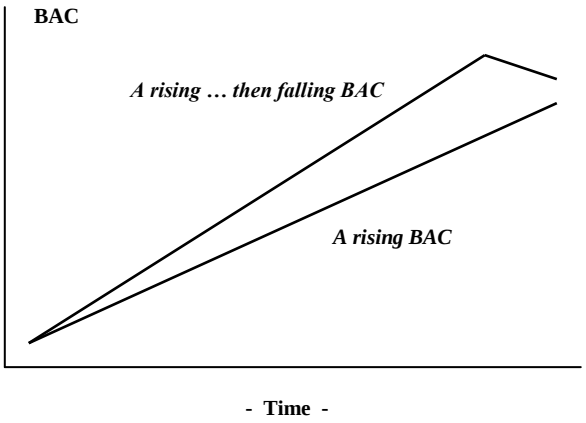
TAC can be expressed as the number of defined drinks or the total volume(s) of alcohol type(s) such as beer or wine or liquor.

Example: If a 180 pound male had a BAC of 0.15% after drinking for five hours, the subject's TBA would be equivalent to about six drinks and the TAE would be equivalent to about three drinks. Therefore, the TAC would be equivalent to about nine drinks or the amount of alcohol in about 13 ounces of 80-proof liquor.

TAE	=	3+ drinks over 6 hours (min.)
TBA	=	6 drinks, given a 0.120%BAC
TAC	=	TBA + TAE
	=	9 drinks (minimum)

Estimation of BAC at a specific time:

The estimation of a subject's BAC at a time-of-interest is usually based on a process of extrapolation that is applied to case-specific information.



A Case-Example Time-Line

[_____ … __]

1 2 3 4

When (1) is the time alcohol was first consumed, (2) is the time alcohol was last consumed, (3) is the time-of-interest, (4) is the time the alcohol test specimen was collected, and (1-4) is the time period during which alcohol was eliminated.

There are a variety of ways to estimate BAC at a specific time and, indirectly, form impressions or opinions regarding expected alcohol-related effects and subject-specific questions.

An experienced expert can consider different approaches to the estimation of a person's BAC at a specific time. Examples follow:

Forward extrapolation
Retrograde extrapolation (*see below)*
Fixed point extrapolation
Range extrapolation
Psychophysical extrapolation

Example: Retrograde extrapolation BAC

If the subject's absorption of alcohol was complete at the time of the accident and the post-accident BAC was falling (i.e. the subject was in a post-absorptive state at the

time of the accident), the expected or average or measured rate of elimination and the time between the accident and the collection of the subject's alcohol test specimen and the alcohol test result can be used to estimate the subject's BAC at the time of the accident. An illustration follows.

Retrograde Extrapolation of BAC

Hour	**Event or BAC**
1	Last service of alcohol
2	Last swallow of alcohol
3	MVA (*post-absorptive*)
4	
5	
6	0.120% test result

BAC at MVA = 0.120% + 3(0.015%)
= 0.120% + 0.045%
= 0.165% BAC

Note: This example assumes a post-absorptive rate of elimination of 0.015% BAC per hour.

Case issues, evidence, forensic analysis, and common sense and experience should guide one's approach to a case analysis.

Alcohol-related effects and risk of accident:

Subject-specific features such as gender and age are related to the risk-of-accident at the same BAC. Other subject-relevant features include tolerance and the use of drugs. Situational-environmental-circumstantial features of interest include familiarity, visibility, weather, and social-occupational-activity-and-context.

Motor vehicle accidents:

There is scientific consensus that alcohol causes deterioration of driving skills beginning at 0.05% BAC or even lower and progressively serious impairment at higher BACs. *JAMA 255:522-7 (1986).* Research indicates that each 0.02% increase in BAC doubles a driver's risk of being in a fatal crash; the risks increase even more rapidly for drivers under age 21; and, the risks also increase more rapidly for women. *Reference to Zador in Alcohol and Health Res World 17(1):28-34*

Alcohol-and-drug interaction and effects and MVA:

Reports of increased risk of MVA include opiates, benzodiazepines, muscle relaxants, and antidepressants. The elderly are more susceptible to accident as the result of the use of multiple CNS-depressant medications.

A review of pre-accident medical and pharmacy records is often an important part of a case review-and-analysis.

Accidental falls:

A large percentage of falls are related to alcohol. Compared to the population, studies of fatal falls among alcoholics report odds ratios of 2.9 to 16. Determination of the odds ratios of significant BACs for fall-related patients compared to disease-related patients yielded odds ratios from 2.5 to 10. 53% of patients injured in accidental falls in the evening in Helsinki Finland] and 15% of the time-, site-, and sex-matched control pedestrians were alcohol-involved. Relative risk of injury (if 1.0 at zero BAC), was 3 at BACs of 0.060-0.100%, 10 at 0.101-0.150%, and about 60 at BACs greater than 0.151%. The authors concluded that 1) alcohol increases a pedestrian's risk of accidental fall somewhat more than it does a driver's risk of traffic accident; 2) the relative risk of a fall increases with an increase in the pedestrian's BAC; and, 3) the risk at BACs greater than 0.100% is so high that practically all cases with such BACs can be considered to have been caused by alcohol. *J Stud Alcohol 44(2):231-245 (1983)*

Aquatic accidents:

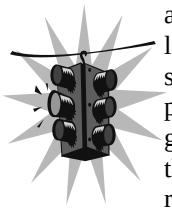
Alcohol is associated with an increased risk of neck fracture and spinal cord injury. One study found that 44 percent of the 220 hospital admissions for neck fracture from diving accident showed evidence of alcohol use; and, more than 22 percent had BACs greater than 0.10%. Another study reported that subjects who sustained spinal cord injury from diving were four times more likely than controls to have consumed alcohol. Perrine et al. reported that diving performance is impaired at a BAC of 0.04%. *J Stud Alcohol 55:517-524 (1994)*

Snowmobile accidents:

Studies have found strong association between the consumption of alcohol and snowmobile accidents. 64% of the drivers were OUI and fatalities had a ratio of 4.3 for the use of alcohol; 86% of the fatally injured drivers were OUI and had a mean BAC of 0.17%; alcohol was implicated in 69% of the fatally injured and 59% had a BAC over the legal limit; and, 80% (24 of 30) of the fatally injured drivers were found to have been DWI. A review of these studies leads to a general overall impression that fatal snowmobile accidents are most frequently associated with the use of alcohol and sub optimal lighting conditions and young male drivers. *Ann Emer Med 24(5):842-8 (1994); Artic Med Res 51(Suppl 7):56-8 (1992); J Can Med Assoc 146(2):147-52 (1992); J Trauma 22(12):977-82 (1982)*

Pedestrian-MVAs:

Of the 10,000+ pedestrians killed and 100,000+ pedestrians injured each year as a result of pedestrian-motor vehicle accident (Ped-MVA), the consumption of alcohol plays a contributing factor in a large percentage of these accidents. Case studies have reported that at least 50 percent of the pedestrians having a BAC greater than 0.10% were responsible for the accident. Studies of risk analysis have reported that as the pedestrian's BAC increased, the apparent risk of accident increased more rapidly than the increase in the pedestrian's BAC.



These studies relating to risk assessment are similar to studies of the risk of other types of accident.

Alcohol and risk of other accident types:

Fire	**Motorcycle**
Subway and train	**Boating**
Snow skiing	**Horseback riding**
Bicycle	**Hunting**
Electrical	

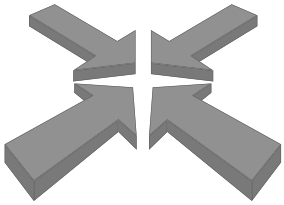
Alcohol-drugs and aggressive behavior:

A Common Theory: Alcohol and Drugs

Alcohol-related theories of aggressive behavior are probably applicable to a consideration of the relationship between the use of some drugs and aggressive behavior.

Alcohol/drugs and Behavior: Case Factors

Personal History **BAC/Drugs**



Situational and Circumstantial Factors **Inter-personal Relationships**

Behavioral theories include the following:

Physiological disinhibition theory: Alcohol/drugs increases aggression directly by depressing the brain center that normally inhibits aggressive behavior.

Expectancy theory: Alcohol/drugs increase aggressive behavior because people expect it to.

Indirect cause theory: Alcohol/drugs increase aggression by causing changes within the person that increase the probability of aggression (e.g. by reducing intellectual functioning).

Testimony and statements:

Relevant information should include a consideration of a case-related time line, locations, activities, observations, and events.

Discussion of evidentiary conflict-comparison-confounding factors, request for additional information, and discussion of "next steps":

This is when an experienced and frank-speaking expert is often worth a lot more than what might be a relatively modest fee for case review and consultation.

Expert report:

All of these topics can be addressed in an expert report.

When available, case foundation should include the police/accident/EMS reports, medical/laboratory records, and relevant statements or testimony.

Brian Pape, Ph.D.

Dr. Brian Pape specializes in toxicology and related sciences. His prior professional positions include Clinical Associate Professor of Pathology, University of Massachusetts School of Medicine; Senior Associate Consultant for Mayo Clinic and Director of Toxicology at New England Toxicology Services; and Director of Toxicology and Associate Professor of Pathology, University of Missouri School of Medicine.

P&A

Pape & Associates

Providing expert services in New England and PA-NY-NJ and the mid-Atlantic region.

Phone: (800) 736-0503

Areas of Concentration

Alcohol

Drugs

Selected Toxic Torts