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Medical Aspects of Chemical Tests for Intoxication

*Philip Jones, M.B., Ch.B.**

THE WORD "WHISKY" IS AN ABBREVIATION of the ancient Gaelic expression *uisge-beatha*, meaning, literally, water of life. In the highly mechanized Twentieth Century, with its ever increasing slaughter on the highways, it might, perhaps, be more aptly named "water of death."

To the average layman, alcohol is a stimulant. The pharmacologist, however, recognizes it as a depressant of the central nervous system, its action being similar to that of many anesthetic agents. Even today it is still used occasionally by the anesthesiologist for this purpose. This apparent paradox is readily explained by the fact that the most recently acquired, the so-called higher centers of the brain, are those first depressed by alcohol. These centers are responsible for exerting the self-restraint, habit, training and conduct demanded by life in modern society. With these controlling influences removed, the drinker becomes uninhibited in thought, word and deed, often to the embarrassment of his more sober friends.

In the assessment of any person suspected of being under the influence of alcohol the following facts must be established:

1. Alcohol has been recently consumed and in sufficient quantity to render the person incapable of safely executing the task in which he was engaged at the material time.
2. Whether his condition may be wholly or partially due to some pathological state which gives an appearance similar to that of alcoholic intoxication.
3. Whether the effect of any alcohol consumed has been intensified or exaggerated by some disease or drug.

Every physician knows that many diseases produce signs and symptoms closely simulating that of drunkenness and that many of these conditions require urgent hospitalization for medical treatment. In a series of 1150 consecutive admissions to a large

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hospital with a diagnosis of acute alcoholism, 72 were found to be suffering from such conditions as barbiturate and paraldehyde overdosage, cranial injuries, heart conditions, diabetes, uremia, etc.¹

The diagnosis of these medical conditions usually requires examination by a skilled physician who may not be immediately available. Thus, a reliable chemical test for the detection and quantitative estimation of body alcohol which can be applied by a properly trained non-medical person would be a most useful step in the screening of persons suspected of drunkenness. In this way many unfortunate tragedies would be prevented, the innocent protected and the guilty apprehended.

Chemical Tests for Intoxication

Three chemical tests are most frequently used. These are the estimation of the alcohol content of the (1) blood, (2) urine, and (3) breath. Each of these shows a reasonably accurate estimation of the degree of intoxication provided certain precautions are observed. Unfortunately, under some circumstances the results of these tests may be misleading and be invalid in evidence. In order to appreciate these limitations it is necessary to understand the physiology of the absorption and excretion of alcohol in the body.

Ingested alcohol is absorbed into the blood stream mainly in the stomach and small intestine. The rate of absorption depends on the quantity and concentration of the drink, the amount of material already in the stomach and the rate at which the stomach empties its contents into the small intestine. For example, a concentrated form of liquor when taken on an empty stomach is 90% absorbed in 1 hour and has a more intoxicating effect than the same amount of alcohol taken after a heavy meal. The reason that less alcohol is necessary to produce intoxication when rapidly absorbed is that it is normally destroyed in the body at a rate of about $\frac{1}{3}$ fl. oz. per hour. This rate is constant for a given individual irrespective of the concentration of the alcohol in the blood. Therefore, if the blood level rises rapidly, there is little time for any detoxication while, conversely, it is possible to drink 1 pint of 100 proof whiskey over 24 hours without the blood alcohol ever rising to intoxicating levels.

¹ Forrester "Chemical Tests for Alcohol in Traffic Law Enforcement," American Lecture Series No. 50 (C. C. Thomas, Springfield, Illinois, 1st Edition).

As soon as the alcohol enters the blood stream, it penetrates all the other tissues of the body in concentrations dependent on their water content. Equilibrium is usually established within one hour of drinking, being dependent to some extent on the rate of absorption. When this is rapid, tissue distribution lags behind blood stream absorption. During the absorption period of about one hour, Harger² has shown that the alcohol concentration of the capillary blood, which very closely approximates to that of arterial blood, was greater than in peripheral venous blood. This difference averaged 7.5% greater in 34 samples and 15% to 22% in 7 out of the 34. Later samples showed no significant difference. As the capillary blood alcohol concentration more accurately indicates the level reaching the nervous system, samples of peripheral venous blood collected during the period of rapid absorption of alcohol will be misleading and favor the defendant.

In the collection of blood samples for analysis the skin must not be cleansed with alcohol preparatory to veni-puncture, as some alcohol may contaminate the syringe during penetration of the skin. Similarly syringes and needles must not be sterilized by immersion in "spirit."

Theoretically, contamination of blood samples after collection by alcohol forming yeasts and bacteria is possible. Estimations of alcohol content as soon after collection as practicable is, therefore, advisable.

While the alcohol concentration of ureteral urine bears a fairly constant ratio to that of arterial blood, voided urine taken for analysis may not necessarily do so. An individual may have, say, 200 cc. of urine in his bladder when he commences drinking. If a sample is taken an hour later this urine, which contains no alcohol, dilutes the alcohol containing urine which he has formed since the ingestion of the liquor. Low values for blood alcohol are thereby obtained to the advantage of the accused.

Conversely, a person may fall asleep after a drinking bout. On waking several hours later a urine specimen would show a high percentage of alcohol while the blood alcohol could be very low or zero. In practice this difficulty is overcome by getting the suspect to empty his bladder and get rid of any diluted urine. The urine subsequently voided is then used for analysis.

All urine samples should be tested for the presence of for-

² Harger, Forney, Baker "Estimation of the Level of Blood Alcohol From Analysis of Breath—II Use of Rebreathed Air," 17 *Quart. J. Stud. Alcohol* (1956).

maldehyde as the accused may be taking medication in the form of methenamine (urotropin) tablets for a urinary disorder. These tablets release formaldehyde in acid urine. During analysis this reacts like alcohol and Jetter³ describes a case in which it gave a reducing value to the urine equivalent to 0.05% alcohol.

The principle on which the breath alcohol test is based is that the alcohol content of the pulmonary blood bears a constant relationship to that of the alveolar air. Thus, if the alcohol concentration in the alveolar air can be determined the blood alcohol may be estimated indirectly from an empirically determined formula.

Due to technical difficulties associated with the estimation of alveolar air, exhaled air is collected instead. The amount of alveolar present can then be calculated by an estimation of the CO₂ content of the sample. This calculation assumes that the CO₂ content of alveolar air is constant at 5.5% by volume. A sample of exhaled air is, therefore, examined for alcohol and CO₂ content and from this data the percentage of alcohol in the blood calculated.

Many of the instruments devised for the quantitative estimation of breath alcohol have incorporated in them a qualitative test for the presence of alcohol. This is usually a colored solution which becomes colorless in the presence of alcohol. If no alcohol is present the color persists for many minutes alerting the operator to the possibility that the symptoms may be indicative of some state other than acute alcoholic intoxication.

The assumption that the alveolar CO₂ concentration is constant at 5.5% can lead to errors in the calculation of the blood alcohol when variations from this figure occur. In conditions where there is a lowered alveolar CO₂, the calculated blood alcohol will be too high. In practice this may occur in severe metabolic acidosis associated with diabetes and uremia, the hyperventilation syndrome and following the ingestion of alkalis. Vomiting can affect the alveolar CO₂ by producing a temporary alkalosis and may also increase the breath alcohol by vaporization from alcohol-containing vomitus retained in the mouth. Violent exercise temporarily raises the alveolar CO₂.

In order to eliminate as far as possible these sources of error, breath samples should be taken with the subject quiet and at

³ Jetter, "A Critical Survey of Various Chemical Methods for Determining the Alcohol content of Body Fluids and Tissues With Their Physiological and Medicolegal Significance," 2 Quart. J. Stud. Alcohol, 512 (1941).

least 10 minutes after vomiting. If acetone is detected on analysis of the sample, the test becomes invalidated on the assumption of the presence of an abnormally low alveolar CO₂.

To exclude the possibility of the absorption of alcohol and CO₂ by condensed breath water vapor, the apparatus should be used in a heated atmosphere during cold weather.

For a discussion of the various methods of analysis of alcohol samples and the identification of other reducing substances which may be present, works by Forrester,⁴ Harger,⁵ and Jetter⁶ should be consulted.

Sensitivity to Alcohol

Certain drugs and diseases increase the sensitivity of the nervous system to the effects of alcohol or produce untoward effects in combination with it. In these conditions, the affected person may be obviously incapable of, for instance, driving a motor vehicle, while a chemical test shows a low or borderline alcohol concentration.

A violent form of intoxication, *mania a potu*, may result from the consumption of small amounts of alcohol in persons suffering from epilepsy, cerebral arteriosclerosis, previous cerebral trauma and mental instability.⁷

Of the drugs commonly prescribed which may have an additive action with alcohol may be mentioned the barbiturates,⁸ anti-histamines⁹ and oblivon.¹⁰

The use of T. E. T. D. (disulfiram, antabuse) in the treatment of alcoholism has led to many severe reactions following the ingestion of alcohol in persons taking this drug.¹¹ This reaction may be associated with flushing, vomiting, blurred vision, confusion and unconsciousness and can closely resemble acute intoxication. Similar reactions following the ingestion of alcohol

⁴ Note 1, *supra*.

⁵ Note 2, *supra*.

⁶ Note 3, *supra*.

⁷ Imrie, *Acute Alcohol Poisoning In Emergencies In General Practice*, 376-383 (Published by the British Medical Association, London, 1957).

⁸ Combined Alcohol and Barbiturate Intoxication: (Querier's and Minor Notes) 148 *J. Amer. Med. Assn.* 976 (1952).

⁹ Antihistamines and Alcohol, 1 *Brit. Med. J.* 403 (1954).

¹⁰ Drugs and Driving (Foreign Letter, England), 156 *J. Amer. Med. Assn.* 628-629 (1954).

¹¹ Goodman, and Gilman, *The Pharmacological Basis of Therapeutics*, 116-120 (2nd Edition, MacMillan Company, New York, 1956).

have been reported in the rubber industry and in cyanamide workers. Sensitization to alcohol can also occur after eating the fungus, *Corprinus atramentarius*, or following the ingestion of animal charcoal.

Tolerance to Alcohol

It is well known that the repeated use of alcohol in large quantities may result in the development of tolerance in some persons so that comparatively large amounts can be taken without serious consequences. The nature of this tolerance is not fully understood but there are at least two factors involved. There is evidence that the habitual drinker can eliminate alcohol from the blood stream at a faster rate than the novice.¹² The cells of the nervous system also probably acquire a true tolerance for alcohol and a given concentration has a less depressant effect on them.¹³

The neophyte and occasional drinker usually have a low tolerance and the blood alcohol levels associated with clinical intoxication in them may not, therefore, be a reliable index to the condition of the habitual inebriate.

¹² Muehlberger, "The Physiological Action of Alcohol." Committee on Medicolegal Problems, 167 J. Amer. Med. Assn. 1842-1845 (1958).

¹³ Goodman, and Gilman, Note 11, supra, at 107.