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## ASPECTS OF THE BLOOD ALCOHOL TESTS TO DETERMINE INTOXICATION

F. EARL MILLER AND R. W. GETCHELL

We have today definite, scientific methods for determining the degree of alcoholic intoxication of any individual. We commonly hear that some person can "hold his liquor" better than another. Alcohol must be absorbed into the bloodstream and carried to the brain where it acts as a depressant, to cause intoxication (2). Alcohol may be absorbed directly into the blood stream and its absorption is affected by a full or empty condition of stomach, strength of alcoholic beverage, rate of drinking, quantity of alcohol, and resistance to absorption such as might be found in the case of "topers." Intoxication is therefore not to be measured by amount of liquor drunk but by the amount reaching the brain. The blood alcohol concentration is a very close indication of the brain alcohol concentration. Maximum intoxication usually occurs between one-half hour and two hours after drinking. Most of the alcohol is oxidized at the rate of 5 to 10 grams per hour in the body. Not more than about 10 percent is lost through excretions as in urine, breath and sweat.

It has long been known that ethyl alcohol may be oxidized to acetic acid. It has also long been known that potassium dichromate in the presence of sulfuric acid furnishes a quantitative means for this oxidation. Nicloux (1) of France, in 1896, was probably the first to use this oxidation method for the blood alcohol determination. The chemical tests for intoxication have been in use in Sweden, Germany and other European countries for some time.

The method used in the laboratory at Iowa State Teachers College is a modification of the Nicloux method as used by Dr. C. W. Muehlberger (1, 6), Chicago toxicologist. This method requires a special steam distillation apparatus consisting of a 500 ml. steam generator, 300 ml. Kjeldahl type distilling flask and a water cooled, coil condenser. This is an all-glass apparatus with universal taper, ground glass connections.

Solutions required in the determination are (6):

- (a) 0.3472 normal potassium dichromate solution.
- (b) Approximately N/20 sodium thiosulfate solution.
- (c) Saturated picric acid solution.

- (d) 0.2% starch indicator solution.
- (e) Pure potassium iodide crystals.
- (f) 95% sulfuric acid.
- (g) Distilled water.

For a blood alcohol determination the steam generator is half filled with distilled water. 3 to 10 ml. of blood (depending upon how much is available) are pipetted into the distilling flask and about an equal volume of the saturated picric acid solution is added. This mixture is steam distilled and the distillate is collected in a test tube which has previously been charged with exactly 5 ml. of the 0.3472 normal potassium dichromate solution and 5 ml. of sulfuric acid. These are mixed in the test tube and cooled under water to or below room temperature. About 12 to 15 ml. of distillate are collected and the test tube placed in a steam bath to hasten the oxidation of the alcohol by the chromic acid. After about 15 minutes of this heating the contents of the test tube are mixed with about 200 ml. of water in a 500 ml. Erlenmeyer flask and about 3 grams of potassium iodide crystals are added. The liberated iodine is titrated with the sodium thiosulfate solution until the end point is reached as indicated by the starch solution which has been added near the end point. One ml. of the 0.3472 normal potassium dichromate solution is capable of oxidizing 4 mg. of alcohol to acetic acid in the presence of sulfuric acid. The sodium thiosulfate solution is standardized against the potassium dichromate iodometrically. From this standardization the alcohol equivalence of the sodium thiosulfate can be derived. In a computation of a sample it is only necessary to subtract the amount of thiosulfate used in the determination from the amount used in the standardization and multiply by the alcohol equivalence of the thiosulfate, to determine the milligrams of alcohol in the sample.

Some frothing occurs in all blood distillations. If any of this froth should rise into the neck of the flask and pass over with the distillate it would, of course, invalidate the results. The saturated picric acid solution probably serves a two-fold action: to keep this frothing at a minimum by regulating the pH and to precipitate blood proteins. During the distillation the tip of the condenser must reach to or even below the surface of the chromic acid mixture in the test tube.

It is often contended that acetone, ether, salicylic acid, lactic acid, etc. may interfere with the test. Heise (4) states that these substances are never present in amounts sufficient to disturb the validity of the test.

A representative group of results show that the accuracy of the method is very high. The following data show known amounts of absolute alcohol put into blood samples and the results of determinations on these samples.

Calculated Alcohol of Control Samples	Determined by Analysis
0.00 mg. per ml.	0.00 mg. per ml.
0.56 mg. per ml.	0.54 mg. per ml.
1.10 mg. per ml.	1.07 mg. per ml.
1.79 mg. per ml.	1.79 mg. per ml.
2.06 mg. per ml.	2.09 mg. per ml.
2.54 mg. per ml.	2.54 mg. per ml.
2.54 mg. per ml.	2.53 mg. per ml.

This method of analysis can be changed very slightly and used for samples of urine (1). A special distillation flask with indentations in the neck should be substituted. Picric acid need not be used with urine but the 3 to 5 ml. of urine used should be diluted to about 25 ml. with distilled water. This mixture does not require steam distillation but can be distilled directly.

Other methods in common use for the determination are the Heise test (4), the Harger tests (4, 7), the Widmark test (7) and the Friedemann test (7). The Heise test is similar to the Muehlberger test throughout the distillation but the color change of the dichromate is compared with a set of standards instead of using the iodide-thiosulfate titration. The Harger breath test deserves mention because it is the only one that may be employed in the field by a fairly unskilled person and because it employs the breath, which is easier to secure than body fluids.

The chemical tests for intoxication are more and more gaining acceptance in the courts. Ladd and Gibson (5) state, "There can be little doubt today that the blood and urine tests have reached sufficient standardization to entitle them to admission in evidence as reliable proof." Legal aspects (5) dealing with (a) the physician-patient privilege, (b) due process of law and self-incrimination and (c) unlawful search and seizure are the biggest problems that must be faced. The test is only of value if we can be fairly certain of its acceptance in courts. The physician-patient privilege concerns violations of confidential relationships which might have been established between a physician and his patient. Therefore, if a physician is called to draw a blood sample, then treats the patient for injuries or illness the courts can hold that presentation of this blood sample in courts is not constitutional because the

physician is not allowed to disclose any of these "confidential relationships" as evidence. Dr. Gibson of Iowa City states that he has appeared in three court cases. In the first one, the analytical evidence was thrown out because the doctor who took the specimen had definitely a "patient-physician relationship" inasmuch as he had treated the patient for a small abrasion incurred as a result of the accident. In the other two cases, the evidence on the alcohol content of the blood was admitted as was his testimony on the significance of the findings. The familiar law that "no man can be forced to testify against himself" has bearing here in that some courts hold that a specimen of body fluid would represent self-incriminating evidence. The courts are, however, beginning to take the attitude that a specimen is not to be considered as oral self-evidence and that its court acceptance should therefore be unquestioned.

A physician or technician who takes a specimen of blood should observe several precautions (5). The skin and syringe must not be sterilized with alcohol, phenol or any other volatile substance which might affect validity. Mercuric chloride solution 1:1000 in water is best to use on the skin and the needle and syringe should be previously sterilized in boiling water, steam or with dry heat. Approximately 10 ml. of blood should be withdrawn and placed in a flask containing an anti-coagulant and preservative. Sodium fluoride is best for this purpose. Specimens preserved for more than a month with sodium fluoride at room temperature showed only a slight drop in alcoholic concentration (7). Sodium or potassium oxalate or citrate may also be used. The physician should not violate the physician-patient privilege or in any other way permit a possibility for rejection of evidence. Great care should be taken that the specimen is never out of responsible hands until after it is analyzed and all possible legal action settled. The analyst should preserve whatever is left of the specimen after analysis for presentation in case of court action. Since taking a blood sample requires puncture of the skin with possibilities of infection no unqualified person should attempt to take a sample. A peace officer should send for a physician.

There is naturally much discussion as to where to draw the line between the point at which a man is or is not intoxicated. A survey of much of the literature of the field points to about 1.50 mg. per ml. or 0.15 per cent alcohol in the blood as a point at which a person becomes unquestionably impaired in *his motor* control so that he becomes a menace.

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