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PROOF OF ALCOHOLIC INTOXICATION*

HENRY W. NEWMAN, M. D.**

DEFINITION

In any consideration of the proof of alcoholic intoxication, either from the medical or the legal aspect, the first point to be settled is of necessity the definition of the term itself. That there is far from a unanimity of opinion on this point was strikingly brought out in the answer to a query sent by the National Safety Council to the attorneys general of the several states, reported in the Progress Report of 1937.¹ The definition of the terms "in-

* Memorandum Concerning the National Symposium on "Scientific Proof and Relations of Law and Medicine" (2nd Series).

The Journal, in this issue, is printing this article from the national Symposium series dealing with "Scientific Proof and Relations of Law and Medicine" (2nd series). The Symposium contains fifty or more studies prepared by legal and medical scholars on problems of joint interest to the two professions. The papers will be published in the pages of participating legal and medical journals during the Spring and Summer of 1946. The intent of the effort is to muster up legal and scientific learning relevant to various types of problems which need illumination from both sources for their proper solution. The scientific writers have undertaken, under editorial direction, to prepare their studies in a basic style comprehensible to lawyers, without, however, any sacrifice of scientific authority.

The new Symposium is a continuation of the first series, published by leading law reviews and medical journals in the Spring of 1943. As before, the general Editor of the Symposium is Hubert Winston Smith,† who holds an appointment, under the Distinguished Professorship Fund, as Professor of Legal Medicine in the University of Illinois, affiliated with the College of Law and with the College of Medicine. Readers interested in procuring a master index containing citations to the studies published in both the first and second series of "Scientific Proof and Relations of Law and Medicine", may do so by sending 20c in currency or stamps to Professor Smith, College of Law, University of Illinois, Urbana, Illinois. Copies so reserved will be mailed between May 15 and June 1.

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¹National Safety Council, Progress Report of the Committee on Tests for Intoxication of the Street and Highway Traffic Section, 1937.

toxicated" and "under the influence of intoxicating liquor" varied widely from state to state, but can be grouped in a few main categories. Twenty-four states had no legal definition of either term, the understanding of such matters being considered a matter of common knowledge. Another group of 12 states had definitions which are typified by that of Arizona, which can be expressed in the following manner: if the ability of the driver of an automobile has been lessened in the slightest degree by the use of intoxicating liquor, then the driver is deemed to be under the influence of intoxicating liquor. A number of these states distinguish between two conditions, the more serious being termed "intoxicated," and the less serious, the one applied to motor vehicle operation, "under the influence." Thus in these states the only criterion of being "under the influence" is the lessening, to the slightest degree, of the ability to perform a certain act, when this lessening is due to imbibition of alcohol. It matters not, under this definition, how great was the original skill of the individual, so long as this skill was in any degree lessened by alcohol.

In another group of 5 states, which can be typified by California, there is a fundamental difference in the definition. This definition can be expressed as follows: any abnormal mental or physical condition caused by indulgence in any degree in intoxicating liquor which impairs, to an appreciable degree, the ability of the driver to operate his car in the manner in which an *ordinarily* prudent and cautious person, in full possession of his faculties, would operate a similar vehicle under like circumstances. Here the situation is quite different from the one covered by the Arizona definition. It is not alone necessary that ability be decreased, but that it be decreased to the point at which the particular individual can no longer drive in the manner of the ordinarily prudent and cautious person, presumably the average driver. Since it is well known and accepted that different individuals possess differing degrees of skill in the operation of motor vehicles, it is at once evident that a degree of diminution in skill which would make an originally marginal driver no longer able to drive in the manner of an ordinarily prudent and cautious person might well not so reduce the skill of an exceptionally good driver. Thus it is necessary under this

definition not only to prove some appreciable degree of impairment due to alcohol, but sufficient impairment to lower that individual's skill below the standard accepted in his community. This is much more difficult of accomplishment than merely proving an appreciable degree of impairment.

The remaining 7 states had definitions of a somewhat more general nature, tending more to the California type, and referring to "normal control of bodily functions" and the so-called proper operation of vehicles.

While these definitions were directed at the operation of motor vehicles, they were in no way specific for that type of activity, and no doubt the same general principles would apply to other types of offenses in which alcohol might play a part. In summary, it may be stated that the terms "intoxicated" and "under the influence of intoxicating liquor" may be defined on the one hand as any degree of impairment of ability, and on the other hand as that degree of impairment necessary to render the particular individual incapable of performing the act in the manner of an ordinarily prudent and cautious person. In the first instance the individual's condition is compared with that of himself when no alcohol has been taken, in the other with the ability of the "ordinarily prudent and cautious person," presumably the average citizen. Under the first definition proof of intoxication is, as we shall see, relatively much less difficult than under the second. Which definition makes for the greater degree of justice is not easy to ascertain. Regardless of this, these definitions have been established, and it is of the utmost importance in regard to the prosecution or defense of such charges that one be familiar with the definition currently applied under the law of the state which has jurisdiction of the case.

TYPES OF PROOF

In the establishment of a diagnosis of alcoholic intoxication there are three categories of observations available on which to base the case. The first of these, and in many instances the only one available, consists of the observations of lay witnesses of the behavior of the individual both at the time of the offense and for a period of time before and after, during which his condition may be assumed to have been essentially the same. Here the state-

ments of individuals familiar with the suspect's normal mode of behavior are at once most valuable, because of this familiarity, and at the same time are subject to criticism of partisanship. Most adults are familiar with the behavior of an intoxicated person, and thus are competent to give evidence on this point. They are not, however, in general familiar with other conditions of medical or psychological nature equally able to produce the symptoms associated in the lay mind with alcoholic intoxication, such as might be exhibited by an individual in mild insulin shock² or suffering from cerebral concussion.³ Of the greatest importance is objective evidence of the behavior of the individual just prior to the offense. Thus erratic procedure of a motor car from one side to the other of the highway, either attested by eye-witnesses or evident from tire marks, is of inestimably more value than the befuddled behavior of the driver when pulled out of his car after it has crashed into a stone wall. Such evidence of inability to conduct himself in the manner of an ordinarily prudent and cautious person should be the keystone of the evidence presented to establish a diagnosis of drunkenness, and should be diligently sought for in every case. One of the greatest drawbacks of legislation establishing some specific blood level of alcohol concentration as prima facie evidence of intoxication is the resulting tendency toward blind reliance on this easily attained form of testimony, to the neglect of other and often more reliable sources.

The second source of evidence is to be sought in the examination of the suspect by a person with professional experience in the clinical diagnosis of intoxication. In this regard the experienced police officer may be qualified, although he may readily be suspected of partisanship. The medical examiner's testimony is much less subject to such criticism, and may be of great value. The examination for intoxication should be carried out as soon as

² *Insulin shock*: A condition of circulatory insufficiency resulting from overdosage with insulin (usually seen in diabetics). The overdosage of insulin causes too sudden a reduction of blood sugar and produces a condition marked by tremor, sweating, dizziness, double vision, convulsions, and collapse. Diabetics, in a state of mild insulin shock from overdosage of insulin or in a comatose stage resulting from diabetic coma, might well be thought by uninformed persons to be suffering from alcoholic intoxication.

³ *Cerebral concussion*: Concussion of the brain, a condition caused by violent blows upon the head, attended with dizziness, loss of consciousness, nausea, weak pulse, and slow respiration. A person in such a state might well mistakenly be classified as intoxicated.

possible after the apprehension of the suspect, and should concern itself as much with the ruling out of conditions other than alcoholism which might be responsible for the suspect's actions as with the accurate description of such signs and symptoms⁴ of alcoholism as may be present. In the latter regard, the report should be written in ink at the time of the examination, and should include data on the general appearance, condition of dress, odor of alcohol on the breath, presence of containers of alcohol on the person, condition of the pupils, flushing of the face, incoherence of speech, incoordination of motion, personality disturbances in the nature of combativeness, emotional lability,⁵ profanity, and degree of cooperation, and a statement from the suspect on how much alcohol he took and when he took it. After such an examination it should be possible for the medical examiner to testify with some authority as to whether or not the suspect was competent at the time of the offense, and if incompetent whether such incompetence was due to alcohol or to some other medical or psychological condition. Such expert examination should be readily available, and there is no excuse for not obtaining it promptly in every case where acute alcoholism may be a factor in the decision of the case.

The third type of testimony available consists of chemical data concerning the concentration of alcohol existing in the brain of the suspect at the time of the offense. This type of evidence has the great advantage of objectivity, with no opportunity for prejudice. It is, however, more easily obtained than interpreted, the reasons for which we shall consider in some detail.

ABSORPTION, METABOLISM, AND EXCRETION OF ALCOHOL

In order to be able intelligently to assess the evidence secured from alcohol analysis of body tissues or fluids, some knowledge of the mechanism of the metabolism⁶ of alcohol in the

⁴ *Signs and symptoms*: These are the data which guide medical diagnosis. *Symptoms* are subjective feelings, such as pain, which the doctor discovers by interrogating the patient; *signs*, on the other hand, are *objective* evidences of disease discoverable by medical examination without aid of the patient, as, for instance, a rapid pulse, a swollen joint, or a fractured bone.

⁵ *Emotional lability*: Emotional instability.

⁶ *Metabolism*: The chemical processes by which a food, or substance, such as alcohol is broken down and transformed to make energy available for uses of the organism.

body is necessary.⁷ From the legal standpoint it may be assumed that alcohol enters the body by the mouth through ingestion of one or several of the many types of alcoholic beverage. Part of the ingested alcohol is absorbed directly from the stomach, but by far the greater portion is absorbed in the upper part of the small intestine. Once alcohol is absorbed into the blood stream it rapidly diffuses into the body tissues, and ultimately the concentration in the blood and tissues reaches a point of equilibrium. This equilibrium is more rapidly attained in those tissues having a generous blood supply and rapid blood flow, such as the brain, and less rapidly in tissues with a slow blood flow, as muscle in the resting state and adipose tissue. Thus at the end of several hours the alcohol content of the various tissues is fairly equal, being proportional to their water content, but shortly after rapid absorption of alcohol the brain will approximate the blood in alcohol concentration, while muscle tissue will show a much lower alcohol content.

RATE OF ABSORPTION

The rate of absorption of alcohol into the blood stream is dependent on a number of variable factors. The most important of these is the rate of emptying of the stomach, which varies from one individual to another, and is influenced secondarily by several factors. The type of beverage may exert an influence on the emptying time of the stomach in two ways; first, if the beverage is distasteful to the drinker, waves of antiperistalsis⁸ will be set up, and even nausea induced, which effectively retain the alcohol in the stomach or even cause its regurgitation;⁹ second, if the beverage has a high buffer content,¹⁰ thus resisting

⁷ NEWMAN, H. W., ACUTE ALCOHOLIC INTOXICATION (1941).

⁸ *Antiperistalsis*: Peristalsis is the worm-like movement or contraction by which the alimentary canal propels its contents. It consists of a wave of contraction passing along the tube. A similar form of contraction is seen in other tubes that are provided with both longitudinal and circular muscular fibers. Antiperistalsis, or reverse peristalsis, involves movement proceeding in the other direction, causing the contents of the intestine to be impelled back towards the stomach and upward. It may result in vomiting.

⁹ *Regurgitation*: The casting up of undigested food.

¹⁰ *Buffer content*: A buffer is any substance in a fluid which tends to prevent or lessen the change in hydrogen ion concentration (reaction), which otherwise would be produced by adding acids or alkalis. That is to say, even when one adds acid to a buffer solution, the solution will not become as acid in reaction as one would otherwise expect.

acidification of the gastric contents by the gastric juice,¹¹ absorption will be slowed due to prolonged retention in the stomach. Distilled liquors have a small buffer capacity, while wines, with much greater buffer capacity, are much more slowly absorbed. Dilution of the alcohol in the beverage also plays a part. Concentrations around 50% may retard their own absorption by reducing gastric motility¹² and causing inflammation of the gastric mucosa,¹³ while on the other hand the great volume of very dilute alcoholic beverages acts to slow absorption because of the length of time required to pass through the pylorus.¹⁴ The optimum concentration for rapid absorption is about 20%, which is the concentration prevailing in most mixed drinks.

The presence of food in the stomach has a profound effect on the rate of absorption of alcohol, slowing it by prolonging its stay in the stomach. Thus alcohol taken with a meal is much more slowly absorbed than when taken on an empty stomach.

It is quite possible that absorption is influenced by emotional states, which through the intermediary of the sympathetic nervous system¹⁵ alter the gastric motility.

¹¹ *Gastric juice*: The clear liquid secreted by the stomach. It has a part in the process of digestion and because it contains hydrochloric acid, it tends to acidify the contents of the stomach.

¹² *Gastric motility*: Spontaneous movements in the stomach wall which occur during the course of digestion and tend to propel the stomach contents into the duodenum.

¹³ *Gastric mucosa*: The mucous membrane which lines the wall of the stomach.

¹⁴ *Pylorus*: The aperture by which the stomach contents enter into the duodenum. It is surrounded by a fold of mucous membrane which contains circular muscular fibers.

¹⁵ *Sympathetic nervous system*: The reader should understand that each of us possesses an autonomic nervous system which is largely independent of the cerebrospinal, or central nervous system in that its nerve fibers do not proceed directly from the nerve centers to the organ controlled, but pass as neurones from the gray substance of the spinal cord to a ganglion, or midway station. Here they encounter a break or "synapse" on the other side of which a post-ganglionic neuron proceeds to the organ controlled. The autonomic fibers regulate the action of the ductless glands, the large internal organs, the blood vessels, various secretory glands, and all structures containing involuntary muscles. The autonomic nervous system is comprised of the sympathetic and parasympathetic divisions, and the effects exerted by the two types of fibers going to a given organ are antagonistic. As a whole, the actions of the sympathetic division are directed towards strengthening an animal's defenses against various dangers which beset it such as extremes of temperature, deprivation of water, or the attacks of its enemies. (Best, C. H. and Taylor, N. B.: *The Physiological Basis of Medical Practice*, 2d edition, Baltimore, Williams & Wilkins Co., 1940.)

EQUILIBRATION

The rate of absorption of alcohol determines, dosage remaining constant, the height to which the blood alcohol concentration will rise, and consequently the degree of inebriation. With rapid absorption, alcohol enters the blood stream more rapidly than it comes into equilibrium with tissues such as muscle and fat. In very vascular tissues,¹⁶ such as brain, however, the tissue concentration is closely reflected by the blood concentration. Thus, on rapid absorption of alcohol there is a sharp rise of blood alcohol, and consequently of brain alcohol, followed by a rather rapid decline during the period when active absorption is almost complete yet equilibration with the other tissues is still taking place. This results in rapid onset of symptoms of intoxication, which last but a short time. With the same dosage of alcohol taken over a longer period of time, or taken as wine, the maximum concentration in the blood and brain will be appreciably lower, but will be maintained for a longer period. Thus a dose of alcohol which when rapidly absorbed will just produce symptoms of intoxication will fail to produce such symptoms when it is slowly absorbed. For this reason dosage of alcohol alone is not a reliable index of the degree of intoxication produced.

METABOLISM OF ALCOHOL

Once absorbed into the blood stream, about 90 to 95% of alcohol is metabolized, yielding heat, as in the case of other food-stuffs. This energy production may account for more than 50% of the resting metabolism in man. The seat of the primary metabolic process is in the liver, and the rate of metabolism is fairly constant regardless of the amount ingested or the concentration in the blood stream. This rate varies from one person to another, and is roughly 10 to 15 cc. of alcohol per hour, resulting in a rate of decrease of blood alcohol concentration of from 10

Thus, while the parasympathetic division augments digestive processes and inhibits heart action, the *sympathetic*, when stimulated, augments heart action, inhibits digestive processes, and by selective constriction and dilation of blood vessels, shifts blood from the abdominal area to the striated muscles as a step in mobilizing the resources of the organism for action. The main outflow of sympathetic nervous fibers from the central nervous system is from that limited portion of the spinal cord corresponding to the first thoracic to the second or third lumbar vertebrae—roughly from the base of the neck to the low back area.

¹⁶ *Vascular tissues*: Tissues well supplied with blood.

to 25 mgm. per 100 cc. per hour. From these data it is possible to approximate, from the blood alcohol concentration determined at some later time, the concentration that existed at any time after imbibition. For example, blood alcohol concentration 2 hours after an accident is found to be 140 mgm. per 100 cc., and the evidence indicates that no alcohol had been taken for several hours before the accident. Since the average rate of alcohol metabolism would have been expected to have lowered the blood concentration 30 mgm. per 100 cc. during the 2 hour period, the concentration at the time of the accident was probably 170 mgm. per 100 cc., and almost certainly between 160 and 190 mgm. per 100 cc.

The rate of alcohol metabolism is quite resistant to change. The lowering of blood pressure to shock levels,¹⁷ with fall of body temperature will appreciably slow it, while administration of insulin¹⁸ in large doses will increase it.

EXCRETION OF ALCOHOL

The 5 to 10% of ingested alcohol that is not metabolized is excreted, in about equal parts in the urine and in the breath. Except under very markedly abnormal conditions this percentage remains fairly constant, so need not be given much consideration for our purposes, particularly from the legal viewpoint. Thus we can say in summary that alcohol is absorbed with varying speed dependent on the presence or absence of food in the stomach, the type of beverage, and the physiologic and psychologic state of the drinker; that the faster the rate of absorption the higher will be the peak of blood alcohol concentration and thus the greater the intoxication; and that once absorbed, alcohol

¹⁷ *Shock levels:* The reader should understand that in cases involving considerable hemorrhage or surgical shock, the blood pressure falls markedly. This lowering of blood pressure indicates a reduction in blood volume, either by direct loss of blood or by diffusion of fluid elements of the blood into the tissue spaces, or both, and is an important phenomenon involved in the production of a state of shock in the patient.

¹⁸ *Insulin:* A clear, colorless aqueous extract of the active principal of the internal secretion of the Islands of Langerhans of the pancreas of slaughter-house animals. It is employed in the treatment of diabetes, as it raises the body's power to metabolize carbohydrates, reducing the blood and urinary sugar to normal, causing diminution of the acetone bodies of the urine, and relieving all the clinical symptoms of the disease.

disappears from the body mainly by metabolism at a slow and rather constant rate.

CORRELATION BETWEEN ALCOHOL CONCENTRATION AND
" DEGREE OF INTOXICATION

If determination of the concentration of alcohol in the body fluids is to be useful as evidence of intoxication, it must first be shown that there exists a correlation between such concentration and the degree of intoxication. Also, this correlation must be such that at any concentration set up as *prima facie* evidence of intoxication *all* individuals will be under the influence of alcohol according to the definition prevailing in the community. Since the whole basis for the chemical diagnosis of drunkenness lies in the relatively small number of investigations on this point, we would do well to examine them in some detail.

Southgate and Carter¹⁹ in 1926 reported the alcohol concentration in the urine of 27 inebriates apprehended by the police, and found it to be over 200 mgm. per 100 cc. in all but 3. Bogen²⁰ is responsible for the pioneer work in this country, reporting in 1927 on 300 patients brought to hospital suspected of inebriation. He made a clinical diagnosis of intoxication only in the presence of unmistakable loss of control of speech and movement. He found that no person with less than 100 mgm. per 100 cc. was clinically adjudged intoxicated, while 50% of those with concentrations from 100 to 200 and 75% of those from 200 to 300 were so adjudged. *Almost* all with 400 mgm. per 100 cc. were thought to be clinically drunk. He felt that the chemical test, although the most reliable single factor, should not supersede entirely all other clinical examinations.

Gettler and Tiber²¹ in the same year published a report on autopsy material, stating that in all with 100 mgm. per 100 cc. and under, behavior *ante mortem* (before death) was normal, from 100 to 250 there was "some physiological disturbance" but in no case great enough to be noticed by others or described as

¹⁹ Southgate, H. W. and Carter, G. *Excretion of Alcohol in the Urine as a Guide to Alcoholic Intoxication* (1926) 1 BRIT. MED. J. 463.

²⁰ Bogen, E., *Drunkenness, a Quantitative Study of Acute Alcoholic Intoxication* (1927) 89 J. A. M. A. 1508.

²¹ Gettler, A. O. and Tiber, A., *The Alcoholic Content of the Human Brain; Its Relation to Intoxication* (1927) 3 ARCH. PATH. AND LAB. MED. 218.

intoxicated, while all above 250 were described as intoxicated. Gettler and Freireich²² later made the statement, again on autopsy material, that intoxication was not present when the brain concentration was below 200 mgm. per 100 cc. Heise and Halporn²³ found that blood alcohol concentrations even lower than 100 mgm. per 100 cc. slowed the reaction time required for application of brakes in a motor car.

Smith and Stewart²⁴ administered whiskey to college students, and found that some of the subjects showed no evidence of intoxication with blood alcohol concentrations over 200 mgm. per 100 cc.

Turner²⁵ tested 32 cases brought to hospital and found those with blood alcohol concentrations from 100 to 200 mgm. per 100 cc. not to be intoxicated, while those from 210 to 300 mgm. per 100 cc. were drunk.

The best controlled study of correlation of alcohol concentration and inebriation is that of Jetter²⁶, who found in more than 1000 subjects brought to hospital on suspicion of drunkenness that at 5-75 mgm. per 100 cc. blood alcohol, 10.5% were adjudged intoxicated, at 75-125, 18.5%, at 125-175, 47%, at 175-225, 83.6%, at 225-275, 90%, at 275-325, 95.1%, at 325-375, 96%, at 375-425, 93.3%, at over 425, 100%. Thus there was shown a great variation in tolerance to alcohol, for although almost 20% of the subjects were intoxicated at about 100 mgm. per 100 cc., an almost equal percentage were adjudged sober at concentrations twice this great. Jetter has made the statement that because of this variation in tolerance the chemical test should be supplemented by clinical examination.

Harger, Lamb, and Hulpieu²⁷ reported in a series of 140

²² Gettler, A. O. and Freireich, A. W., *Determination of Alcoholic Intoxication During Life by Spinal Fluid Analysis* (1931) 92 J. BIOL. CHEM. 199.

²³ Heise, H. A. and Halporn, B., *Medicolegal Aspects of Drunkenness* (1932) 36 PENN. MED. J. 190.

²⁴ Smith, S. and Stewart, C. P., *Diagnosis of Drunkenness from Excretion of Alcohol* (1932) 1 BRIT. MED. J. 87.

²⁵ Turner, R. G., *Blood Alcohol and its Relation to Intoxication in Man* (1935) 32 PROC. SOC. EXPER. BIOL. AND MED. 1548.

²⁶ Jetter, W. W., *Studies in Alcohol I. The Diagnosis of Acute Alcoholic Intoxication by a Correlation of Clinical and Chemical Findings* (1938) 196 AM. J. MED. SCI. 475.

²⁷ Harger, R. N., Lamb, E. B., and Hulpieu, H. R., *A Rapid Chemical Test for Intoxication Employing Breath* (1938) 110 J. A. M. A. 779.

subjects brought to hospital that 92% with concentrations from 150 to 200 mgm. per 100 cc. were intoxicated.²⁸

Bavis²⁹ found that while better than 90% of his subjects were under the influence at concentrations from 110 to 200 mgm. per 100 cc., 1 case was not influenced at over 310 mgm. per 100 cc.

Newman and Fletcher³⁰ tested a group of normal individuals after imbibition of whiskey in an experimental situation. They found that all individuals showed some evidence of deterioration in the performance of skilled acts when the alcohol concentration rose above 105 mgm. per 100 cc., but that many individuals with concentrations much higher than this retained sufficient skill to maintain their performance above the average for the group. Moreover, when a group of these superior drivers were tested in a motor car on an obstacle course, even though their alcohol concentrations were in excess of 150 mgm. per 100 cc. their performance was superior to that of the average driver when sober. Moreover, when they were followed through city traffic without their knowledge they showed no evidence of inability to drive in the manner of an ordinarily prudent and cautious person.

Thus it can readily be seen that there is considerable individual variation in tolerance to a given concentration of alcohol in the blood. Added to this, because of the variation in degree of skill and nervous stability of different individuals, some persons have a greater margin of safety than do others. To add further to the confusion of the picture, it has recently been demonstrated by three investigators working independently that the degree of intoxication in a given individual is dependent not only on the alcohol concentration, but also on how rapidly that concentration was achieved. Thus a person may show signs of intoxication at a concentration of, say, 150 mgm. per 100 cc. when this is achieved in a period of half an hour, yet show no intoxication when this same concentration is reached more slowly, as perhaps in two hours time.

²⁸ And see, Selesnick, S., *Alcoholic Intoxication: Its Diagnosis and Medicolegal Implications* (1938) 110 J. A. M. A. 775.

²⁹ Bavis, D. F., 145 *Drunken Drivers; Blood and Urine Alcohol Studies* (1940) 25 J. LAB. AND CLIN. MED. 823.

³⁰ Newman, H. W. and Fletcher, E., *The Effect of Alcohol on Driving Skill* (1940) 115 J. A. M. A. 1600.

VALIDITY OF FIXED MAXIMUM VALUES OF
BLOOD ALCOHOL CONCENTRATION

In spite of the variability in tolerance to alcohol and the variation due to different rates of increment of alcohol concentration, the work of Newman and Fletcher has shown conclusively that in all individuals a blood alcohol concentration appreciably above 105 mgm. per 100 cc. is capable of affecting the ability of the individual to perform skilled acts in an appreciable degree. Thus the value assigned by the National Safety Council, 150 mgm. per 100 cc., is, if anything, a trifle too high in those states whose definition of intoxication is consistent with that of Arizona; that is, any influence of alcohol, however slight. In these states the presence of such a concentration of alcohol may be considered *prima facie* evidence of being under the influence of intoxicating liquor. On the other hand, there is no evidence extant to show that at 150 mgm. per 100 cc., or even at considerably higher values, *all* individuals will be so affected as to be incapable of performing skilled acts in the manner of an ordinarily prudent and cautious person. Here the variability of tolerance to alcohol, and more particularly the variation in initial skill of the individual, are such as to prevent the satisfactory establishment of a maximum value of blood alcohol which will be at once sufficiently high not to do injustice to the highly tolerant individual of high initial skill, and still be effective in bringing to justice the susceptible person of marginal skill. In states having this type of definition, the value of blood alcohol determination is merely the introduction of corroborative evidence which, in conjunction with that from other sources, as already described, may permit the court to decide whether or not the subject was intoxicated.

Which of the two types of definition is more desirable we will not attempt to judge. Certainly the Arizona type simplifies the prosecution of such offenders. However, under such a definition a man may be subject to punishment for conducting himself in the manner which another man would not be punished for, the sole difference being the presence of alcohol in the blood of the first. Thus there is introduced into the law a degree of arbitrariness which may be productive of the same disregard for law by the public which is so prevalent in regard to similarly

arbitrary speed laws. The California type definition, on the other hand, makes prosecution more difficult, but at the same time tends to punish, not the individual whose only offense may be his possession of a certain concentration of alcohol in his blood, but that individual who by achieving such a concentration has, by reason of his susceptibility to alcohol and his lesser initial skill, so lowered his capacity for the task at hand as to be no longer able to perform it in the manner required in his community.

CHOICE OF METHODS

Since it has been shown to be of value in the diagnosis of intoxication to secure data on the alcohol concentration of the brain, due consideration should be given to the selection of methods best fitted to the needs of the case.

The first problem to be solved is the selection of the material for analysis. Obviously, since it is the alcohol in the brain which is effective in producing intoxication, analysis of this organ should yield the most valuable results. However, except in autopsy material³¹ it is impossible to secure samples of human brain. It has been held that because of the close proximity of the spinal fluid to the brain this should be used. However, it has been definitely demonstrated that the alcohol content of the lumbar spinal fluid³² lags far behind the brain alcohol concentration, the spinal subarachnoid space³³ being a relatively inert

³¹ *Autopsy material:* Small samples of tissue taken at the time of post-mortem examination. These are embedded in paraffin wax, cut in infinitesimally thin sections with a microtome, and properly stained so that they may be studied microscopically. Alterations in the normal architecture of the particular tissue will go far to show the trained pathologist the nature, degree, and cause of abnormal changes due to disease and toxic factors. When the alcohol content of brain tissue is to be determined, this requires chemical estimation made according to the methods of Gettler and others.

³² *Lumbar spinal fluid:* The spinal cord is surrounded by a spinal fluid. The spinal cord ends at the level of the first lumbar vertebra, and it is therefore customary to do a "spinal puncture" to obtain the spinal fluid, at a slightly lower level, usually between the second and third lumbar vertebrae or the third and fourth. Spinal fluid so obtained would properly be describable as "lumbar spinal fluid" and the reader will readily perceive that since this region is in the low back area, the alcohol content might be appreciably different from that found in the spinal fluid surrounding the brain itself.

³³ *Spinal subarachnoid space:* The brain and spinal cord are invested by three membranes, these being from without inward as follows: the dura mater, the arachnoid mater, and the pia mater. The spinal fluid circulates between the pia mater and the

reservoir insensitive to changes in brain alcohol concentration. Moreover, it is difficult to obtain. Therefore, we may abandon spinal fluid as a satisfactory material for analysis.

It has been repeatedly shown that there is a fairly constant relationship between the concentration of alcohol in the blood and in the urine, the ratio being approximately 1:1.35. The reason for the higher content in urine is two-fold; first due to the higher water content of the urine, and second because the urine was formed, not at the time the blood specimen was taken, but at some previous time, when the falling level of blood alcohol may be presumed to have been somewhat higher. Urine retained in the bladder over a long period of time may show an alcohol content much higher than that of the blood. Such is the diuretic effect³⁴ of alcohol, however, that the bladder urine usually reflects the concentration in the blood at most a couple of hours earlier. Urine is relatively easy to secure, since the apprehended inebriate is usually anxious to void when the opportunity presents itself. Of course, he may not be forced to produce a sample, but if he does, there seems to be no reason why an alcohol determination performed on it may not be admitted in evidence, just as may the finger-prints that are left on the handle of a revolver. In neither case can it be said that the individual was forced to testify against himself.

The alcohol concentration in the alveolar air³⁵ bears a fairly constant relationship to that in the blood. Thus breath may be used as a material for analysis. Since the percentage of alveolar air in the expired air varies with the depth of breathing, but the carbon dioxide content of alveolar air is practically constant, it is possible by means of simultaneous carbon dioxide determination to estimate the amount of alcohol in alveolar air, and consequently in blood, with a fair degree of accuracy. This is true even if there is considerable leakage in securing the sample, such as when the intake is merely placed in the breath stream, which may be

arachnoid mater. The spinal subarachnoid space, therefore, is that space between the pia mater and the arachnoid mater investing the spinal cord and filled with spinal fluid.

³⁴ *Diuretic effect:* Any medicine or substance that promotes the secretion of urine.

³⁵ *Alveolar air:* The air contained in the air sacs and alveoli of the lungs. Its gases come into equilibrium with those in the blood of the pulmonary capillaries. The alveolar air is continually replaced as a result of the to and fro effect of the respiratory movements in the course of breathing.

done without the cooperation of the suspect. There should be no legal obstacles to the use of breath samples so obtained. However, it is always possible to render such evidence subject to doubt because of the possibility of the breath sample being contaminated by alcohol in the mouth from recent drinking, or by eructations from the stomach.

Blood is without a doubt the material of choice for alcohol analysis. It has been shown to reflect the alcohol concentration of the brain quite faithfully. It is not subject to contamination, and it indicates the concentration in the brain at the time the sample is taken, and not at some indefinite previous time as in the case of urine. However, from both the medical and legal standpoints it is more difficult to obtain, in the first instance because of the necessity of the services of a skilled technician for the venapuncture,³⁶ and in the second because of the necessity of invading the privacy of the individual if consent for the test is not given. It is probable that so far as the principle of the defendant being required to testify against himself is concerned, this right is not jeopardized by the compulsory taking of blood any more than by the compulsory taking of fingerprints. However, when it comes to penetrating the tissues of a man for the purpose of obtaining evidence, legal questions arise as to what may be done without the subject's consent and as to the admissibility in evidence of blood level determinations made from involuntary blood specimens.³⁷

In summary, blood is the material of choice for alcohol analysis. Breath may easily be contaminated, and urine reflects

³⁶*Venapuncture*: Use of a needle to withdraw blood from a vein. Most readers are doubtless familiar with the procedure from having a blood sample thus taken in the course of one of their physical examinations.

³⁷The constitutional objections usually made are that the use of involuntary blood specimens violates the privileges against self-incrimination or involves unlawful search and seizure. The courts of the several States are divided in their opinions, but the majority and progressive view now seems to be in favor of admissibility. See, in the Symposium series "Scientific Proof and Relations of Law and Medicine" (1st Series, April, 1943) the following paper: Ladd, M. and Gibson, R. B.: Legal-Medical Aspects of Blood Tests to Determine Intoxication, 29 Va. L. Rev. 749: (April, 1943); Ann. Int. Med. 18: 564, 1943.

During the recent war the Navy department issued a general order expressly authorizing the taking of involuntary blood specimens in any cases where the question of alcoholic intoxication might be involved.

the concentration at some unknown previous time. If a sample of blood can be obtained, it is the best procedure, and the concentration found is a reliable index of the actual brain concentration. If consent cannot be obtained for a blood sample, or if the necessary technical aid is not available, a sample of urine or breath may be secured, by subterfuge if need be, with the knowledge that the information so obtained is not so reliable as that obtained from blood.

No matter what the origin of the sample, it cannot be too strongly stressed that there should be an unbroken chain of evidence regarding its custody from the time it was seen to leave the body of the defendant until the analysis was completed. Unless this is effected, the evidence will surely be ruled out. It is desirable, although not absolutely necessary, that the analyst testify in person, although the individual in charge of a laboratory may present the evidence if he actively supervised the analytical procedure. By far the most satisfactory plan, however, is to have the man who actually did the analysis testify as to the concentration found. Then further expert testimony regarding interpretation of the findings may be secured elsewhere.

METHOD OF ANALYSIS

There is little choice between the various methods of analysis of body fluids which are in common use. It is of the utmost importance that the analyst be professionally qualified, and that he shall have had considerable experience with the particular test employed. He should from time to time run blank analyses on his reagents, and also on known concentrations of alcohol to check his procedure. Particularly in those localities where an arbitrary value of blood alcohol concentration is considered *prima facie* evidence of intoxication the responsibility devolving on the analyst is very considerable, and all possible precautions should be observed to safeguard against errors.

Determinations of the alcohol content of the breath are particularly subject to error, both from contamination from the suspect's mouth, and from loss of alcohol in the apparatus, from condensation. Evidence from such a source should not be given the weight of that obtained from analysis of blood.

CONCLUSIONS

The ideal procedure in establishing the existence of alcoholic intoxication should give consideration to all sources of evidence bearing on the case. An effort should be made to secure testimony of those who were in a position to observe the suspect and his actions at or about the time of the alleged offense. A sample, preferably of blood, should be secured as soon as possible and submitted for analysis for alcohol by a competent laboratory specialist, taking care that the sample shall not pass out of the hands of responsible individuals from the time it is secured until the analysis is completed. Most important, the suspect should be examined by a physician who has had some experience in examination for evidence of alcoholic intoxication, and a written record of the findings made at the time.

By so securing all available evidence, it should not be difficult to present a clear picture of the condition of the suspect, on which may be based a valid conclusion as to the presence or absence of intoxication.

By far the greatest number of cases in which a diagnosis of alcoholic intoxication is important are concerned with the operation of motor vehicles, and most of the investigations of an experimental nature have been aimed at this particular type of offense. There can be no doubt that the presence or absence of intoxication is not an absolute fact, but that there are innumerable degrees of intoxication from the medical viewpoint. A condition of mild intoxication may incapacitate an individual for a task or act requiring a high degree of skill or judgment, while a much greater degree of drunkenness may not interfere with acts of a less exacting nature. In short, a degree of intoxication which would render a man a potential offender against society when at the wheel of a motor car might be entirely innocuous if he remained in his home. Thus the type of activity required must be considered equally with the blood alcohol concentration if justice is to be done.