age speeds were during daylight, 48 1 miles per hour, during darkness, 47 2 miles per hour.

The cars that were apparently from some other part of the state and could be classed as through traffic constituted 22 7 per cent The average speeds were: during daylight, 48 3 miles per hour; during darkness, 48 miles per hour.

We find that the average speed of all vehicles checked on all types of highways and under all weather conditions is 43 7 miles per hour

The above data are all we can obtain from the reports as submitted With this experience we expect to make a more detailed survey in the coming year, and would like suggestions as to data that should be included

The results of the survey seem to indicate that 45 miles per hour is a good average speed, and that a regulation declaring speeds in excess of that figure to be prima facie evidence of unreasonable speed would be in order

ALCOHOL AND MOTOR VEHICLE DRIVERS

By Dr W R Miles

Yale Institute of Human Relations

SYNOPSIS

A man may keep his car right side up and on the road when he is too intoxicated to walk but this fact is not reassuring to others on the highway Although beverage alcohol appears to give subjective stimulant action to a person, its real effect is a depressant action on most of the functions of body and mind The alcohol effect which interferes with driving ability is fourfold. (1) A poorer grade of attention to external signals and environment, (2) Slower responses of eyes, hands and feet, (3) Less dependable, that is more variable, muscular responses, (4) Increased self assurance which prompts to the assumption of right-of-way and willingness to take a chance Although alcohol is directly mentioned in only 7 to 10 per cent of fatal highway traffic accidents, it is the belief of informed traffic officials that one-third of such accidents are at least partly chargeable to use of alcohol by the driver Officials need a method to definitely determine whether a driver is intoxicated as a basis for court action Determination of percentage of alcohol in the blood or urine by biochemical means is a feasible undertaking This method should be tried out in some representative areas to secure scientific data in this controversial field

The motor car of today is a splendid mechanism, comfortable, responsive and powerful, a truly marvelous extension of the human personality but it can not drive itself, society counts on its being used by responsible people who have reached and are maintaining the human adult level of understanding and emotional balance A large army of engineers is continually at work improving the automobile in all possible ways

consistent with reasonable economy: for example in giving it greater pickup and speed plus effective traction and brakes Another army is equally energetic and effective in providing roads and highways suitable in special pattern and in surface characteristics for motor traffic The human factor is the third dimension in this picture and it is the most difficult one to treat successfully The third army, therefore, needs to be and is the largest of the three It has been relatively slow in mobilizing and has found difficulty in analyzing its field and organizing its program The task of the human engineer is comparable to that of the automotive engineer or the highway engineer, for in the last analysis, he is interested in designing, constructing, testing, remodelling, etc but here the materials worked upon are human habits, psychological attitudes, economic stresses, and social customs Within this special field of human engineering, traffic accidents and fatalities constitute the all too literal "break-down-test" from which crucial facts applicable to general practise are derived And within the traffic accident division of the field falls the subject of alcohol intoxication, or to speak more generally, accident-proneness following upon the drinking of alcoholic beverages

Many of the members of this conference are no doubt familiar with alcohol accident statistics as published and know that in recent years approximately 20 to 40 per cent of cases where drivers licenses have been suspended or revoked the charge has been intoxication (34) [1] Although alcohol is directly mentioned in only 7 to 10 per cent of our fatal highway traffic accidents, it appears to be the belief of traffic commissioners (56) and other informed individuals that probably a fourth to a third of our automobile accidents are at least partly chargeable to alcohol use by the drivers Alcohol statistics at present available are necessarily understatements especially for two reasons In the first place on both the legal and the medical sides it has been difficult to arrive at satisfactory definitions of intoxication (2) (33) A moderate impairment of performance due to the effect of alcohol on the nervous system is not always qualitatively different from the impairment which may come with fatigue, the loss of sleep, illness, or at times from a period of prolonged inattention The relative similarity of behavior mismanagement from different causes (some of them quite usual ones) has tended to draw the line defining actual "intoxication" near the extreme pathological side, thus omitting generally from the group all except the most flagrant cases This minimizes the total statistical import of the alcohol factor as far as the police records are concerned, and it is from these that the alcohol traffic figures are drawn at present In the second place, society has been more ready to wink sympathetically at the drinker than to scowl disapprovingly at him

[1] Numbers in parenthesis refer to bibliography at end

and is inclined when he has a motor vehicle accident to bring a charge of "careless driving," thus sparing him from a more obnoxious designation On the scientific side there is a third important factor operating to confuse recorded statistics, namely that impairment from alcohol does not continue at a constant level and is a characteristically transitory psychological state The results in an examination of a traffic violator depend on his condition at the time of the examination, they cannot show except by inference what the condition was an hour earlier There is now considerable evidence to support the expectation that the use of chemical tests as a means of examining for "intoxication" will partly overcome the difficulties mentioned But the total situation is undoubtedly very complex on the side of personal judgment because so many drivers are their own employers without a sense of employer's responsibility American railroads have adopted a stringent rule "G" forbidding employees to drink or to frequent places where intoxicating liquors are sold But traffic violators do not come under the control of one or of a group of responsible employers, nor do they become subject to traffic commissions until after the misdemeanor has taken place and so preventive measures are not systematically possible

Alcohol's immediate impairment of driving ability is quite generally recognized The amassing of scientific evidence on the effects of alcohol and the fitting together of this evidence with the result of finding alcohol to be a depressant and not a stimulant for mental functions (12) (44) (58) has been reviewed repeatedly (e g , 16) and need not be restated here in detail It will be sufficient for us to remind ourselves of some of the characteristics of behavior, following the ingestion of alcohol, that are pertinent to the task of the motor driver One important effect which is predominantly physiological should be mentioned first Experiments on different kinds of animals agree in showing that muscular incoordination resulting from alcohol appears more strongly in malcontrol of the lower or hind limbs than in the fore limbs or arms Rats and dogs and other animals suitably dosed with alcohol can continue locomotion, of a rather poor type, by means of their forelimbs while actually dragging their hind limbs The human being is, of course, out of the running under similar dosage conditions, and hence it is that the staggering gait of the partially inebriated man has such classical diagnostic significance Because of this marked effect on the legs the automobile is particularly useful to the more or less intoxicated individual He can sit and drive when it would be difficult for him to proceed as a pedestrian The vehicle, guided and driven largely by use of the less affected arms, permits him to make progress that would if he were dependent solely on the more affected legs, be physiologically inconvenient even impossible for him at the time

The mental changes produced by alcohol are numerous and among them are included the alterations in mood and attitude that account for the wide and enthusiastic use of the substance by pleasure-seeking

mankind Because these emotional changes are psychologically at least as important as the sensory and muscular alterations which typically follow the ingestion of moderate amounts of beverage alcohol in being at variance with the theoretical normal conditions for the automobile driver, I include them in the following catalogue of behavior patterns of those who drive after drinking The muscular and sensory responses are more amenable to experimentation than the emotional, and, whatever the mood, speed, precision and undivided attention are essential to efficient driving

(1) Experiment shows that reaction times in the responses of eyes, hands, and feet are slower after alcohol ingestion than under similar conditions but without the beverage Measured in the laboratory this slowing of reaction time is approximately 5 to 10 per cent after the usual experimental dosage This change is in itself large enough to contribute to accident proneness and sometimes to present the chief precipitating cause

(2) Less uniformity in response follows the ingestion of alcohol Motor coordinations of the arms and legs are less true to patterns of efficiency and more variable in amplitude when alcohol is influencing the nervous system Under certain circumstances what is essentially the correct coordination may be performed in such a clumsy indirect manner that the result is the equivalent of having done just the wrong thing

(3) A poor grade of attention to diverse external stimuli follows the taking of alcohol The less erect body posture together with modifications of vision and hearing in the direction of poorer perceptual facilities all operate to accentuate the attention decrement This effect of alcohol is sometimes spoken of as a narrowing of the attentional field The well-known tendency of the alcoholized individual to repeat himself or to continue talking interminably on the same topic is evidence of the perseveration occurring in this narrowed attentional field and of the similarly limited ability to turn from one type of stimulus or cue to another

(4) On the emotional side the achievement of increased self-assurance is apt to be the first change noticed, it is probably, often unconsciously, an objective in the use of alcohol Everywhere even a slight socially acceptable toxic effect is recognized as bringing this subjectively desirable feeling to the drinker Many are the claims advanced for the gains achieved among friends by a glass or two of "stimulant," but in highway traffic the characteristic alcohol effect beside making the individual satisfied with his poorer muscular control prompts him to the assumption of the right-of-way and makes him unduly willing to venture on a sporting chance [1]

(5) Further disturbance of emotional balance is a fairly common

[1] The person who knows the scientific side of the alcohol effect but who notwithstanding has imbibed alcohol, as a driver, may employ more cautionary measures than usual, e g stopping at the side when traffic seems thick.

result from imbibing alcohol, it tends to increase as the tolerance level of the individual is passed This modification in the psychology of the driver may take diverse forms, some of which are conceivably desirable, while others are fundamentally undesirable Certainly a person who is by nature inhibited, fearful and over-cautious may be without the use of alcohol a danger on the road, but probably the number of people of this kind who can best alter their temperamental difficulties through the use of alcohol as a preliminary to driving is relatively small because in general other less desirable changes will occur to offset the intended gain On the other hand, the individual who knows from past experience that it is unwise for him to drive after having taken alcohol may, if he has indulged, be made thereby to assume the hampering timid and overcareful manner somewhat as does a man who knows that he is driving without a license Individual differences in emotional effect are quite large Alcohol makes some individuals hilarious, others bad tempered and irritable Paradoxically, the important element in common is variability which characterizes emotional mood after alcohol and this means that habitual attitudes are no longer to be depended upon Whatever its characteristics an undercurrent of unusual feeling is apt to be a liability on the highway

Exact laboratory experiment has been made with reference to the effect of alcohol upon efficiency in the objective part of behavior The subjective has also been studied and qualitative results are available A brief statement regarding findings on the effects of alcohol on typists is introduced here because it best illustrates alcohol effect on the speed and accuracy of individuals highly trained in the particular skill involved Following the findings on the influence of alcohol on typing a short review will be given of all the available experimental studies showing the influence of alcohol on automobile drivers

Five skilled typists all of whom were spontaneously moderate users of alcohol served in the experiments (44) The results are here presented as averages for the group The men took their alcohol in 20 per cent beverages and the amount was administered according to body weight Dose A contained from 21–28 gm of absolute alcohol (depending on the size of the man), and Dose B similarly contained from 32–42 gm Control non-alcoholic drinks were used with the same five men on non-alcohol days and a comparison made of the two sets of experiments Within the first two hours after the smaller dose the typing rate decreased only 2 per cent, but there was an increase of 39 per cent in the errors The pulse rate was 6 per cent faster, the finger response 3 per cent, the eye response 7 per cent, the voice response 4 per cent slower In the second two hours after taking the smaller amount of alcohol there was practically no change in the rate of typing but there was still an average of 15 per cent increase in errors made The pulse rate remained high, average 7 per cent increase and finger, eye and voice all required

longer times than the normal for response, 2, 5, and 3 per cent respectively. Within the first two hours after taking the larger dose of alcohol, which represented an increase of 50 per cent over the smaller one, a decrease appeared in typing rate amounting to 4 per cent with an increase in errors of 72 per cent. The pulse rate was 8 per cent higher than normal, the finger, eye and voice quickness were slowed up 4, 9, and 5 per cent respectively. In the second two hours after taking dose B the typing rate had recovered practically to normal but the errors were still 35 per cent more numerous than under non-alcohol conditions. The pulse rate had not gone down but was 9 per cent faster than normal, finger, eye and voice speed had regained somewhat, but they still showed 3, 4, and 2 per cent slower speed than at a similar time after similar work on the days when the non-alcoholic solution had been taken. These results are typical and characteristically illustrate alcohol experiments in the psychological laboratory.

The questioning public is not satisfied to estimate accident proneness in automobile drivers from results on what perhaps seems to the layman so different a task as typing. And so a new alcohol experimentation is necessary that directly involves the use of the automobile. Difficulties and actual casualty risks to be overcome in providing conditions for such a scientific experiment are, of course, considerable. Experiments on chauffeurs involving the performance of tasks under special conditions devised to parallel actual driving requirements are a first step in the desired direction. Recent work along this line still mostly unpublished, has been done by Bahnsen and his associates (3) in Denmark, and a paper by Mayerhofer (40) of Germany is of this nature. Mayerhofer studied the effects of 40 cc. of absolute alcohol in wine and beer on some twenty individuals, and he summarized the effects of alcohol on reaction time in situations psychologically quite similar to those involved in automobile driving. He found the following conditions. (*a*) Lengthening of the reaction time, (*b*) marked increase of the errors in coordination reaction, multiple reaction and disjunctive reaction, (*c*) false judgments of the speed of the movements of other people and of oneself, (*d*) greater expenditure of energy in movement, especially in the case of misperformances, (*e*) decreased attention; (*f*) omission or disappearance of critical blocking or protective inhibition, optimistic judgment of situations, (*g*) tremor of the hand; (*h*) ataxia. Heise and Halporn (30) are probably the first to report on a test (prepared by Dietze) involving the actual driving of an automobile (on a closed highway), under otherwise similar alcoholic and non-alcoholic conditions. "A car was rigged up so that shooting a gun would give the signal to apply the brakes and this in turn would shoot another gun. The knowledge of the speed of the car and the distance apart of the bullet marks on the road furnished a means of measuring reaction time. Also a curved lane marked by corrugated packing boxes, whose configuration could be changed without

notice, made quick decisions necessary and prevented the subject from anticipating the signal to stop By spending several hours with each subject we were able to notice changes in the individual, and were also fortunate in being able to elicit the subjective symptoms" It was found with this apparatus that when travelling at a speed of 30 miles per hour the subject, when he had not had alcohol, required 16 feet on the highway from the time of hearing the signal until he began to apply his brakes After taking alcohol (1 to 5 ounces of whisky) the distance required for putting on the brakes gradually increased from 16 to 22 feet "The driving test was ended abruptly when the road rose up in waves before the driver" Heise and Halporn describe the results in Dietze's complete series of tests, as follows "Our subjects all mentioned dizziness and two of them a sense of unreality as the most prominent subjective sensations The most striking change was that of the intelligence, particularly the ability for self-criticism All but one passed the routine (physical) examination for sobriety but all suffered a moderate slowing of reaction time, and all made mistakes such as colliding with boxes and shooting the gun on the brake pedal at the wrong time" These important preliminary experiments should stimulate other investigators to make similar tests under practical driving conditions

The diagnosis of "*pronounced drunkenness*" usually offers no difficulty to the traffic officers But in the preliminary stages of intoxication or in the clearing-up interval after a single or a short time of indulgence diagnostic certainty is difficult For such cases the services of a medical expert are generally regarded as necessary The latter in addition to information derived from answers to their direct questions take into account the individuals' general appearance, attitude, orientation in space and time, memory, pronunciation of difficult words, condition with respect to the conjunctivae of the eye, reaction of the pupils, gait and standing steadiness, accuracy of hand movements, smell of breath and rate of pulse Furthermore, the medical examiner has carefully to rule out possible cases in which a simulation of symptoms of intoxication occur, but where actually the individual has not been drinking but is instead suffering from accident or disease Generally the total picture based on the medical and psychological signs enumerated is fairly adequate for a diagnosis Even though the total picture is quite clearly indicative of behavior modified by alcohol in the direction of accident proneness when it comes to translating this evidence into terms of legal procedures practical difficulties arise A clever attorney by taking the separate symptoms one by one, may convince a jury that all were natural changes due to any one of a number of causes, and when the picture is thus broken up it loses its total psychological impression and medical diagnostic value and so perhaps the case is dismissed Fortunately for progress in diagnosis a new and more objective kind of

evidence has been introduced This is the so-called chemical test and to a discussion of its methods and results I wish to devote the remainder of my time today

Let me briefly sketch the physiological process involved when alcohol is ingested by a human being or other animal It is now very well known that when ethyl alcohol is taken into the stomach it begins promptly to be absorbed without waiting until such time as it passes into the small intestines Also without having been changed in any way by bodily processes alcohol quickly appears in the blood and begins to be used in the metabolism Dogiel in 1874 was among the first to show that alcohol could be found in both arterial and venous blood within two minutes after having entered the stomach, and Higgins (31), a former colleague of mine, showed that alcohol begins to be burned in appreciable quantity within 5 to 11 minutes after drinking The prompt appearance of unchanged alcohol in the circulation and its ready diffusion throughout the whole organism makes the interesting substance uniquely accessible for observation and study not only in the breath but also in the body fluids, the saliva, the blood and the urine By the year 1900 the work of several physiologists and chemists, including noteworthily two Frenchmen, Gréhant (27) and Nicloux (46) had resulted in the general finding that the amount of alcohol appearing in the blood approximately parallels the size of ingestion The next few years saw the development of various methods for detecting alcohol in the body fluids and in 1913 appeared an important paper by Schweisheimer (52) in which the claim was made that the psychic condition of men who have imbibed depends on the degree of concentration of the alcohol in their blood Schweisheimer said "With animal experiments, such a proof could naturally not be given But in this research, it is absolutely demonstrated that with abstainers, moderate drinkers and habitual drinkers, the condition of intoxication indicated by such signs as dizziness, numbness, tiredness, and in slighter cases by talkativeness and hilarity, is exactly parallel in increase and decrease with the increase and decrease of the alcohol content in the blood Furthermore, it appears as far as the abstainer and the habitual drinker are concerned, that an equal concentration of alcohol in the blood caused in the former more marked symptoms of drunkenness, in the latter lesser symptoms" (transl) The next experiments directly involving the relation of the psychological to the chemical function of alcohol were made, I believe, almost simultaneously in England by Mellanby and in America by myself Mellanby in his experiment at this time used dogs checking his results on a few men, my own studies were entirely with men and involved carrying out rather elaborate physiological and psychological measurements, the results being checked at intervals against the simultaneous findings for alcohol content in the body fluids The results of Mellanby and my own verified the general finding of Schweisheimer that the toxic effect

paralleled the height of the alcohol concentration in the blood The main difference, probably quite an important one, between the German findings and ours have to do with the declining portion of the concentration curve We found the parallel in the toxic effect and the concentration curve on the rising part of the curve and at the maximum But after the maximum had been passed and the curve was declining we found the alcohol symptoms clearing up more rapidly than Schweisheimer's statement had led us to expect Mellanby stated "A dog begins to show signs of intoxication when the alcohol in the blood reaches about 354 cubic mm per hundred grams of blood. At this stage it will probably hit its hind toes against the floor in walking. Its movements will be slower and after a period of excitement its interest in external conditions will be less than usual This only applies to the ascending portion of the curve It has already been stated that the symptoms decline after the maximum of the alcohol in the blood has been reached When the alcohol has declined again to 354 cmm the dog will probably appear almost normal and will certainly be less intoxicated than at the corresponding point on the ascent of the curve" In other words intoxication resulting from short periods of drinking is a kind of mental and motor disorganization arising from interferences with normal nervous system action produced by the invasion of the drug substance into the organism When the strength of the pharmaco-dynamic attack decreases the organism experiences a rather sudden turn for the better A psychological factor that complicates attempts at psychochemical correlation is a partial adaptation that the organism makes even when the toxic load is heaviest As soon as the handicap is reduced even slightly a rebound toward adjustment and organization of functions takes place The Schweisheimer concept, that the toxic effect exactly parallels the rising and falling of the concentration curve, has been practically convenient but it does not fully fit the psychological facts The tendency for the subject to clear up psychologically before alcohol has disappeared from his system may account for the contradictory statements made concerning a particular individual and for the great diagnostic difficulty that exists in examining patients 30 minutes or more after an accident has taken place

The value of the objective chemical test is coming to be generally recognized Recently several studies have been published which give comparisons between the results of chemical analyses of fluid samples and independent symptom diagnoses of degree of intoxication Although alcohol appears in all the body fluids, practical considerations limit the types of materials that may be studied. The most accessible sample is the breath, yet it offers certain difficulties as a point of attack In this country Bogen (8) and in Sweden, Liljestrand and Linde (36) have, however, used it rather extensively In their studies the person to be examined blows up a small rubber sack resembling a rubber pillow

and having a capacity of two liters and then the air while still warm is passed through indicating chemicals The test is not entirely reliable because gas coming directly from the stomach may intrude into this exhaled air and thus carry into the sample larger alcoholic content than the same amount of normally mouth breathed air would contain The possibility of this type of error in the sample collection probably applies especially to the period nearest to the drinking of the beverage, and the examiner can not be sure just when his patient last took alcohol It is not uncommon immediately following an accident for a person to have alcohol urged upon him, perhaps even forced between his lips if friends are trying to revive him from a state of unconsciousness or confusion And so the breath test is doubly dubious

Saliva is accessible as fluid to be tested for alcoholic content and it may prove best for the purpose (21) (35) Not a great deal has been done by way of experimentation with it up to the present Blood samples and urine samples, particularly the former present more difficulties on the side of the willingness or unwillingness of the individual under examination, but in spite of the initial psychological reluctance of people to cooperate both of these sample methods are coming into use in connection with automobile traffic and police court activity Where they are used public opinion will no doubt gradually bring about their more common and more ready acceptance The blood sample method is already used by the police doctors of Sweden The lobe of the ear or the tip of the finger of the suspect, after proper non-alcoholic cleansing, is pricked with a needle Small specially prepared capillary tubes ready in a mailing receptacle are filled from the drop of blood that is squeezed out; the tubes are closed and the receptacle is mailed to the central testing laboratory where chemical analysis is made by means of a micro-method devised by Prof. Eric Widmark who has greatly advanced this kind of investigation (62) The preliminary Swedish statistics are of great interest but the work is probably not at present advanced to the point where the boundary line of intoxication can be definitely fixed by this method In addition to the very informing studies of Widmark other publications are appearing in Sweden One on the subject of alcohol and accidents has just come out under the authorship of Hindmarsh and Linde (32) Prof Liljestrand[1] the pharmacologist of Stockholm under whose direction the investigation was carried out has reported this work as follows "From April 1st 1932 to March 31st 1933 such cases as were taken into the Maria Hospital in Stockholm for accidents and put into the surgical clinic were investigated by one of the authors personally and then a blood sample was investigated (by Widmark's method) Some cases—in all 17 per cent—could not be investigated, since they came at times when the two authors were unable to see them, but these cases are all considered in

[1] Personal communication dated November 23, 1933

the calculations to be free from alcohol The number of people investigated was 505 (men, women and children) Among them 125 were found to have alcohol in the blood, 115 men and 10 women In the following therefore only the men are considered The total number of men investigated was 283, thus 41 per cent were found to have alcohol in their blood Of the 283 accidents 113 took place in traffic (motor cars, trains and so on), 50 of them (44 per cent) having alcohol in the blood Of those having alcohol the following table gives some information.

	Alcohol less than 1 pro mille[1]	Alcohol more than 1 pro mille
All accidents	42 (26%)	73 (64%)
Traffic accidents	17 (34%)	33 (66%)

The correlation between the clinical diagnosis and the alcohol in the blood gave interesting results At an alcohol concentration of 1 pro mille 63 per cent were diagnosed as influenced by alcohol, at 1 33 pro mille the corresponding percentage was 78% and at 1 66 pro mille 88% These numbers show that clinical signs of alcohol intoxication were found in this material much earlier than in the material investigated by Widmark in his "Die theoretischen Grundlagen und die praktische Verwendbarkeit der gerichtlichmedizinischen Alkoholbestimmung" (Berlin und Wien 1932) Undoubtedly this is due to the fact that the two authors got a great experience and took much time for each patient (In no case was the diagnosis "influenced by alcohol" without a positive finding in the blood) It is interesting, because it demonstrates that there are obvious symptoms rather early, symptoms that are probably not without danger "

Since alcohol is so highly diffusible it was the theoretical expectation that it would show equal concentration values in blood and in urine for comparable periods following ingestion In my own researches at the Carnegie Nutrition Laboratory in 1919 I trusted this assumption at first and used alcohol measures from urine samples for correlation with results in physiological tests after alcohol ingestion A little later in checking up the comparison between comparable urine and blood samples for my subjects I found that the former gave characteristically a higher alcohol concentration value than the latter, in fact almost 50 per cent higher in the period from 40 minutes to 2 hours after ingestion My data published in 1922 (43) were, I believe, the first to show this difference between the alcohol concentration in the two body fluids importantly used by a number of investigators for obtaining measures of the alcohol in the body The difference relationship that I had found was corroborated with larger quantities of alcohol and over a longer period by Southgate and Carter, in 1926, (55), by Bogen in 1927 and

[1] One mgm of absolute alcohol per cubic centimeter of blood which may be stated as 0 1 per cent

for a larger number of subjects but with similar dosages to my own, by Carlson and associates in 1934 (11) The Carlson study presents for 36 subjects the relation between dosage, blood concentration and urine concentration following in general the method I had employed for my study of nine subjects A formula derived by the Carlson group from a combination of their data with those of Southgate and Carter furnishes a useful practical index for predicting the blood alcohol concentration when the urine alcohol concentration has been measured The formula is as follows blood alcohol equals 0 71 times urine alcohol plus 0 01 The equation derived from my data corroborates the Carlson-Southgate-Carter formula for the range in amount of alcohol concentration covered by both It seems justifiable on the basis of the general agreement of investigators to adopt the practical expedient of using urine samples as an index to alcohol blood concentration at least where there is any legal obstruction to taking blood samples For further details and for the methods of determining alcohol content reference may be made to the original papers cited at the end of this article

Undoubtedly it is rather too early confidently to set the "intoxication line" in terms of blood or urine alcohol content As a program of chemical tests (objective examinations) takes shape it will probably exert some influence in the direction of definiteness on the more subjective side of the examination Many writers at present appear to regard anything lower than one milligram of absolute alcohol per cc of blood, corresponding to $\frac{1}{10}$ of 1 per cent, as permissable and as evidence of a non-intoxicated condition. The present writer has held that this is rather too high if we are trying to pick a safety-first value The results of Hindmarsh and Linde mentioned and discussed above in Liljestrand's communication tend to strengthen this rather more conservative definition since one-quarter of their "alcohol-accident" group appeared within the range falling at or below this value ($\frac{1}{10}$ of 1 per cent) and more than half of the cases included who showed more than 0 1 per cent were diagnosed by these investigators as "influenced by alcohol"

The following personal communication from Dr Larsen[1] who has been using the chemical test at Queen's Hospital in Honolulu is of special practical as well as scientific interest

"We have been using the urine alcohol test for a number of years and have a large number of determinations on both clinical as well as outside alcoholic cases Our findings ran fairly parallel with those of Bogen However, we find the chronic alcoholic can have a much higher alcohol test without clinical symptoms than the individual who is not an habitual drinker

In certain urines there are substances non-alcoholic in type, which if they happen to froth over will give a positive reaction that may suggest the presence of two to three milligrams of alcohol when none is present To avoid this oc-

[1] Personal communication dated October 12, 1933

casional false positive we use a trap between the tubes We have never noticed this caution in the literature, but we feel it might be very important

From the automobile standpoint we feel it is important to prove whether a person has been drinking, for we believe firmly it is not the heavy alcoholic who is the greatest danger in a car, but the one who has merely taken a few 'shots' and considers himself cold sober Therefore a 0 5 mgm test will prove that the man's brain was under the influence of alcohol and his judgment not reliable Perhaps this is old history to you, but here where we have had an unusually high rate of fatalities and definite objection on the part of many to accuse the moderate drinker, we have had to stress this side of the argument

Another point we have made is to take into consideration the specific gravity of the urine to show whether large amounts of water had been ingested before the specimen was obtained We recognize, of course, that occasionally we can have a negative test in the face of some symptoms of alcoholism The test, however, has been very useful in shortening the law process Now both lawyers and clients when they know a chemical test can prove whether they have been drinking or not are much more inclined to confess at once This saves a lot of legal bickering

We have not published our results since we felt that as yet we did not have enough new evidence to warrant a new publication "

It is to be hoped that Dr Larsen and all others in this country and abroad will publish their findings as soon as they become available We wish and need to know each other's results, the technical difficulties as well as the successes that have been met, and not least of all the criticisms of method and treatment that stimulate progress

In presenting the present paper it has been my object to introduce the topic of the relation between alcohol and traffic accidents rather than to settle any points or phases with reference to it The subject is a live one Beverage alcohol has legally returned and will probably continue in many states for years to come Benedict (4) has pointed out the fact that in America alcohol is commonly used as an accessory food, that is, between meals more often than is the case in other countries This imbibing on a relatively empty stomach results usually in a stronger toxic effect relative to the amount ingested Furthermore, it is too frequently the youthfully, thoughtless urge for vivid thrilling experience that brings the alcohol and the speed experiences together temporarily Some individuals are sure to try to employ both of the powerful agencies, alcohol and gasoline at the same time An experienced adult under the mild influence of alcohol can usually drive a modern automobile with some success, but no matter what he claims or thinks about it, probably he is, when even mildly intoxicated, more acceptable to society at large in almost any other rôle than that of motor driver To the army of drivers the right to pursue their way unhampered seems inalienable and to preserve this right safely to the majority objective and thorough means of checking infringements of their privilege by the minority need to be more fully developed and then generally employed The chemical test for intoxication in case of accident is one of the most promising of these.

Highway engineers in the United States are quite aware of the fact that during the last 15 years more of our citizens have been killed in automobile accidents than have lost their lives in military action or have died of wounds in all our foreign and domestic wars Our death toll from the automobile at present is approaching 100 lives per day and for injured nearly 2500 Even though at present we cannot state exactly the percentage value of alcohol's contribution to these figures the fact remains that we know this contribution is quite material Alcohol is among the more specific things that can be pointed to as predisposing causes in the accident picture And yet people of all kinds are interested in facts and especially in the relation of facts to their own comfort and safety They do not want accidents and they want accident makers removed or else taught better traffic habits including especially refraining from drinking before or during the operation of motor vehicles They will be sympathetic to new methods of protecting society on the highroads that are both simple and objectively fair.

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DISCUSSION

ON

ALCOHOL AND MOTOR VEHICLE DRIVERS

MR WALTER W MATTHEWS, *Bureau of Highway Patrol and Safety State Revenue Department, Pennsylvania* I would like to call attention to a paper entitled "Medicolegal Aspects of Drunkenness," which was read before the Medical Society of the State of Pennsylvania in 1932 by Dr. H A Heise and Dr Benjamin Halporn of the Municipal Hospital at Uniontown, Pa Dr Heise has been conducting several tests with the assistance of our department directed primarily towards urinalysis as a measure of presence of alcohol in the system and he has reached some very interesting conclusions In Fayette County, Pennsylvania, in 1924 before the chemical test was used, 34 persons accused of drunken driving were found not guilty and 21 were found guilty or pled guilty He says "In 100 recent consecutive cases in which the alcohol in the urine exceeded 0 19 per cent by weight, 87 were found guilty, 6 were pronounced not guilty but paid the costs, and 7 were acquitted"

Incidentally in the conduct of some of these tests we have furnished highway patrolmen to keep certain portions of the highways more or less free of traffic and to assist as observers, and one of the humorous statements in his report is that he acknowledged the services of, and congratulated, those who have offered to drink whiskey for the sake of science I happen to know that what he did was to ask for volunteers Quite a number of drivers volunteered and he kept feeding the whiskey at intervals until he got up to one-third of a pint per person and then the tests stopped abruptly! Perhaps the most interesting conclusion reached is that it is practically impossible to prove definitely alcoholic intoxication from the symptoms alone One of the things that has to be considered is that drivers may evidently be stimulated by some 16 other biological conditions Just as in the observation, the Doctor speaks of, a typist who was unaccustomed to alcohol, drank one ounce of whiskey, and shortly thereafter was able to type more rapidly than before, but made many more mistakes The next day the experiment was repeated and 15 units of insulin were given a half hour before the alcohol was taken The alcohol curves were identical and the subject displayed many of the symptoms of drunkenness and certainly would have been pronounced intoxicated by the average physician The alcohol in the urine, however, did not exceed 0 015

per cent, giving definite evidence of the value of the test in proving that certain symptoms are not due to alcohol

I would like to hear some discussion on the practical side of handling some of these tests from the police point of view One of the difficulties we have in Pennsylvania is in getting doctors to agree to give such tests because of the fact that they will later be tied up for long intervals in court When they get into court they must qualify as experts Their testimony is often broken down by clever attorneys, and you have a condition whereby discrediting the doctor's testimony and that of the witnesses a man may be proven not drunk, and yet it would be perfectly obvious to a high school girl that her escort in a similar condition was pretty "tight" I would like some of the other gentlemen to explain how some of these intricate tests could be put into actual practice in police work, as it seems to be more and more the assumption that we must have a physician's test to prove intoxication

Then we have on the other hand the legal technicalities involved I have in mind a controversy beyween Pennsylvania and New York State We convict a New York driver in Pennsylvania for, as our law says, "driving while under the influence of intoxicating liquor" We suspend his further driving privilege in Pennsylvania We certify that case to New York on the assumption that New York State will take away the New York license Their law reads that he must be convicted of "driving while intoxicated" and their courts have ruled there is a distinction between driving "while under the influence of intoxicating liquor" and driving "while intoxicated"

There we are again, the technicalities involved in attempted scientific tests, combined with loop-holes in the laws present a very interesting problem from the point of view of actual enforcement

PROF R A MOYER, *Iowa State College* What is the extent of the influence of liquor on the ability of the driver? The test I have in mind is a very realistic laboratory drivers test which Dr Lauer of the Psychology Department at Iowa State College has developed and used during the past ten years He has tested a great many drivers, including the Chrysler test course drivers who were demonstrating Chrysler cars at the World's Fair this summer Although the Chrysler drivers were given a high rating, they were not able to get a perfect rating, which indicates the useful range and reliability of his tests

It seems to me that drivers should be tested in normal condition and then, by varying the amounts of alcohol, should be tested at various stages of intoxication By that means some index would be obtained as to the amount of liquor necessary to make the response of the driver such that he would be considered a dangerous driver I am of the opinion that Dr Lauer would be agreeable to carrying out such tests. He has an excellent set up and I am sure that all of us agree

that it is a very important question concerning which we should have as much subjective test data as it is reasonably possible to obtain

DR MILES: I think Professor Moyer's question is a natural one However we know already the effects of alcohol and unless the opportunity is presented to get a prior rating on individuals who are likely to be intoxicated we cannot afford to waste too much time on just repeats although Dr Lauer and I have talked over the problem of setting up and making some tests with his particular outfit A good many investigators have tested different variations in the dosage and have shown the increasing effect with the increasing dosage

There are individual differences of course Habitual users tend to show somewhat higher amounts of alcohol in the blood after given dosages, in some way or other the adaptation of the body is toward an accelerated appearance of alcohol in the blood rather than the opposite In terms of effect on ten people, if the average is 10 per cent you will find about three that will have an effect of 14 to 17 per cent poorer performance, about three that will have from 9 to 12 per cent, three from 4 to 6 per cent, and one fellow who will have practically zero effect, or perhaps score better than normal But too often we have been willing to stress the extreme individual differences and thus give alcohol the benefit of the doubt Of course we know some men who drink and drive and get home all right, by the law of probability there should be some such cases

Some one has said that the superego is that part of the human that is soluble in alcohol Just the rate of the solubility, etc is a big question but there is no doubt about the totality of the effect We know the gravity of the situation and now we are being faced by insurance companies asking for data on which to rewrite the structure of accident rates because they expect a distinct change

CHAIRMAN MARSH I have heard within the last month or so of a proposal to make a test by the amount of alcohol in the air from the lungs Has that ever been investigated thoroughly?

DR MILES: Yes, it was investigated by Dr Liljestrand in Sweden Such a test was devised by Dr Bogan in Cincinnati It is something that no one can particularly object to The person tested blows up a rubber bag that has a capacity of four or five quarts Then this air (contents of the bag) is passed through some chemicals The trouble is there are other volatile substances given off in the breath that may register on these same chemicals The breath test gives some indication but quantitatively is not dependable,—the urine test is more dependable and the blood test is most dependable