PLENARY SESSION 6:
PRACTICAL ASPECTS OF A CHEMICAL TESTING PROGRAMME (2)

Chairman: H. WARD SMITH (Canada)
Secretary: B. M. WRIGHT (U.K.)

UNSETTLED ISSUES AND PRACTICES IN CHEMICAL TESTING FOR ALCOHOL*

by KURT M. DUBOWSKI**

IN THE approximately 100 years since the first tests for alcohol in human body fluids and tissues were developed, most of the physiological and pharmacological and virtually all of the chemical analysis problems pertaining to the determination of alcohol have been thoroughly investigated and largely solved. Consequently, a few somewhat specialized currently unsettled scientific and technical issues, both physiological and chemical, relating to specimens for alcohol analysis, the performance of alcohol determinations, and the interpretation and application of alcohol analysis results are now assuming greater prominence; particularly in the light of the much more refined analytical methods for alcohol determination in breath and other body materials which have become available during the last decade, and which place a premium upon the adequacy of such ancillary techniques as the proper selection, collection, processing, and preservation of specimens. In a few instances, the more refined chemical methods have now revealed existence of a physiological variability apparently not recognized or fully appreciated previously; and in a few other situations the availability of newer practical and highly reliable analytical methods and associated techniques now permits the investigation—and hopefully settlement—of questions and disputes of some years' standing. It is the purpose of this presentation to list some of the more significant unsettled problems and practices in chemical alcohol testing, and briefly to summarize certain of the main points at issue, with no attempt to suggest the answers.

PROBLEMS RELATING TO SPECIMENS FOR ALCOHOL ANALYSIS

Skin Disinfection

With clock-like regularity and a tenacity worthy of greater goals, numerous attacks have been aimed at the suitability of body material specimens for alcohol determination. Among the most vigorously pursued objections, real or imaginary, are those directed at the supposed contamination of blood specimens by improper skin disinfection. Recently, Beeman1 has revived this controversy, claiming without data citation that under ordinary laboratory conditions, skin preparation with ethanol or isopropanol, prior to venipuncture, will occasionally introduce a positive error of as much as 200 mg. ethanol per 100 ml. of blood. Rabinowitch2 has also repeated his prior claims of having found 0-20% W/W or more of alcohol in blood entirely as a result of alcohol used to sterilize the skin. These otherwise unsupported claims have not been confirmed in controlled experimental studies by Heise3 and by Friedemann and Dubowski,4 among others. It seems both possible and desirable to

*This paper did not arrive in time to be read at the conference.
**Ph.D., Dept. of Biochemistry, University of Oklahoma School of Medicine.
settle experimentally, once and for all, whether the admittedly unrecommended use of ethanol or other organic volatile skin disinfectants can cause spuriously elevated alcohol concentrations of the order of magnitude claimed, in the absence of contaminated syringes, and using analytical methods recognized as adequate in other competent hands.

Specimen Treatment and Preservation

With modern methods of refrigeration and suitable specimen preservation and handling, it is now possible to maintain the original ethanol concentration of a blood or other body liquid or tissue specimen unchanged for periods varying from several weeks to years. However, little uniformity is yet reflected in the literature recommendations regarding blood and other body liquid anticoagulants and preservatives, storage temperatures and the effects of various container and closure materials. In the light of recent studies of the stability of alcohol in stored blood specimens by Karger and Sachs, Krauland and associates, and Gehm and Schmid, it should now be possible to agree upon a recommended specimen treatment and storage routine. Such a standard preservation and storage scheme could have the advantage of readily available, accessible, and documented data regarding stability of alcohol in the specimens with time; an issue being raised with increasing frequency in litigation. Stability in the sense used here thus involves not only prevention of losses but also absence of alcohol neoformation.

If preservation of body tissues and liquids has posed problems, these seem relatively minor compared to the present general state of breath alcohol specimen storage and preservation. Harger and associates have briefly reviewed the major trends in collecting and storing of breath samples for alcohol analysis. These include storage of breath in flexible rubber, aluminum, polyethylene, polyvinyl chloride, and Saran bags; and absorption of ethanol from measured samples of breath with anhydrous magnesium perchlorate, anhydrous calcium chloride, silica gel, sulphuric acid, and water. Progress is being made, as shown by the findings of Harger et al. who reported the least alcohol loss, 15% at the end of 20 hours, from flexible aluminium bags, and of Salem and associates who found that an improved Saran breath container showed alcohol losses of less than 7% after 62 hours. Perhaps a review of the current state of this problem and recent experience with the commercially available breath bags would now prove helpful.

PROBLEMS RELATING TO ALCOHOL DETERMINATION

Blood and Body-Liquid Alcohol Analysis

Among the most important reliability characteristics of analytical methods are accuracy, precision, specificity and sensitivity. Of these, specificity is most often singled out as a point of contention in forensic alcohol analysis, and a great deal of effort has consequently been devoted to the achievement of relative specificity, or at least considerable selectivity, for ethyl-alcohol in various alcohol determination procedures. Until the independent publication of practical enzyme determination procedures for ethanol using alcohol dehydrogenase, by Bonnichsen and Theorell and Bücher and Redetzki in 1951, these efforts had only partly succeeded; and the ADH-procedures seemed at first to offer an adequate answer or at least considerably to simplify the attainment of relatively high ethanol selectivity. Subsequent investigation of the ADH-procedures has disclosed that they are subject to possible interference by or influence of a considerable number of non-ethanol compounds of forensic interest most of which are volatile and cannot be separated from ethanol by distillation, diffusion, or aeration, including the higher aliphatic alcohols, certain aldehydes, etc. Further, calibration of the ADH-methods and calculation of results is dependent upon comparison with specimens of known ethanol concentration, which is unfortunate since ethyl-alcohol has proven in some hands to be a less-than-ideal primary analytical standard.

Most analysts would therefore agree that a suitably reliable and practical simple analysis method for ethanol in any biological material has not yet appeared. The potential usefulness of a completely reliable procedure which could serve as a master referee method even at some sacrifice in practicability characteristics (e.g. speed, simplicity, economy, analytical range, etc.) is so apparent that it seems worthwhile to devote additional concerted effort to its design and development. The substantial advances which have been achieved in certain physical analytical methods, notably gas chromatography, appear to offer the greatest hope of early success in this
Breath Alcohol Analysis

The inherent usefulness of breath alcohol analysis and its many practical advantages in both experimental work and certain law enforcement applications have fostered spectacular developments of apparatus and procedures since the first practical portable breath alcohol system was announced by Harger and associates\(^{17}\) in 1938. Developments and refinements of apparatus and associated chemical methods were generally emphasized together with underlying physiological principles, and only secondary attention was at first given to exploration of the nature and extent of many of the physiological variables affecting breath alcohol analysis. With breath alcohol analysis now highly developed instrumentally and in its applications, it seems desirable to re-examine some key physiological concepts and assumptions with respect to their validity and, if indicated, to reinvestigate the factors involved with modern facilities and methods. Of less fundamental significance, but of increasingly greater nuisance value or practical importance are a few remaining problems with respect to necessary scientific safeguards which could probably be readily resolved.

Necessary Scientific Safeguards

Somewhat divergent views have been aired with respect to retention of alcohol in the oral cavity following its ingestion. Though most investigators have advanced the view that a waiting period of 10-15 minutes after the last oral contact with alcohol prior to breath alcohol analysis suffices to eliminate interference from this source,\(^{18}\) one or two recent articles take issue with this view. Lins and Raudonat\(^{19}\) chromatographically analysed 10 ml. breath samples obtained at 1-minute intervals from subjects who had rinsed their mouths with alcohol and several alcoholic beverages, discharging about 200 ml. of mixed expired breath before taking the analysed samples. Subjects with mouth contact with wine, beer or 10% alcohol solution demonstrated zero breath alcohol levels about 10 minutes later, while those with mouth contact with distilled beverages or 40% alcohol solution reached zero levels after 15-18 minutes.

Coldwell and Grant\(^{20}\) subjected persons who had rinsed their mouth with 40% V/V alcohol solution to breath alcohol analysis using the Breathalyzer. In subjects who had engaged in conversation traces of alcohol disappeared in 15-20 minutes, while up to 25 minutes were required when the mouth was kept closed. Since this factor has some bearing on the forensic reliability of breath alcohol analysis,\(^{21}\) it may be well to continue experiments in actual drinking situations using larger subject groups.

Calibration, standardisation and checking of breath alcohol apparatus is generally recognized as a fundamental technique in monitoring the reliability of these instruments. The literature of these procedures is, however, widely scattered, often proprietary, and not entirely satisfactory. In view of the importance of the standardisation step, commonly by equilibration, in both operator training and actual breath alcohol analysis it seems singularly inappropriate for this phase of breath alcohol analysis to have been comparatively neglected. There is now universal agreement regarding the desirability of equilibrator calibration for training and reliability monitoring\(^{10, 21-25}\) and additional developments of practical instrumentation and methodology to render this important analysis phase free of the effects of ambient temperatures and other non-essential variables are indicated.

Scientific Basis of Breath Alcohol Analysis

There is today agreement that the distribution of ethyl-alcohol between blood and alveolar air obeys Henry's Law.\(^{4, 25}\) Since Henry's Law is a temperature-dependent effect, two questions of fact are paramount: (1) What specific temperature governs this distribution and what physiological variables affect this temperature; and (2) What is the numerical value for the Henry's Law partition constant for alcohol between circulating pulmonary blood and alveolar breath at the existing alveolar temperature? For so fundamental a scientific principle, the 1952 statement usually cited as authority for the current breath alcohol methods, that of a Special Sub-committee of the National Safety Council Committee on Tests for Intoxication (now Committee on Alcohol and Drugs), seems strangely equivocal:\(^{26}\)

"... The basic principle governing the operation of the three presently used breath

\(^{\ast}\)I am indebted to Dr. Coldwell for furnishing me with a prepublication copy of this manuscript.
alcohol methods (the Drunkometer, the Intoximeter and Alcometer) is the constant ratio existing between the concentration of alcohol in the alveolar air and the blood. Available information indicates that this alveolar air-blood ratio is approximately 1 : 2100. . . .” (Emphasis supplied.)

If there is indeed a constant ratio, exactly what is the value? Does it apply to all persons under all conditions, both external and internal? At what temperature is the “approximately” 1 : 2100 ratio believed to apply, and where and how constantly and consistently does that temperature exist in the body or the breath specimen? Harger and associates10 in confirming the constancy of the distribution of alcohol between alveolar air and blood at a ratio of 1 : 2100 report that this ratio also holds for rebreathed air : blood alcohol, and further state that “breath leaves the mouth at a temperature of about 34°. . . .” Harger also makes the following remarks regarding the Blood/Alveolar Air Alcohol Ratio:25

“The gas in the lung alveoli attains equilibrium with the pulmonary blood as regards alcohol, CO₂, acetone, and volatile anesthetics. Alveolar air leaves the mouth at a temperature of about 34°C. In such samples the alveolar air/blood alcohol ratio is close to 1:2100 . . .”

Yet, Borkenstein and Smith27 have recently stated:

“. . . In this situation, equilibrium for a volatile substance such as alcohol will be attained rapidly and the concentrations will be those expected from Henry’s Law. Since the temperature of the body is practically constant, the equilibrium is predictable.

“. . . While there are practical difficulties in the measurement of this relationship, recent work confirms studies made in 1930 that 2,100 ml. of alveolar air contains the same amount of alcohol as 1 ml. of blood when the air is measured at 31°C. This relationship is verified by the results obtained since 1938, using equipment calibrated on this basis.” (Emphasis supplied.)

Not only do these investigators hold the 1 : 2100 ratio to apply to alveolar air measured at 31°C. in comparison with blood from an unspecified site; but serious objections exist to the assumptions that body temperature is both constant in a given individual and uniform for all persons.28 It seems likely that the true alveolar air/blood alcohol ratio at the diffusion site is not 1 : 2100 and that this latter figure more probably represents the alcohol partition ratio between an alveolar breath sample, at the moment of exhalation at the mouth, and blood from some unspecified site. Thus, the well-known 1 : 2100 figure is apparently not the Henry's Law constant at a fixed body temperature for the physiological alveolar diffusion site, but an empirically derived conversion figure for two somewhat arbitrarily selected samples. Since the temperature of exhaled air is obviously more subject to external influences than deep body temperature, it would be well to establish independently and authoritatively what the actual Henry’s law partition ratios for alcohol between alveolar air and pulmonary circulating blood are at the existing range of body temperatures at the diffusion site. Next, the constancy of such ratios in individuals should be investigated under various conditions of rest and activity, health and disease, nutritional and respiratory cycles and similar internal variables, as well as under the influence of external variables such as ambient temperature, humidity, etc. Finally, it seems necessary to perform appropriate population studies to examine the applicability of the population averages to single individuals. With these basic data in hand, corrections can then be applied to the situation modified by breath exit temperature variations and similar factors to the extent and magnitude warranted by the practical applications of the breath alcohol methods. Lest these considerations be thought meritless, it may be well to point out that each 1°C. increase in actual alveolar breath exit temperature between 34°C. and 37°C. would tend to increase a blood alcohol concentration calculated on the basis of an assumed 1 : 2100 ratio by about 6-5% over the actual level.29, 30

With so much emphasis currently being accorded the role of alveolar air in breath alcohol analysis, two additional questions arise: (1) Do present instrumental sampling methods, such as those employed in the Breathalyzer27 and the Photo-Electric Intoximeter,24 actually collect and analyse true alveolar breath; (2) Are breath alcohol determination procedures not employing alveolar air or its effective equivalent (e.g. rebreathed air) thereby outdated? Current instrumental methods for breath alcohol determination by means of the Alcometer, the Breathalyzer and the Photo-Electric Intoximeter actually operate upon breath specimens collected as the terminal portion
of a prolonged expiration. Are these terminal expiration portions in fact alveolar air, or identical to alveolar air with respect to alcohol concentration? The answer does not appear to have been provided to date; yet the instrument calibrations are based upon the Henry's Law relationship claimed to apply to alveolar air. Greenberg has been a persistent critic of breath alcohol methods employing mixed expired air, and has particularly condemned reliance upon the assumption that a single constant carbon dioxide content of alveolar air exists under all conditions and in all individuals, and that the proportion of alveolar air in a mixed expired breath sample can be accurately estimated by using such an assumed constant ratio. The original Drunkometer and the portable Intoximeter relied upon the gravimetric determination of carbon dioxide from mixed expired breath samples for quantitative estimation of blood alcohol levels from breath analysis. More recently, Harger and associates have modified the Drunkometer procedure for analysis of the alcohol content of rebreathed air, and have reported that "for estimating blood alcohol level, the rebreathed air method is definitely an improvement over our earlier Drunkometer methods". The existing breath alcohol methods employing an assumed constant alveolar breath carbon dioxide content do not employ the same carbon dioxide weight as the equivalent of 1 ml. of blood, and this 21-year-old discrepancy reinforces the question regarding the present tenability of those methods employing mixed expired breath samples.

**Blood/Breath Alcohol Correlations**

Traditionally, blood alcohol analysis results have been considered the best chemical evidence of alcoholic influence in living subjects, and other procedures including breath alcohol analyses have been compared with the results of analyses of blood specimens presumably obtained under corresponding conditions. In most early correlation studies and some recent investigations of the relation of simultaneous blood and breath alcohol analysis results, unfortunately little, if any, attention seems to have been paid to the importance of the blood source in such studies. Harger has thoroughly discussed the effect of blood source and timing choice upon the alcohol levels and has noted that studies with drinking subject showed a tendency for the alcohol level of venous blood to lag behind that of capillary blood for about an hour after the last ingestion of alcohol; and that capillary blood from a skin puncture has essentially the same alcohol level as arterial blood. Since much credence is given in some quarters to blood/breath alcohol correlation studies as an index of the reliability of breath alcohol methods and procedures, published results need to be reviewed in the light of these findings, which would explain a tendency for breath alcohol- derived blood alcohol levels to be significantly higher than the results of direct analyses on simultaneously obtained venous blood specimens, during a period extending up to an hour after the end of drinking.

In such controlled investigations, considerable care is also required in the selection and application of a suitable blood alcohol referee method, in order to exclude systematic or random errors attributable to the blood alcohol method from creating discrepancies falsely attributed to deficiencies in breath alcohol analysis.

**PROBLEMS IN THE INTERPRETATION AND APPLICATION OF ALCOHOL ANALYSIS RESULTS**

**Blood Source Problems**

The vast majority of blood alcohol analyses are carried out to obtain information about the sobriety or alcoholic influence state of the subjects examined. Correlation studies of influence states with blood alcohol levels have led to the universal acceptance of blood alcohol concentrations as the prime index of alcoholic influence. It is consequently highly important that interpretation of blood alcohol concentrations not be subject to unrecognized or uncontrolled artifacts arising from the selection of inappropriate blood specimens. Of primary importance in this connection is the fact that the alcohol level is identical in all parts of the vascular system only after alcohol storage equilibrium has been reached, and not during active absorption. Since the arterial circulation is in early alcohol equilibrium with the brain, which is not true for venous blood, conclusions regarding the existence and degree of alcoholic influence of a subject should only be based upon the results of arterial blood alcohol analyses or their alcohol concentration equivalent at the
time the specimens are obtained (capillary blood or breath appropriately converted to blood equivalent) until alcohol distribution equilibrium has occurred in the vascular system.

It follows that during the absorptive phase, good correlations of breath alcohol analysis results can only be expected with the results of blood alcohol determinations performed on arterial or capillary, but not venous, blood specimens. Future experimental programmes should be designed accordingly; and past studies re-evaluated. Reports of blood alcohol studies should include data identifying the blood source and sampling time with relation to completeness of alcohol absorption and distribution.

Blood Alcohol Clearance Phenomena

In other than experimental situations, one is rarely interested primarily in the alcohol concentration of a blood or other specimen at the sampling time. These data are rather used for calculation of the existing blood alcohol level at another time, most commonly prior to sampling. Extrapolation and other back-calculations are therefore of considerable significance. Unfortunately, our present knowledge of the metabolism of alcohol and the blood alcohol clearance process is imperfect in many respects.

Dubowski has discussed the problems in estimating the probable blood alcohol level at a prior material time from the results of one or two subsequent body material alcohol determinations. The major problems include: (a) The difficulty in determining the subject’s stage of alcohol absorption-distribution-elimination at the time of sampling; and (b) lack of information about the subject’s blood alcohol clearance rate. Numerous recent studies, some which are briefly reviewed by Harger and Forney, confirm the extreme variability of the hourly blood alcohol clearance rate (Widmark’s $\beta_{60}$ factor), with most investigations disclosing significant numbers of individual clearance rates which exceeded or trailed the averages by factors of 2 to 4, and some extremes differing by factors of 8. It is clear that statistical population averages cannot form the basis for accurate and, in law enforcement work, fair extrapolations and back-calculations. It remains to be seen whether Bayly and McCallum were truly prophetic in stating that “an accurate assessment cannot be made of the blood alcohol concentration in an individual at some time prior to the taking of a blood sample”.

Back-calculation of pre-existing blood alcohol levels also requires knowledge of the shape and configuration of the subject’s blood alcohol curve (particularly during the declining phase in the post-absorptive state), and of the possible variables affecting it. In the alcohol concentration range of usual forensic interest, the blood alcohol level in the post-absorptive phase after single alcohol doses initially declines approximately rectilinearly with time over periods of several hours. Most of the earlier experimental work on this problem was performed using venous blood obtained by venipuncture which tended to limit the frequency of alcohol determinations and consequently produced relatively smooth curves apparently declining at a single constant rate throughout the entire period of alcohol disappearance. Moreover, single dose alcohol loading has generally been used experimentally, which does not correspond to the usual drinking situation. Elbel and Schleyer have illustrated the possible errors in such retrograde extrapolations by actual examples in subjects receiving divided alcohol doses. In one of their wine-drinking subjects back-calculation over one hour yielded a calculated 0.043% blood alcohol level compared to the actual 0.065%; in a second subject a one-hour back-calculation yielded a 0.078% blood alcohol level compared to the actual 0.124% existing concentration. The spiking nature of typical blood alcohol concentration curves during the declining phase is well illustrated by the recent work of Shumate and associates, who found mean hourly blood alcohol elimination rates varying from 0.0119% to 0.0207% in six subjects, and repeatedly noted instability of the blood alcohol decrease curve during the first hours after ingestion of alcohol was completed. Fig. 1, from this study by Shumate and associates, illustrates four typical blood alcohol clearance curves obtained on four separate days in a two-week period by monitoring the breath alcohol level of a female subject at five-minute intervals, using the Breathalyzer, following the ingestion of 1.5 ml. of 100 proof alcohol per pound of body weight at a rate of about 50 ml. in 25 minutes. The fluctuations in the blood alcohol clearance

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*1 am indebted to Messrs. Shumate, Crowther and Zarafshan for furnishing me with a prepublication copy of this manuscript.

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curves are obvious; as are the potential errors in a back-calculation attempted from Point A (85 minutes) or Point B (195 minutes), even when using the subject's own average blood alcohol elimination rate.

Diabetic subjects under otherwise identical conditions. Coldwell and Grant have experimentally studied the disappearance of alcohol from the blood of 18 diabetic subjects, whose diabetes was drug con-

![4 DAYS IN A 2-WEEK PERIOD](image)

Fig. 1. Blood ethyl-alcohol levels of an experimental subject following ingestion of 1.5 ml. of 100 proof ethyl-alcohol per pound body weight. Tests 1–4. (From Shumate et al.)

Clearly, individual variations in blood alcohol clearance can create substantial and often unpredictable aberrations from the population-derived "typical" mean elimination pattern, and can thus vitiate attempts reliably to estimate pre-existing blood alcohol concentrations from the results of subsequent body material alcohol analyses.

Alcohol Metabolism in Diabetic Subjects

Recently, Blotner reported that when a dose of 0.6 ml. of absolute alcohol per kilogram of body weight was given to fasting normal and diabetic subjects without acetonuria, the blood and urine alcohol concentrations in the diabetic subjects rose appreciably higher than in the non-diabetic subjects. He postulated that diabetic subjects possibly could not metabolize alcohol as rapidly as normal persons, leading to a greater accumulation in the blood and a higher concentration in the urine. A figure included in Blotner's article, however, illustrates a blood alcohol clearance rate of approximately 0.015% per hour in his diabetic subjects, compared with a blood alcohol clearance rate of approximately 0.008% per hour in his "normal" subjects. These data appear inconsistent with slower metabolism of alcohol by trolled. The blood/urine ratios and the rate of alcohol disappearance from the venous blood of these diabetic subjects were found similar to those of non-diabetic persons. The experimental findings do not appear to support the hypothesis of altered alcohol metabolism in subjects with drug-controlled diabetes. It would be of interest to extend these investigations to diabetic subjects in uncontrolled diabetic states, using specific methods for alcohol analysis, such as gas chromatography.

Nomenclature of Alcohol Concentration Reports

It is somewhat astonishing to find unnecessary sources of difficulty in a field already amply supplied with genuine occasions for scientific disagreement and dispute. One such source of difficulty is a lack of uniformity in the methods of expressing body tissue and fluid alcohol concentrations. In Europe, body material alcohol concentrations have usually been reported using the term "promille (°/00)", meaning parts of alcohol per thousand parts of containing material; while in North America it has been customary to

*I am indebted to Dr. Coldwell for furnishing me with a prepublication copy of this manuscript.
employ the units milligrams of ethanol per 100 ml. (mg./100 ml.) of containing material, per cent by weight, per cent by volume, and per cent weight/volume. Friedemann and Dubowskii have pointed out the practical difficulties inherent in this diversity of concentration units, and particularly the possibilities for misinterpretation of the unspecified "per cent" form. The difficulties created by the attempt to interpret alcohol concentrations reported in per cent weight/volume in terms of legal standards expressed in weight/weight percentage are probably more semantic than actual. However, such confusion is unnecessary and can be readily eliminated by the simple expedient of properly specifying the units of concentration employed for alcohol and the containing biological or other substance. This particularly means that the term "per cent" should always be further qualified by the phrases "by weight", "by volume", or "by weight/volume". Appropriate interpretation can then follow.

"Normal" Body Alcohol

Periodically during the past hundred years, articles have appeared examining whether ethyl-alcohol is a normal body substance. Before the advent of highly alcohol-specific analytical methods, most of the so-called "normal" body alcohol found represented the responses of relatively unsophisticated dichromate procedures to the volatile trace substances found in distillates from biological materials. The subsequent demonstration of the presence of ethanol traces in animal and human tissues from abstaining subjects failed to establish the endogenous origin of the isolated ethanol which was, more probably, artificially produced in the tissue distillation process. Harger and Goss concluded after a detailed experimental study that the apparent endogenous alcohol demonstrated by analysis of biological materials, using a dichromate method, was an artifact and not pre-formed ethanol. Later findings of investigators employing alcohol dehydrogenase methods for alcohol determination have been reviewed by Harger and Forney; all studies demonstrated considerably less than 1 mg./100 ml. of blood. McManus and associates found higher levels of alcohol they believed to be of endogenous origin in rat tissues and human liver, by analysing (using an alcohol dehydrogenase method) the distillate obtained by lyophilizing homogenized tissue and water mixtures. They reported endogenous alcohol in a concentration of 6-7 mg./100 g. of human liver. Lester reviewed much of the published work and concluded that endogenously formed ethanol occurs in humans and other mammals, probably at a level of about 2-3 mg./100 ml. in serum. In subsequent experimental work employing gas chromatography, Lester found 0.05-0.15 mg./100 ml. blood alcohol in 19 non-alcoholic subjects, but concluded that whether this alcohol was a normal body constituent of endogenous origin remained unresolved.

It seems safe to conclude from the currently published studies that "normal" body alcohol, if any, is of no consequence with respect to interpretation of toxicologically significant alcohol levels. It seems timely to settle the controversial question of whether endogenously produced ethyl-alcohol exists in all or some human subjects and modern methodology should make the indicated studies feasible and practical.

REFERENCES

References (cont.)


36 Harger, R. N., and Forney, R. B. "Aliphatic Alcohols", Chapter in Advances in Toxicology, (ed. A. Stolman), to be published.


41 Coldwell, B. B., and Grant, G. L., "The Rate of Disappearance of Alcohol from the Blood of Diabetics", to be published.


