

## Letters to the Editor

### **Quality Assurance—Considerations in the Expression of Professional Evaluations from Examinations\***

Dear Sir:

After 26 years in the capacity of Crime Laboratory Director, I now find myself in the role of a Forensic Science Consultant, assisting lawyers to understand the physical evidence involved in their cases in both criminal and civil cases.

This work invariably leads to a review of reports followed by a study of case notes and in many instances a reexamination of the physical evidence.

I have no information on the extent that the points that I am about to discuss occur outside my country, but I believe that it is time to address the subject and open the door to future discussion.

It was only after I began to review and study the work of other laboratories that I gained an insight into the extent of a lack of a standard of practice which exists in crime laboratory operations. It has been a revelation to find that misleading statements of evaluation to prosecutors and triers of fact are frequently made from a given set of experimental findings.

Guidelines in this subject for criminalists in various stages of development are not available in texts and it behooves those with experience backgrounds to contribute to the state of the art whenever possible. It is in this spirit that these considerations are discussed. In the capacity of an independent consultant, one is in a position to review physical evidence examination results from a broad base of crime laboratory sources. The scope of variation in the form and method of expression of evaluations is surprising and in some instances dismaying.

Before discussing some actual cases, as a preface to further discussion let me lay a foundation of conceptual approach to the delivery of laboratory evaluations to the user of laboratory services.

The question of common individual source is a central theme of forensic science work as practiced in criminalistics laboratories whenever the identification of the suspect with the crime is needed by the user of crime laboratory resources. In this aspect of the work, the word "identification" could very well be substituted for *forensic science* or for *criminalistics*, and "blood identification tests" could be substituted for *forensic blood tests*, or "firearms identification examination" for *forensic firearms examination*, and so forth. In other words, "forensic" and "criminalistic" are adjectives which have as much identification import as they have import of the science-law connection, perhaps more. The application of an evaluation process to a problem which terminates in legal procedure makes it no more or less of an exacting process than application to the solution of any other analytical problem involving identification.

The forensic scientist should never be confused to the extent that he thinks that he should be determining guilt or innocence. Such a question should not enter into his thinking processes. His job is ever to evaluate the effect of examination processes on the question of identification.

In criminal law investigations, the crux of identification work is that it must stand the test of "reasonable doubt." Independent of any doctrines in law, this is what the precept of identification is all about anyway. On a basis of scientific logic, two things are either identified with a same source or they are excluded. The middle ground of being incapable of being decided or settled is in fact "indeterminate."

In civil litigation there is a doctrine of "preponderance of evidence" which the trier of fact must apply. However, this does not change the fundamental concept of identification which the scientist must use. The bases for "identification," "exclusion," or "indeterminate" apply

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equally to applications whether they be in industry, criminal law, civil law, or in any other field of logic.

Despite these fundamentals, in official reports from crime laboratories one frequently sees evaluations from examinations couched in various expressions of probability in favor of either an identification or an exclusion, some of which are contradictory within themselves. For example, here are some actual excerpts from crime laboratory reports that I have reviewed recently.

*Case 1—Document Case*

“While it is not possible to conclusively identify the defendant as the author of the faces of the two checks, it is probable that he did author the faces and maker signatures.”

*Comment*

If the examination was not determinate, the examiner could have told the submitter why. (In this case it was because of lack of exemplars. The examiner could have suggested additional “due course” exemplars as a possible route to a conclusive outcome.) If the result is not determinate, the probable authorship statement is contradictory on a basis of examination.

*Case 2—Fired Bullet—Homicide Case*

“The fatal bullets and test bullets lack sufficient striae to constitute a positive identification; however, it is the examiner’s opinion that they were probably fired from the same gun.”

*Comment*

How can the examiner emit such a contradictory statement? How is a “positive” identification different from any other identification, unless one thinks that there are “unpositive” identifications, which the report seems to indicate. There is no rational justification for a “probable” identification from examination in such a circumstance.

*Case 2-A—Fired Cartridge Case—Double Homicide*

“The extractor marks on the four fired cartridge cases have class characteristics and some individual characteristics similar to the extractor marks on the unfired cartridge. However, insufficient correspondence in the individual characteristics of the extractor marks precludes positive identification. The extractor marks on the four fired cartridge cases and the unfired cartridge were probably made by the same extractor.”

*Comment*

In this case, we again see the examiner arriving at a conclusion of indeterminacy yet reporting contrariwise.

*Case 3—Blood Tests—Homicide*

“The blood test results were not conclusive which means that the stains at the crime scene could have come from the defendant.”

*Comment*

This statement is typically the most misleading type of stated conclusion. When an indeterminate result imputes any weight to either an identification or an exclusion, the trier of fact can be misled to the point of error. If a statement were made that "blood stain tests were not made" this also would mean that the stains at the crime scene could have come from the defendant and doesn't such a statement have just as much meaning as Case 3? In other words, the testing procedure has added no determinative value to the original question. At least the examiner could have said "might or might not have come from the defendant." The correct report obviously should have been "indeterminate" without further qualification. Even in the event of a battery of sophisticated blood group tests in which the frequency distributions in the population might be discussed, it is appropriate to report the final evaluation as indeterminate if there is neither an exclusion nor an identification.

*Case 4—Hair Evidence—Rape Case*

"Human hair on the rape victim's dress was different from that of the victim and indistinguishable from hair samples from the defendant."

*Comment*

Indistinguishable? In what respect? A review of examination notes shows that ten independent similarities were as follows:

*Tips*—cut; *Color*—light brown/blond range;  
*Length*—3<sup>3</sup>/<sub>4</sub> to 4<sup>1</sup>/<sub>2</sub> in. range; *Root*—normal;  
*Diameter*—medium; *Cuticle Thickness*—medium;  
*Pigment*—small; *Medulla, Dark or Light*—both;  
*Bleached*—no; *Damaged*—no.

A reexamination of the hairs by an independent hair microscopist showed that of the criteria examined, the characteristics of color and medulla were the only two that had any possibility of exclusion or identification potential. The hairs had such wide variations in these characteristics that neither identification nor exclusion of the suspect was possible. Yet, the wording that they were "macroscopically and microscopically similar" erroneously conveyed to the prosecutor the conclusion that the suspect was therefore connected to the incident by the hair evidence. An equally irresponsible but true statement could have been that the hairs are determined to be dissimilar, and this could be the result of comparing opposite ends of the range of variations. However, the correct report should have been that the examination was indeterminate because of the wide range of variations in both sets of hair and the commonness of this type of hair in the population.

Reports of findings of hair examinations are probably more abused than those concerning any other type of physical evidence because of the range of variations of two sample sets and the failure of the examiner to take this into account along with the local frequency distribution.

This brief sampling of crime laboratory report conclusions to submitters gives an idea of the lack of consideration being given to the evaluation of test results in the output of some crime laboratories. If a determination cannot be reached by the technology used, the evidentiary effect is sometimes the same as if the examinations were not made, unless further investigation can be stimulated in order to provide samples for additional attempts at a determinative outcome.

Some criminalists obviously avoid the evaluation of results, preferring to state observations without comment on their meaning and without consideration of the consequential impact upon the overall investigation which is involved. This approach in itself in my opinion is irresponsible. Is it not the objective of the forensic scientist or professional level criminalist to provide not just the observational data, but more importantly the overall evaluation rationale? This is what distinguishes the professional from the technician. The title of criminalist or forensic scientist appearing under a signature on a report of identification that contains test results with no evaluative information is like having a fruit tree that bears no fruit. In other words, the omission of an evaluation is the failure to accomplish the mission.

The responsibility for finalized crime laboratory reports that are meaningful to the user and that at the same time avoid the possibility of misinterpretation by giving more significance than is deserved lies squarely on the shoulders of the person in charge of the management of that facility. The manager or director should design a system of review of all outgoing reports and evaluations so that facts of examination are neither understated nor overstated, and that all test results are documented so that they can be reproduced and demonstrated upon reexamination. The reviewer should be able to reconcile report conclusions with examination notes so as to be certain that:

- (1) all determinations in the report are documented in work notes;
- (2) all experimental findings of significance in work notes are included in the report;
- (3) identification problems are resolved in terms of: (a) identified, (b) excluded, or (c) indeterminate;
- (4) when the common source principle is involved, the indeterminate results are expressed so as to avoid unjustifiable weighting; and
- (5) language to be avoided without complete evaluation and explanation of the basis includes: (a) indistinguishable, (b) identified as this source or one just like it, (c) cannot be differentiated, (d) are the same, (e) are just like each other, (f) are probably from the same source, (g) in the opinion of this examiner are from the same source, and (h) in the opinion of this examiner are not from the same source.

To avoid ambiguity, all identifications and exclusions should contain a supporting statement consisting of the basis for the conclusion, no matter how brief.

A fired cartridge case examination, for example, can have a supporting statement as brief as:

The identification is based upon a classical comparison microscopic examination which demonstrates matching imprints of tool marks of the breech block upon both evidence and test fired cartridge cases.

In a shoe print identification:

The identification is based upon a photographic transparency overlay comparison in which wear and tear defects unique to the evidence shoe match exactly with counterpart defects in the submitted shoeprint.

In a typewriter problem:

The identification is based upon several typeface characters which are deformed and serifs which do not print in the exemplar material. The same defects appear in the questioned typing.

If notes of examination are properly made, the determinations of fact are then easily traceable to the notes, which then enable the reconstruction and demonstration of proof at a later time with a clearly defined basis.

I leave you with the following cliché:

*"AN EVALUATION FROM THE LABORATORY AND CONSEQUENTLY AN  
OPINION FROM THE WITNESS BOX IS ONLY AS GOOD AS THE FACTS  
UPON WHICH IT IS BASED."*

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### **Laboratory Management: Preliminary Analysis of Narcotics Evidence\***

Dear Sir:

Probably the biggest challenge facing the crime laboratory director in the mid 1980s is the management of scarce resources. Modern crime laboratories are impaled on the horns of a classical dilemma: tax revolts at the beginning of the decade seriously eroded local governments' revenue sources making it more difficult to fund adequately police forensic science laboratories; at the same time, there has been a public outcry for greater and more effective law enforcement. The public's demand for more police often results in more officers put onto the streets with the accompanying larger number of arrests and more cases submitted to the laboratory. The laboratory manager is thus required to do more with less.

Two years ago, the Los Angeles County Sheriff's Crime Laboratory was faced with a large backlog of cases. With mounting concerns voiced by judges, prosecutors, the press, and public interest groups, we began to look at many of our operating procedures and policies that we had long assumed to be inviolate. The specific area that I am going to discuss concerns drug analyses, that is, how much laboratory testing is actually needed in the early stages of a judicial proceeding. The concept behind the Preliminary Testing Program developed as a result of a meeting we had with several members of the Municipal Court Presiding Judges Association. The judges were concerned about matters of case management, that is, expeditiously moving cases through the judicial system. Criminal cases requiring a laboratory analysis to prove a key element of the crime cannot move forward if the crime laboratory is slow in getting out cases. Such delays create bottlenecks in the litigation of criminal cases. Two years ago the laboratory was the focus of the problem; there were more cases coming into the laboratory than it was possible to analyze in a timely manner given the existing laboratory staff.

At this point it is useful to describe how a case proceeds through the justice system in California. California is one of several states utilizing preliminary hearings. Preliminary hearings differ from grand jury proceedings in that a complaint is the initial charging document rather than an "indictment." If there is sufficient evidence presented at a preliminary hearing, then an "information" document is prepared charging the defendant of a crime without the intervention of a grand jury. States using a grand jury system use an "indictment" as opposed to an "information."

Case law in California has held that "evidence that will justify a prosecution need not be sufficient to support a conviction." Simply stated, the burden of proof at the preliminary hearing is not the same as at the trial. As a matter of fact, the burden of proof that the prosecution must prove at the preliminary hearing is a "strong suspicion" instead of "beyond a reasonable doubt" needed at the trial.

Armed with these facts, we proposed a cut in the level of testing conducted by the laboratory in narcotics cases. Over the years we evolved to the level of testing now used in the laboratory

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for narcotics analyses. Changes in technology as well as the nature of the controlled substances encountered caused testing changes. Personnel assigned to the laboratory's narcotics section are often newer and thus less experienced and tend to rely on sophisticated scientific instrumentation. All of these factors resulted in more detailed and comprehensive analyzes compared with those used 10 or 15 years ago.

Our first challenge was to define what constituted a "preliminary analysis." Using the legal definition of the burden of proof required at the preliminary hearing, we attempted to reach a consensus among the laboratory staff. The question posed was, "How much testing would you have to do to form the opinion that the material in question was probably a controlled substance?" By "probably" I mean greater than 50% likelihood or meeting the burden of proof of "more likely than not." It became obvious that uniform testing procedures were impractical. Each case required different amounts of testing for the analyst to form an opinion because of differences in the purity and adulterants in the seizure. Analysts were encouraged to decide for themselves what constituted a "preliminary test." In general, preliminary tests consist of standard color spot tests plus microcrystalline tests. Instrumental analyses are generally not used.

Convincing the technical staff of the necessity and viability of the preliminary testing program was one challenge. Convincing others in the criminal justice system: police, prosecutors, defense attorneys, and judges, was the real difficulty. Communication and coordination of effort are the only means by which such a program can ever become fully implemented.

Our decision to go forward with this program was based on our belief that only a very small percentage of the thousands of narcotics cases annually submitted to the laboratory ever go all the way through the felony trial stage of the justice system. Many narcotics defendants are diverted or never get beyond the preliminary hearing stage for a variety of reasons. Thus the laboratory is committing significant personnel resources to prove an element of a narcotics violation beyond a reasonable doubt and to a scientific certainty when, for a preliminary hearing, far less certainty is needed. Those personnel working on narcotics cases could be reassigned into other areas of the laboratory requiring more personnel.

We initiated the program in one judicial district on a pilot basis. Prosecutors were concerned about two issues. First, they expected that defense attorneys would no longer stipulate to the analysis. Next, there was the matter of performing a "final analysis" when one was needed. We expected and did see a sharp increase in the number of court appearances we made as a result of the new program. However, we felt that eventually this would decrease as defense attorneys found that judges would hold defendants to answer based on a preliminary analysis.

The need for final analyses is a problem. Presently we are experimenting with alternative ways of retrieving evidence for final analyses at the three judicial districts now part of the pilot program. At one court narcotics evidence is not admitted and remains in the custody of the investigating agency. This saves considerable effort on the part of the prosecutor but places a large burden on the police who must store the evidence and keep track of its progress through the criminal justice system.

In two other judicial districts the evidence is admitted and is under the control of the municipal court clerk. If the case is disposed of, the court clerk is responsible for arranging for the destruction of the evidence. When the defendant is held to answer and "bound over to superior court," the evidence comes under the control of the superior court clerk. The prosecutor handling the case in superior court must determine if the defendant requires a final analysis of the evidence. If so, the prosecutor must make arrangements to release the evidence from the custody of the clerk and request the laboratory to pick up, conduct a final analysis, and return the evidence to the clerk in a timely fashion. This procedure has yet to be fully tested to determine if it will work. It does however get police officers out of the evidence storage business.

In conclusion, the Preliminary Testing Program offers the laboratory the possibility of conducting fewer tests on narcotics seizures and, hence, allows the laboratory staff to be more productive while not adversely impacting the work product of the laboratory. Still to be deter-

mined is the long-range impact on court appearances and a more efficient means of returning evidence to the laboratory when final analyses are needed.

While this program may not be applicable for all jurisdictions, it is worth considering as an innovative way of managing scarce laboratory personnel resources.

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### **Marijuana Testing and Litigation**

Dear Sir:

Urine tests for marijuana metabolites (cannabinoids) became generally available in 1980 to 1981. At the present time millions of these tests are being performed annually. The availability of relatively simple and inexpensive immunoassays, which allow for the screening of large numbers of specimens, made such testing popular. It is not known whether the number of such tests exceeds the number of tests for alcohol but tests for other drugs of abuse are performed much less frequently. The urines of job applicants, drug abusers, athletes, prisoners, parolees, probationers, workers, members of the armed services, and others are tested. Rarely are top management and administrative people who must be mentally alert and make critical decisions tested or known to be tested. The tests may be employed at random, when there is suspicion of drug use, or following some incident. The person may appear normal, may be suspected of being impaired, or may be impaired. In most instances the person is free of any symptoms which could be related to marijuana use. The reasons for such testing do not appear to be based upon any scientific reports of significant deterioration of performance in individuals who have been exposed to marijuana.

Most laws do not prohibit the use of the drug but do prohibit the sale, transfer, and possession. Some people consider the presence of the drug in the body as possession. There is no question that the possession of the drug in the crude or refined state is a crime. The punishment for this crime varies greatly from place to place. In most instances possession is not given as the reason for urine testing. The extent of the marijuana problem is unknown but use of the drug appears to be very widespread. It is not known whether a significant number of users are significantly impaired at any time, or how long any possible impairment lasts.

The objective of the marijuana testing may be to establish that the person has used (ingested) the drug in the past, or to establish that the person has used marijuana while at work or before work and that performance is or was adversely affected while working.

The identification of cannabinoids in blood, saliva, or urine in sufficient quantity should establish the first premise, that the person has used the drug. Cannabinoids will be detectable in the first voided urine and in urines voided from days to weeks after use of the drug. Cannabinoids are detectable in blood specimens collected during the first minute of smoking, and in saliva specimens collected immediately following or while smoking. Positive findings in blood and saliva persist for hours depending on the sensitivity of the testing method. A method for the collection and analysis of saliva on Q-tips has been reported [1]. In addition to other problems with the method, the small and unmeasurable sample size of about 0.2 mL makes quantitation and confirmation very questionable.

Scientific evidence, which would serve as a basis for an expert to give an opinion as to when the person used the drug or that they are or were impaired at some time, based on the results of the analysis of any specimen, does not appear to be available and has not been found in the literature. There is no evidence that a "chronic heavy user," which has been defined as a per-

son who smokes one marijuana cigarette daily, will have a detectable impairment 8 or 10 h or less after smoking. This smoker will probably have significant quantities of tetrahydrocannabinol carboxylic acid (THC-COOH) in his blood and urine and detectable quantities of tetrahydrocannabinol (THC) in his blood at all times.

Impairment caused by marijuana use alone by the average subject is at best very subtle, is not identifiable by expert observation, is probably not significant beyond 2 h after smoking, and is not correlatable with cannabinoid concentrations. Studies relating unsafe performance with cannabinoid concentrations in the body have not been found in the scientific literature.

It appears that it is not presently possible to attribute scientifically any impairment to the finding of cannabinoids in any specimen. Since any signs and symptoms of impairment could be due to other drugs or causes, the only evidence to support a positive test would be an admission, the witnessing of use, or the circumstantial evidence of the availability or possession of a marijuana product. Attempts to avoid the issue of proving impairment by marijuana have been made by arbitrarily assigning "per se" concentrations of THC and THC-COOH in blood and in turn agreeing to various sanctions on those whose blood or serum exceeds such concentrations. The finding of very low concentrations of THC such as less than 5 ng/mL in blood or serum is questionable because of the uncertainty of the identification and of quantitation at such low concentrations. If 5 ng/mL is found in serum then about 2 ng/mL should be found in whole blood.

In a passive inhalation study serum THC concentrations of about 2 ng/mL were found by radioimmunoassay (RIA) and 4 ng/mL by gas chromatography/mass spectrometry (GC/MS) [2]. Serum THC concentrations of 2 to 8 ng/mL were found by GC/MS and THC-COOH concentrations of 27 to 93 ng/mL were found using RIA despite the fact that the subjects were instructed to refrain from marijuana use for at least 48 h before testing [3]. Another study reported that "blanks" ranged from 0 to 5.5 ng/mL in serum using RIA and zero time serum concentrations were 0 to 22 ng/mL using RIA. "Blanks" were serums which contained no THC [4]. Another study reported average concentrations of 3.1 and 3.7 ng/mL of THC were found in serums by RIA 6 h after 1.3, 2.0, and 2.5% THC cigarettes were smoked [5]. Another study reported 3.4 ng/mL of THC and 8.9 to 109 ng/mL of THC-COOH in serums by GC/MS, 12 h after smoking.<sup>1</sup> We found serum concentrations of 0.5 to 4.8 ng/mL of THC 9 h after two 1% THC cigarettes were smoked 2 h apart. It was not until very recently that it was realized that such concentrations persist and that subjects will have to be monitored and blood obtained for such a long time after using the drug in order to document fully concentration-time profiles and behavior.

"Arbitrary" concentrations have not been established based upon scientific reports of impairment, but more upon concentrations found in a few reports with a few subjects. Unfortunately such reports are very rare and apply to very limited use of marijuana. THC-COOH, a metabolite of THC which has no psychoactivity, should be found along with THC and almost always in greater concentrations than those of THC. Although there is no way of relating THC-COOH concentrations to THC concentrations or to past or present impairment, finding it lends some weight to the certainty of the identification when the THC concentrations are low. A review of the pharmacology of the drug and effects interpretations has been reported [6].

### *Analytical Methods*

The adequacy of various analytical methods used to identify and quantitate the cannabinoids is questionable. There is a consensus in the forensic science community that immunoassays which are excellent for screening specimens are not adequate enough identification of cannabinoids when the results are to be used in adversarial proceedings or for instituting sanctions [7,8]. Alleged "confirmation" of immunoassays by gas chromatography (GC), high performance liquid chromatography (HPLC), or thin-layer chromatography (TLC) add weight to

<sup>1</sup>M. A. Peat, personal communication.



the positive immunoassays but there is not agreement among forensic toxicologists that any one of these methods are to be considered adequate enough for confirmation [9]. Combinations of the above methods [10] or, in some instances, laboratory personnel with a high level of competence can add weight to the adequacy of the confirmation.

A properly performed and interpreted gas chromatographic-mass spectrometric method of analysis should serve as adequate identification of THC and THC-COOH. A properly documented GC/MS method allows an independent expert to confirm that the GC separation has the proper retention times, that the proper mass ions of the right relative intensities are reported, and that the full spectral display is free of confusing interferences. The cost of such a confirmation is and should be much greater than the cost of the other methods. Since there are no certified methods, laboratories, or personnel, those offering such analyses should be prepared to offer adequate evidence of their competency, the validity of their methods, and to state whether they can offer proof that their findings can be related to the time of use of the drug and any possible impairment. Since there are very few laboratories where complete and adequate analyses can be performed, the screening tests are usually performed at less sophisticated laboratories. For this reason and because confirmatory tests are complex several people might be involved in the chain of custody which must be firmly established. Most analysts who perform the tests may not be accustomed to presenting proof of their qualifications and the validity of their work at adversarial proceedings. Most attorneys are not scientifically trained or knowledgeable enough to appreciate the complexities of trying such cases. Both sides in such proceedings need to consult experts acquainted with the analyses and possible interpretations of the test results.

Whether the confirmation of any test is adequate enough depends in part as to how the results are to be used. For some purposes a single test screening procedure might be sufficient. In adversarial matters, when the results are to be entered as evidence, the adequacy depends on the standards applied in evaluating the sufficiency of evidence needed to satisfy the due process clause. Some courts have held under the "scintilla rule" that the case is legally sufficient if there is even a scintilla of relevant evidence on each element of the charged offense. Other courts have applied the "substantial evidence rule" and that is that the evidence is adequate to support fairly or rationally a permissive inference or conclusion. A more recent decision is that the evidence must have sufficient cumulative probative value to persuade a rational trier of fact of the existence of each element of the offense beyond a reasonable doubt [11]. It appears that expert witnesses will have to give their documentable opinions of how much weight can be placed on the identification and quantitation procedures used and if the results obtained can be related to the time of drug use and if and when there was any impairment.

### *Interpretation of Findings*

Interpretation of the meaning of the drug and metabolite concentrations is very difficult. There are several reasons for this. The time interval from a reported incident until obtaining specimens is usually a few hours. The time interval from possible use to obtaining the specimens is almost always greater than a few hours. The concentration of THC in blood peaks while the person is still smoking marijuana and drops very rapidly at first so that in about an hour the THC concentration is about 10 to 15% of the peak concentration. At 2 h, the concentration of THC will be about 5% of that of the peak and then will decline very slowly. There is great variability between the concentrations obtained with different subjects smoking identical cigarettes in the same way. There is no scientific basis for calculating from THC or THC-COOH concentrations back to what they would have been several hours in the past. Concentrations of 1 to 5 ng/mL of THC in serums and 10 to over 100 ng/mL of THC-COOH have been reported up to 12 h or more after smoking [2]<sup>1</sup> and also within 30 to 90 min after smoking [12]. To offer an opinion of any past impairment based upon back calculations is scientifically indefensible.

It has not been demonstrated that marijuana use has a significant adverse effect on motor vehicle operation. The occurrence of cannabinoids in the bloods of dead motor vehicle operators has been reported. Blood specimens in the following studies also contained alcohol 57 to 85% of the time. Blood THC concentrations of 5 ng/mL or more were found in 1 dead driver of 401 drivers [13], in 3 of 600 [14] whose blood contained no alcohol, and in 23 dead drivers of 440 where alcohol was found in 81% of the 440 [15]. These three studies do not indicate that marijuana in the absence of alcohol or another drug could be responsible for a significant number of motor vehicle fatalities. The National Safety Council accepted a "Statement on Drugs and Driving" from the Committee on Alcohol and Other Drugs which is as follows:

In most states, it is unlawful to drive while impaired by drugs. The concentration of a drug in a blood specimen can be used as evidence of impairment. Therefore, it is recommended that if analytical results are to be used as legal evidence, that: 1. Both the analyst and the method of analysis be approved by the appropriate state agency. 2. Interpretation of the results be made by knowledgeable qualified scientists [16].

### *Litigation*

Civil litigations which takes about three to four years to reach the trial stage are just beginning to appear. The reasons for litigation are many. In most cases, the chain of custody, proper specimen identification, and methods of analysis are matters which are contested. The terms of any contract between employees and employers are very important. Phrases such as, "under the influence of drugs, narcotic drugs, controlled substances," and "free of the harmful effects of drugs" certainly raise important issues. In most instances, no evidence of impairment is offered and thus the total evidence is the alleged presence of the drug in a body fluid. The question of jurisdiction also arises. Jurisdiction refers to the use of a drug either while on duty, or less clearly, use before reporting to work and being adversely influenced by some presumed continued action of the drug. In some occupations and in the armed services, claims are made that personnel must always be free of drugs because they can be called to perform at anytime. This leads to attempts to back calculate concentrations and then to relate the estimated concentrations with impairment which at best is most unscientific. Some personnel are asked to sign a statement that they have never used drugs. Is there such a person?

For forensic science purposes specimens should be properly taken, stored, be identifiable throughout testing, and properly preserved for the defendant should he desire to have the specimen retested. Specimens which are screened by using an immunoassay and found positive should be confirmed by fully spectral GC/MS. The procedures used should have been validated and controlled, and adequate documentation should be available to the defense expert. The analysts should be available to testify what was done and what the results were. For someone else to do so could be ruled as hearsay [17]. The results should be evaluated by experts familiar with marijuana analyses and with interpreting the meaning of cannabinoid concentrations. If only marijuana use is to be established, the proper analysis of urine might be adequate enough. If time of use and any possibility of impairment are issues then blood or serum determinations are essential. At the present time, concentrations of THC in blood less than 5 ng/mL and in serum less than 10 ng/mL should be viewed with caution for several reasons. No service laboratories have offered documentation of their ability to identify and quantitate properly such low concentrations. Whatever impairment is claimed, it probably occurs at higher concentrations and it is impossible to calculate what a prior concentration would have been with any scientific certainty. Obviously "probable cause" and other evidence might bolster a less rigorous identification and quantitation.

### *Court Decisions*

A driver of a jeep which overturned and killed a passenger was convicted in circuit court of reckless conduct. The appellate court held that: where there was no evidence supporting an in-

ference that consumption of alcohol and use of *Cannabis* in any way affected ability of the defendant that trial court should not have admitted evidence of nominal consumption of alcohol and *Cannabis*. The state failed to prove that the defendant was intoxicated or that his faculties were impaired or to present evidence of heavy drinking. No evidence of excessive speed was introduced [18].

A driver of a school bus was charged with driving under the influence of intoxicating drugs, to wit: marijuana. Chemical tests(?) indicated that the defendant had been using marijuana. He was operating a school bus in excess of the speed limit, causing the bus to skid almost sideways. Defendant "was talking out of his head," "acting lightheaded," "driving wild as usual," "his eyes were dilated and bloodshot," and was stated to be aggressive. Denied [19].

Employees were discharged for using a narcotic drug, methadone, which they were receiving in methadone maintenance treatment for heroin addiction. Employees argued that their discharges were violations of their civil rights and the Equal Protection Clause of the 14th Amendment. The Transit Authority Rule which was allegedly violated was: "Employees must not use, or have in their possession, narcotics, tranquilizers, drugs of the amphetamine group or barbiturate derivatives or paraphernalia used to administer narcotics or barbiturate derivatives, except with the written permission of the Medical Director-Chief Surgeon of the System." Methadone is an "opiate" and thus falls within the definition of a "narcotic drug." The appeal court ruling in favor of the employees was reversed by the U.S. Supreme Court [20].

Defendants had not established standards for the taking of blood and urine specimens from correctional employees for drug analyses. The court issued a restraining and injunctive order [21].

Court entered a temporary restraining order against the use of unconfirmed enzyme multiple immunoassay technique (EMIT®) drug detection system on prison inmates [22].

Another case involved the revocation of probation for the use of marijuana based upon a positive immunoassay. The technician admitted to having no understanding of the scientific theory underlying the immunoassay. The technician's conclusion that the instrument could detect THC in a urine specimen was said to be hearsay [23].

### *Military Court Decisions*

"The fact that courts-martial have no jurisdiction over nonsoldiers, whatever their offense, does not necessarily imply that they have unlimited jurisdiction over soldiers, regardless of the offense charged" [24].

Finally we deal with peacetime offenses, not with authority stemming from the war power. Civil courts were open. The offenses were committed within our territorial limits, not in the occupied zone of a foreign country. The offense did not involve any question of flouting of military authority, the security of a military post, or the integrity of military property [25].

The conviction of a serviceman by courts-martial for unlawful use of marijuana was reversed and remanded. The serviceman was in civilian attire and properly absent from post at the time of use of 5.9 g of marijuana, an amount which indicated only a casual connection with the drug. Serviceman's alleged use of marijuana did not satisfy constitutional requirement for service connection and courts-martial was without jurisdiction [26].

Enlisted marines were charged with possession and sale of controlled substances where all offenses took place off base while accused were off duty and in civilian clothing and undercover agent to whom accused allegedly sold controlled substances was also in civilian clothes, though he did not represent his status and it could be inferred that one or more of accused understood that the undercover agent was a member of the armed forces. Accused could not constitutionally be tried for the offenses by courts-martial. Relief granted [27].

Accused was convicted by special court-martial of selling, off base, LSD and marijuana to a fellow serviceman for that serviceman to take back to his base for use and sale and that the accused's conduct was "service connected." Conviction was affirmed. Note 28 stated, "It would

not appear that use of marijuana by a serviceman on a lengthy period of leave away from the military community would have such an effect on the military as to warrant the invocation of a claim of special military interest and significance adequate to support court-martial under O'Callahan" [28]. Should the military be required to show that the off-base use of marijuana adversely affects the on-base performance of a serviceperson?

Off-base use of a drug by a serviceman will be service connected if he enters a military installation while subject to any physiological or psychological effects of the drug. This was a petition before trial and did not prejudice further appeal after trial. "Moreover in a trial Murray will enjoy the safeguard that, in order to convict him, the Government must convince the trier of fact beyond a reasonable doubt that his use of marijuana was service-discrediting or to the prejudice of good order and discipline." It appears that it will have to be proven that the subject was affected by the drug while on duty [29].

### *Labor Decisions*

The Federal Rehabilitation Act of 1973 states as follows:

#### 29 USC 794

No otherwise qualified handicapped individual in the United States, as defined in section 706(7) of this title, shall, solely by reason of his handicap, be excluded from the participation in, denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal Financial Assistance. . . .

#### 29 USC 706(7)(B)

Subject to the second sentence of this subparagraph the term "handicapped individual" means, for the purposes of subchapters IV and V of this chapter, any person who (1) has a physical or mental impairment which substantially limits one or more such person's major life activities, (2) has a record of such impairment, or (3) is regarded as having such an impairment. For purposes of section 793 and 794 of this title as such sections relate to employment, such term does not include any individual who is an alcoholic or drug abuser whose current use of alcohol or drugs prevents such individual from performing the duties of the job in question or whose employment, by reason of such current alcohol or drug use, would constitute a direct threat to property or safety of others.

The outcome of labor arbitrations have depended on the interpretations of the labor contracts. The use of urine testing by a bus company has produced mixed results. Two employees were granted reinstatement as long as they came up negative on another urine test for drugs. The arbitrator based his decision on three factors: the illegality of marijuana, the lack of a better test which would show impairment, and the unknown effects of chronic marijuana use [30]. In a later case where the policy stated, "The use of narcotics, marijuana, hallucinogenic substance, or habit-forming drugs is prohibited at all times," the employee was reinstated despite the fact that his urine tested positive three times by EMIT. The arbitrator decided that there is a necessity of showing that such criminal activity is in some way job related and that the company prove that the worker was under the influence of cocaine and marijuana when on the job [31]. In another case, the arbitrator decided that the scientific evidence "must be free of question and be able to pass all scientific scrutiny." He was not convinced that "confirmed" urine tests satisfied this standard. Further he concluded that the previous use of marijuana, which does not interfere with performance of duties, cannot be deemed an act which "per se" should be understood as a basis for discharge [32]. It remains to be seen whether blood or saliva tests will lead to the same conclusions. It appears that the burden of proof will fall upon those who claim that blood cannabinoid concentrations can be related to impairment which affects job performance.

Except for what is known about alcohol and its effects, less information than is available for marijuana is available concerning the validity of identification, quantitation, and the possible impairing effects of most other drugs. Some drugs which are more likely to cause impairment are: barbiturates, other hypnotic sedatives, opiates (heroin, morphine, codeine, and so forth),

propoxyphene, PCP, LSD, diphenhydramine, methapyrilene, and many others. Some that are probably less likely to cause impairment are: caffeine, nicotine, phenylpropanolamine, cocaine, amphetamines, lidocaine, diazepam (Valium®), other benzodiazepines, amitriptyline, other antidepressants, phenytoin, other anticonvulsants, the phenothiazines, insulin, and many others.

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### Electrophoresis in Forensic Sciences

Sir:

I have been following with interest the lively debate between Juricek and Sensabaugh [1]. As a practical forensic biologist I heartily agree with Dr. Sensabaugh's comments and feel that additional statements made by Juricek [2] should be challenged.

The use of controls in any crucial testing of course is axiomatic and Dr. Juricek's continued reference to recommendations regarding lack of controls [3] is misleading for a number of reasons. Firstly, Culliford refers to results obtained with the common variants of PGM only. Secondly, reference is made to rare variants and reference samples, and finally his opinion expressed in the publication is of course investigated by forensic scientists who will make their own decisions.

The same criticisms can be levelled at Juricek's comments regarding fluoride as the recommended preservative. As far as I am concerned this is utter nonsense; I can find no reference to this and if anything fluoride is to be avoided as an additive to whole blood. The whole point raised is totally irrelevant anyway because even if fluoride were the anticoagulant/preservative that *had* to be used, dried blood stains are usually reconstituted with distilled water or diluted buffer.

The matter of alteration of enzyme mobility under certain conditions has been investigated for each enzyme polymorphism in use. If the particular conditions do not alter the enzyme separation then there is no drama or hysteria—if however they do then such changes have been reported along with signals that changes have occurred and possibly ways to reverse the effects of the adverse conditions.

A number of conditions can lead to loss of enzyme activity and, as long as the criteria for interpretation are adhered to, these can and usually do lead to an increase in inconclusive results.

Crucial tests generally are repeated where possible, however, paucity of material may prevent this. Results are usually interpreted by at least two experienced analysts and, as most laboratories use some sort of coding system within their organization, the samples are read in a blind manner.

Dr. Juricek is obviously extremely naive in her assessment of crime lab reports. These are not submitted in a leisurely manner to impress a group of referees as to the ingenuity of the author and its suitability for publication in a learned journal. The report is to summarize in lay terms what (if anything) has been found by the analyst and the significance (if any) of such findings.

This approach could explain why statistical analysis of blood grouping results can be included in reports. The analyst would be derelict in his duty and impartiality if such information were omitted. In the absence of such information the jury might assume that "blood of the same types as the deceased" is in fact the deceased's blood.

Ideally, the statistics should be compiled from the blood samples processed by each laboratory, however it is quite obvious that no matter how the statistics are obtained there will always be some academic scientists prepared to criticize the population examined. This phenomenon could be termed Newton's Forensic Law—for every opinion there is an equal and opposite.

The matter of photographs must be examined in a scientific manner and I shall attempt to be constructive.

Photography of electrophoretograms of ideal samples *may* be reliable for the purposes of leisurely scientific appraisal, however, I know of no such proven testing of samples of varying activities as does occur in forensic samples. A single photograph of such a separation could not adequately cover the range of such activity with the sensitivity of the human eye.

Photography does not necessarily represent the true picture and can lead to artifacts. Such photographs can be faked (by the operator) or deliberately misinterpreted (by the independent verifier).

In the courtroom context reference would have to be made to record books in order to identify the samples in question and in addition the analyst could be examined on his photographic qualifications.

The whole situation can be seen to be a farce where interpretation of data from a leisurely examination by an isolated observer (of unknown relevant experience) of a photograph (of untested quality) of the analysis of a sample (of assumed identity) with an unknown history performed by an operator (of unknown competence, reliability, and impartiality) is accepted by the court.

It is very easy to be critical of the practical scientist from the lofty heights of academia and I would suggest the only truly scientific way of testing the crime lab work is to retain relevant material where possible, at ultra-low temperatures so that any independent scientist can actually analyze the material personally. This has the advantage that the independent verifier has as complete a knowledge as possible of the sample and also such an expert can be vigorously tested in court as to his competence, experience, and so forth. Perhaps this approach will go a long way to silencing the ill-informed and perhaps educating such people as to the difficult conditions under which the forensic scientist works. Not for him the leisurely pace of research, attendance at many scientific meetings, but the ever present deadline and harassment in court.

In conclusion, I must endorse Dr. Sensabaugh's comments [1] in his final paragraph.

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## Request for Information

Dear Sir:

Our paper, presented at the 1985 Annual Meeting, outlined several methods for determining, with varying degrees of specificity whether or not a sudden death had been caused by electrical shock. One idea shows considerable promise in the case of alleged low voltage electrocutions, where no marks are found on the cadaver.

Tests on CPK and LDH enzymatic activities in the pericardial fluids of cadavers under 48 h old have established that postmortem differentiation of myocardial infarction from other causes of death may be possible. Significant differences were found in total CPK and MB-CPK

activity in pericardial fluid, between myocardial infarction and other causes of death such as pneumonia, pulmonary embolism, mechanical asphyxia, cranio-cerebral trauma, and acute hemorrhage [1,2].

To complement this finding, following elective DC cardioversion in patients with atrial fibrillation or atrial flutter but without evidence of acute cardiac ischemia, no substantial changes in CPK or LDH cardiac isoenzyme activities were observed in the serum [3,4].

Combining these two results, one may visualize the possibility of reduced uncertainties in resolving many disputes concerning the causes of death in the presence of electrical apparatus. In particular, one can postulate that elevated levels of pericardial MB-CPK may serve as a specific negative indicator of the occurrence of death due to electrical shock as opposed to primary myocardial infarction. However, extensive field data must first be assembled and analyzed statistically before it may be possible to utilize the study of enzyme levels for this purpose with any degree of confidence.

Readers are encouraged to employ the quantitative methods outlined in the references where electricity appears to be one of the possible causes of death, and to forward their results for accumulation and statistical analysis to the undersigned. Both pericardial fluid and serum test data are important for establishing the statistical validity of the methodology. Field data may not possess the same elegance and consistency as clinically generated data because of the varying conditions under which they are obtained. The nature of electrical equipment that was or may have been involved should be reported to the extent known. Accidents at all voltages are of interest, since impedance considerations may give a high voltage shock the appearance of a low voltage contact. We welcome correspondence and inquiries concerning this methodology.

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