Common Legal Challenges and Responses in Forensic Breath Alcohol Determination

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ABSTRACT: No other single criminal/civil offense connects the forensic science community together with the legal community more than driving while under the influence of alcohol (DUI). Statutory changes along with political pressure have caused DUI to be a very serious and expensive offense. The result has been an enormous increase in DUI defense challenges in recent years with the primary focus on breath alcohol measurement. This paper addresses several of the more common DUI defense challenges regarding breath alcohol analysis, along with suggested responses. Common DUI defense challenges include: uncertainty in breath alcohol results near statutory limits; interfering substances; storage of alcohol simulator solutions; simulator thermometer uncertainties; instrument repair history; Widmark computations; instrument software; program records; pre-exhalation observation time period; and concurrence between the officer's report and breath alcohol results. Most of these issues are addressed with the prudent construction of administrative rules and employing a forensically sound breath test protocol.

KEY WORDS: Breath alcohol, DUI defense challenges, quality control.

INTRODUCTION

During 2000, over 1.4 million arrests occurred for driving while under the influence (DUI) in the United States. This exceeded the number of arrests for most other individual felonies including murder, rape, robbery, aggravated assault, burglary, larceny-theft, auto theft, arson, and other assaults [12]. No other crime or civil proceeding impacts such a broad spectrum of society as does DUI. Although DUI may be a criminal offense or an infraction, depending on the jurisdiction, the focus here will be on the criminal context, where more significant defense challenges commonly occur. In response to increasing epidemiological evidence and political pressure, most jurisdictions continue to increase the penalties for a DUI conviction in order to address this significant public safety problem. In addition, many jurisdictions have revised their criminal and administrative statutes regarding DUI, which has added complexity to the issues. Revisions to "implied consent" statutes along with defining the offense as having a "per se breath alcohol concentration" have resulted in relying principally on breath alcohol evidence in many jurisdictions. Since an individual's property and often livelihood are impacted by a DUI conviction, people are willing to incur significant expense for their defense. No other single offense brings the forensic science profession into contact with the legal system more than DUI.

The criminal defense community, therefore, has responded with a variety of challenges to this increasingly complex and specialized area of litigation. DUI defense is a highly specialized law practice today. These challenges have been directed primarily toward forensic breath alcohol analysis because over 90% of DUI cases involve breath alcohol evidence. As breath-test programs have advanced with regard to technology, protocols, biological and epidemiological research, data analysis, etc., the defense issues have expanded, becoming more sophisticated and focused. In view of per se legislation, breath alcohol evidence is persuasive and compelling. Therefore, the defense is often directed toward pretrial suppression hearings in an effort to preclude the "trier of the facts" (e.g., judge, jury, hearing officer, etc.) from hearing the evidence. Many firms specializing in DUI defense have learned well the technology and mounted a host of technical and creative challenges (e.g., circuitry voltage values, causes of error records, susceptibility to radio frequencies, clock accuracy, error record percentages, etc.). Forensic personnel in Washington State, where over 40,000 persons were arrested for DUI and administered breath alcohol tests during 2002, encounter many of these challenges. Moreover, the defense community in Washington State has become technically educated and well networked in their efforts to scrutinize all program aspects including:

- Administrative rules;
- Program policy/protocol manuals;
- Maintenance records;
- Technical instrument features;
- Training outlines and records;
- Phone call and e-mail records;
- Prior court testimony, etc.

The purpose here is to present several of the most common defense challenges encountered with the presentation of forensic breath alcohol evidence in DUI cases. Although all of these challenges have been experienced in the State of Washington, most have also been encountered in other jurisdictions. Given the efficient network within the defense community, all of these issues are expected to eventually appear in all jurisdictions. Knowledge of these issues should assist other jurisdictions in program development, rule adoption, training, and case preparation. Since jurisdictions differ with regard to legislation, case law, instrumentation, protocols, administrative rules, resources, program policies, etc., several of the defense challenges experienced in one area may have little impact elsewhere. However, knowledge of challenges in one jurisdiction may assist in preparation elsewhere in an effort to minimize the impact. Finally, limited space allows for only a small number of the multitude of challenges to be discussed.

I. THE ADVERSARIAL CONTEXT

Responding to legal challenge is clearly a significant responsibility for forensic toxicologists. A significant proportion of their time may be spent on legal matters including:

- Pretrial discussion with prosecutors or defense attorneys;
- Providing pretrial discovery material;
- Case preparation; and
- Testimony.

For example, the forensic toxicologists in the Washington State Toxicology Laboratory, who prepare alcohol-water simulator solutions, spend approximately 80% of their court preparation time in regard to breath test cases and only 20% regarding blood or drug cases.

Forensic toxicology is among the "mandated sciences" where science finds itself applied in response to public policy and directives. Our scientific knowledge, however, is incomplete, our technology is limited, and our evidence is subject to interpretation. Challenge, therefore, is to be expected [32]. Indeed, our constitutional framework outlines an adversarial legal system, a crucible of challenge and controversy from which, arguably, truth emerges. Unlike that of the forensic scientist, the role of the defense is not to be objective or to advance scientific understanding, but to be an advocate. Moreover, this is often how we are made aware of weaknesses within our breath test programs. Every forensically sound program can be improved and is often facilitated by legal challenge. Part of the objectivity and professionalism of science is to consider and weigh the criticisms raised by persons holding different views. Indeed, part of our professional responsibility is to ensure and demonstrate that the evidence we present is fit-for-purpose (e.g., suitable and relevant for its intended application).

II. COMMON LEGAL CHALLENGES

A. Uncertainty in Measurement Results Near Critical Limits

Per se legislation, prohibiting the operation of a motor vehicle by a person having a specified breath alcohol concentration (e.g., 0.08 g/210 L or more), has prompted defense focus on the measurement process, the analytical results and their uncertainty. Part of the defense strategy is to assert that breath alcohol results just above the prohibited limit could likely have been obtained from a subject, who in reality, had a true breath alcohol concentration below the limit. The argument is that excessive random or systematic error resulted in an aberrantly high result. Moreover, this argument will apply to all prohibited concentrations (e.g., 0.02 g/210 L for minors, 0.04 g/210 L for commercial motor vehicle operators, and 0.15 g/210 L for enhanced penalties).

Measurement uncertainty near the critical limits is a fair and relevant argument. Breath alcohol analysis results, like all measurements, possess uncertainty. Forensic scientists must be prepared to acknowledge this and compute appropriate estimates. **Figure 1** illustrates this issue by showing different hypothetical uncertainty intervals (A and B) that can arise in different measurement contexts for the same sample mean (0.088 g/210 L). This could be applied to any critical concentration. The question is, which uncertainty interval is correct for a particular case? Clearly, this would be relevant for the court to know. The defense would like to argue that B is correct while the prosecution would prefer to argue for A. The forensic scientist must be prepared to compute these intervals (e.g., a confidence interval quantifying the uncertainty) based on estimates appropriate for their instrumentation and protocols. Duplicate breath analyses along with control measurements from a properly maintained program will provide reliable data for these calculations. Clearly, at some mean BrAC, the lower 95%, 99%, or other selected confidence interval limit will fall below the critical level. This reality of measurement must be acknowledged. The approach taken by some European jurisdictions is to perform this calculation and then offer the evidence in the prosecution only if the lower 99% confidence interval limit exceeds the statutory limit.

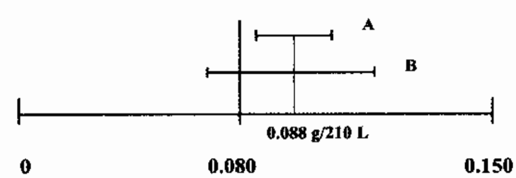

Figure 1. Breath alcohol concentration (g/210 L)

Preparation prior to trial is very important on this issue. The forensic scientist must have the relevant information and perform the computations before trial. These must also be disclosed to attorneys for both sides prior to trial so that all are aware of the computations along with their assumptions and limitations. Often, these results become the basis for a plea bargain or other agreed arrangement prior to trial.

B. Biased Results Due to the Presence of an Interfering Substance

As early as 1927, Bogen recognized that acetone and other volatile organic compounds (VOC) were potential interfering substances in the potassium dichromate oxidation of breath alcohol [1]. Except for the application of multiple filters, modern infrared instruments suffer from the same lack of specificity for ethanol. Not only is the endogenous production of acetone from diabetes or extreme fasting a potential argument, but the widespread potential for occupational exposure to VOCs in industry has also resulted in defense challenges. Moreover, the arguments have extended to gasoline exposure [6], fuel additives [2], aerosol inhalers [19], and even the VOC present in normal human breath [28]. Even though highly improbable for biasing a breath alcohol measurement, the implication that subjects may have some other VOCs in their breaths presents a defense challenge requiring a response. Mostly, due to statutory construction and case law, this issue goes to the weight rather than admissibility.

Depending on the specific facts of the case, there are several approaches that the prosecution can take in response to this challenge. If the subject is diabetic or fasting, then some evidence of medical diagnosis should be solicited. In these cases the prosecution may be able, through the forensic witness, to introduce some of the voluminous literature showing the extremely small probability that endogenous acetone will bias a breath alcohol measurement [9,13,25,26]. If the subject experienced occupational exposure, then the critical information to obtain includes:

- Duration of exposure;
- Environment of exposure;
- Use of respiratory protective equipment;
- Materials exposed to;
- Time between last exposure and breath alcohol test; and
- Observations of the arresting officer.

The forensic witness should also be able to introduce some of the literature relating to occupational exposure [16–18]. In addition, some of the literature relates to specific breath test instruments [3,7,29]. The observations of the arresting officer are important in this regard. They may reveal that the individual had organic material on the clothing, contributing to the VOC being inhaled just prior to breath sampling. Depending on statutory construction, the subject may be deemed incapable of providing a breath sample and allow for the request of a blood sample under implied consent. Moreover, many VOCs do not yield normal breath alcohol exhalation curves as expected by the instrument during sample acquisition. In addition to several other defense arguments, the response to this issue can be enhanced through implementing a sound breath test protocol including:

- 15-minute minimum pre-exhalation observation time;
- Using only approved instruments;
- Trained operators;
- External wet-bath simulator or dry gas controls; and
- Duplicate breath samples with acceptable agreement [8].

One final possibility, depending on the facts of the case and agreement of all parties, is for the subject to be offered a reduced charge in exchange for the provision of breath samples following normal occupational exposure to the VOC. Such an experiment can be arranged for more than one occasion and has the potential to greatly advance our forensic understanding of potential interferences in measuring breath alcohol.

Several analytical approaches to this issue have also been advanced. Most infrared instruments employ multiple filters to improve the selectivity for ethanol. One instrument, the Alcotest 7110 (Drager Safety: Durango, CO), employs dual technology (infrared and electrochemical), which also improves selectivity for ethanol since electrochemical technology is less susceptible to VOC. If the subject was administered a roadside pre-arrest test using an electrochemical (fuel cell) device, the results can be compared to the subsequent evidential device and supplemented with appropriate expert testimony. Finally, the forensic scientist can determine the amount of vapor acetone necessary to produce a 0.01 g/210 L ethanol equivalent on the particular instrument and compare this to the biomedical literature on expected levels resulting from specific medical conditions.

C. Storage of Alcohol Simulator Solutions in Plastic Containers

Simulator solutions in Washington State, like most jurisdictions, are stored in both 500-mL and 1-gal polyethylene (plastic) bottles. The solutions are labeled with a batch number and date of preparation. By administrative rules, they are not used beyond one year thereafter. Through the testimony of an expert witness, the defense may argue that volatile solutions such as alcohol must be stored only in glass containers at 4 ^{0}C.

An effective response to this issue begins with a clearly written program policy regarding the preparation, storage, distribution, and use of simulator solutions. The policy should include:

- Preparation protocol;
- Testing protocol by an independent method (e.g., gas chromatography);
- Record documentation;
- Sealing, storage, labeling and shelf life;
- Installation protocol;
- Qualified personnel, etc.

When these predefined and approved procedures are complied with, the admissibility of the evidence should follow with various arguments going to the weight of the evidence.

Evidence regarding the storage stability in plastic containers can be obtained where solutions stored in plastic bottles for varying periods of time are reanalyzed and compared to the original results. **Figure 2** illustrates such results where the change between the first and subsequent analysis by gas chromatography is shown as a function of time. Figure 2 represents solutions stored both in 500-mL and 1-gal plastic containers. While including solutions stored over time periods ranging from 4 to 53 months, the mean decrease was 0.0007 g/100 mL with a 95% confidence interval including zero. In addition, sequential plots of simulator results on specific breath test instruments using solutions stored over several months can also reveal analytical stability. This evidence should demonstrate that for alcohol concentrations contained in simulator solutions, the loss occurring through polyethylene is immeasurable over reasonable time periods. In addition, the suitability of storing simulator solutions in

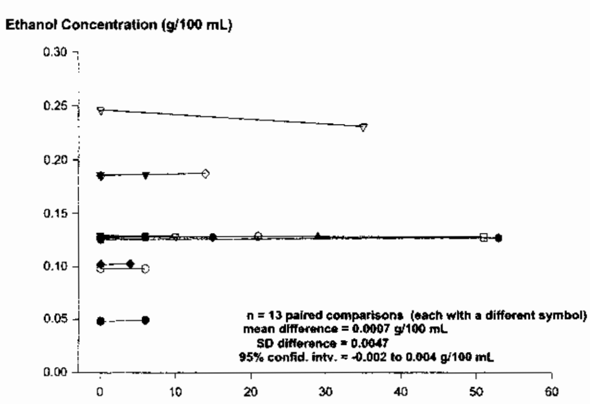

Figure 2. Reanalysis of solutions stored in plastic bottles for varying periods of time.

polyethylene containers was recently verified in a study evaluating the change occurring over a one-year period [10]. The requirement to store volatiles in glass, therefore, may be appropriate for trace analysis, but is unnecessary for alcohol simulator solutions. Moreover, program personnel should be prepared to provide solution samples to the defense team for their independent analysis. In addition to advancing our forensic knowledge, objective measurement data are often the best way to evaluate the substance of some of these challenges. Finally, it can be argued that storage of simulator solutions in polyethylene plastic is "customary to the discipline", of which the court should also be made aware.

D. Simulator Thermometer Accuracy and Traceability

The temperature of simulator solutions is critical to ensure the appropriate application of Henry's Law. Where the administrative rules require specific temperatures, the uncertainty in temperature measurements becomes a basis for legal challenge. As with all analytical instruments, thermometer measurements have uncertainty. Moreover, their uncertainty does not necessarily directly affect a breath alcohol result. The issue is technical compliance with a foundational evidential requirement. In addition, there are several spin-off issues including:

- Position of immersion lines relative to the solution on partial-immersion mercury thermometers;
- Definition of traceability;
- Acceptable protocols to establish traceability to the National Institutes of Standards and Technology (NIST) reference materials or standards;
- Admissibility of certification records from out-of-state labs that are not "regular business record exceptions to the hearsay rule", etc.

Challenges can also arise where the forensic protocols for establishing traceability do not conform to those recommended by NIST [31,34].

Again, responding to this issue begins with a sound protocol for the periodic testing and documentation of simulator thermometers using a traceable reference thermometer. Moreover, these protocols should be part of policy/laboratory manuals and not within the administrative rules that govern evidence admissibility. The policy should include:

- A clear definition of traceability to be applied within the program;
- Thermometer testing protocol;
- Testing interval;
- Accuracy required;
- Documentation;
- Testing required for the reference thermometer, etc.

Documentation must be retained and provided to the defense regarding the traceability of simulator thermometer measurements up through the reference thermometer and ultimately to NIST. In addition, measurements at all levels should be done in replicate to allow for uncertainty estimates, as recommended by NIST.

Administrative rules requiring a specific solution temperature must be carefully written to minimize legal challenge. They should be written so the requirement is that the measurement result from a certified thermometer is appropriate (e.g., 34±0.3 ^{0}C), not that the solution itself must exist at a specified temperature. Like so many areas, carefully written administrative rules coupled with sound protocols should minimize the success of these challenges. The required simulator temperature is best retained in policy manuals while the required simulator measurement result remains in the administrative rules. At most, these issues should go to the weight and not admissibility of the evidence. Often, however, it will require the creation of a thorough legal record and appeal to an appellate court level for resolution of these highly technical matters [5].

E. Repair and Error Record History on a Particular Instrument

One of the advantages of computerized instruments and advanced technology is the ability to collect records of all tests. Many jurisdictions collect these data within their breath test programs [4]. Along with all other documentation maintained within the program, however, such data are subject to legal discovery or public disclosure. An adequate and responsible defense, after all, requires the review of these data along with all other relevant records maintained by the program regarding the instrument used in testing the defendant. Often the defense strategy is to laboriously introduce each document through the prosecution witness in an effort to portray the instrument as having a long history of maintenance problems. The database may also contain error records (e.g., simulator out of range, calibration error, system won't zero, radio frequency interference, etc.), which the defense will also want introduced in court. Finally, phone call complaint records received from instrument operators and maintained by communication facilities will also be requested and introduced if available.

Managing all of these data and paperwork can be an overwhelming but very important responsibility. All of these records must be efficiently maintained and fully disclosed to the defense when requested. There are also significant costs associated with providing this information including:

- Paper;
- Computer media;
- Personnel time;
- Postage, etc.

In some cases, these costs, or a portion thereof, can be recovered from the requesting party. Some programs have experienced significant legal challenge with unfortunate consequences by either not fully disclosing all documents or giving the appearance of hiding or destroying information. Other than proprietary information owned by a manufacturer or the redaction of arrested subject identification, there should be no reason for failing to disclose all documents in the possession of breath test program personnel. Where jurisdictions lack resources to efficiently provide the requested information, arrangements might be made with libraries for their availability. Moreover, some jurisdictions have developed Internet sites where all of this information and documentation is readily available.

The prosecution can respond in several ways to this challenge. When appropriate, it should be emphasized that all of the requested material was promptly provided or made available to the defense because there was nothing to hide. The purpose of retaining this information from the program's perspective should also be explained, such as:

- Carefully document the performance of all instruments;
- Document all calibration and certification records;
- Document all repairs for program cost and maintenance history;
- Provide summary statistics of DUI enforcement efforts;
- Evaluate trends in DUI demographic data;
- Project future program and public safety needs, etc.

The court and jury will appreciate the need for data retention in our present "information age". Through the forensic witness, the prosecutor should also emphasize the independence of each subject test. For each subject, the instrument must fully complete all test criteria from beginning to end. If the system fails at any point, the test is aborted. Therefore, each completed test is independent of all others before or after in some respects. The forensic witness should be able to fully explain all steps of the test protocol and why the witness has confidence in particular results. A carefully designed and easily interpretable breath test document is also important to illustrate the full compliance with the preapproved test procedure. Visual aids are also helpful for explaining technical details to the court. It will also be important for the forensic witness and prosecutor to review all records prior to trial so their explanation and impact are well understood. Here again, carefully worded administrative rules that clearly define a complete and proper breath test document as the sole required basis for evidence admissibility will mitigate much of the defense challenge. Finally, when addressing the challenge of error records in the database, the prosecution can argue that not all subjects offered a breath test will produce a fully valid result. If this occurred, one might question the forensic sufficiency of the program standards. The important instrumental feature in this regard is its design to abort or identify any test not fully complying with predetermined quality-control parameters.

F. Computation of Widmark Estimates

The equation developed by E.M.P. Widmark has long been used by forensic toxicologists to provide an estimate of either the number of drinks necessary to yield a particular blood alcohol concentration (BAC) or the BAC resulting from consuming a specified number of drinks [37]. Widmark's basic equation is:

$$N = \frac{Wr\left[B_t + \beta t\right]}{0.82\left[fl.oz.\,alcohol / drink\right]}$$

where N = number of drinks; W = body weight in ounces; r = volume of distribution in L/Kg; B_t = the BAC at time t in Kg/L; β = the linear elimination rate in Kg/L/hr; t = time since first drink in hr; and 0.82 = the density of ethanol in ounce/fluid ounce.

A large body of research has evaluated all aspects of this equation and its forensic relevance [14,15,33,35,36]. Frequently, the defense approach is to have the forensic witness compute the BAC based on the subject's statement that he/she had only "two drinks". If the defense does have the witness compute the number of drinks based on the breath alcohol result, the emphasis is generally on discrediting the measurement result due to the seemingly enormous amount of alcohol necessary to achieve that level.

The approximation nature of the equation must be emphasized. The equation is a function of several random and uncertain (either measured or arbitrarily estimated) variables. This is why an uncertainty estimate (e.g., ±20%) should always accompany the result. Even Widmark provided an equation for an uncertainty estimate. [38] If the defense introduces only the estimated BAC based on the subject's statement regarding what he/she had to drink, the prosecution should have the witness compute the number of drinks based on the actual breath alcohol results. Having done this, the question can be posed to the court regarding which computation is more realistic:

- The one based on information provided by an intoxicated subject when arrested or thereafter; or
- The one relying on forensically acceptable analytical results.

Moreover, the prosecution should note that using BrAC in place of BAC in the equation would yield reduced estimates for the number of drinks since BrAC predominantly underestimates BAC [22]. Ideally, the forensic witness should be prepared to perform all computations in front of the court for subsequent review and consideration. Finally, when addressing the apparently large amount of alcohol necessary to achieve specific breath alcohol concentrations, it might be useful to introduce the fact that the average BrAC for those arrested for DUI is near 0.15 g/210 L and breath alcohol concentrations in arrested drivers range from zero to above 0.40 g/210 L [21]. If the witness cannot address this in his/her testimony, the prosecutor might include it in closing argument. Clearly, people consume large amounts of alcohol to achieve these forensically relevant alcohol concentrations.

G. The Software Within the Instrument Is Inadequate

Modern breath alcohol instruments are computerized with microprocessor control and associated software or firmware. The software is often encoded within some form of EPROM (erasable programmable read-only memory) device. A lower-level language format, such as Assembly, is generally employed. The software may require approximately 24 kilobytes of memory and comprise over 150 pages of printed material. Since the software contains the instruction set necessary for controlling all instrument operations, including computation of the breath alcohol result, it is frequently of claimed interest to the defense and their experts. The defense will typically request the software to be provided in electronic and hardcopy format for review by its experts. Pretrial hearings will likely follow in which the defense experts highlight alleged weaknesses in the code. These alleged deficiencies are then introduced before the jury in subsequent trials in order to minimize the weight of the evidence.

The software, along with certain other components, is a critical element within the total measurement system. The proper function of the software is best evaluated as part of the total system operation. Using known controls to evaluate accuracy, precision, and linearity evaluates the total measurement system and demonstrates the fitness-for-purpose of all integrated components, including the software. The prosecution should argue that a complete and successful breath test, with the accompanying document, ensures that all components of the measurement system were operating properly during that particular test run.

Software versions can be formally approved and included within the administrative rules, following a thorough evaluation while operating within the instrument. The printout document for an individual should then reveal the software version employed for easy verification of its approval. This should ensure legal admissibility.

Prior to purchasing new instruments, jurisdictions should request that the manufacturer obtain independent testing and evaluation of the software. This will document that a reasonable effort was made to independently ensure its integrity. Breath test device manufacturers must also be made aware that their software, often proprietary, may be requested by the defense under discovery or court order. Protective orders can be employed to protect the manufacture's legitimate interests.

Defense experts may come from other specialized fields of computer and software application. Rarely is there a direct correspondence between the fitness-for-purpose in these other fields (e.g., Department of Defense, Federal Aviation Administration, etc.) and the needs of forensic breath alcohol measurement. Fitness-for-purpose is always determined within the context of the measurement's intended application [11]. Alleged errors in the code, however, should be carefully considered since software quality is an elusive concept, determined largely within the context of its intended application [27].

H. Records Generated by Other Program Personnel

Records generated by program personnel are often critical to establishing the foundation for admissibility of breath test evidence. Such records might include:

- Instrument certification forms;
- Simulator or dry gas control replacement certifications;
- Thermometer certification forms;
- Repair or maintenance forms, etc.

Where several individuals have similar responsibilities for a specific task, there will be occasions when the one performing the work is not able to testify during the trial. Often, the defense argues that the form is not admissible except through the individual who actually performed the specific work described on the document.

These documents should be admissible through qualified personnel as a "regular business record exception" to the hearsay rule. These qualified personnel should have "custodian-of-the-records" as part of their responsibilities so they have access to the records and are able to describe the work reported on the forms as part of their normal duties. Personnel may need to submit copies to others so that all are able to handle the admissibility testimony in the event of someone's unavailability. Their job descriptions should also list "records custodian" as part of their responsibilities. Records not routinely generated within the program may not be admissible, except, perhaps, in pretrial admissibility hearings where evidentiary rules are often relaxed. However, even records generated by other agencies may be admissible as a component part along with documents that would be defined as a "regular business record exception".

I. Compliance With Pre-Exhalation Observation Time Requirements

Virtually all jurisdictions performing evidential breath alcohol testing require that the subject be observed for a minimal time period (e.g., 15 or 20 min) prior to breath testing to ensure they place no foreign material in their mouth and allow the dissipation of "mouth-alcohol", if any. The administrative rules generally contain the specific requirements and may vary among jurisdictions. Depending on the specific requirements, the defense may argue that the required observation was not complied with for a number of reasons including:

- The officer turned his/her back for a moment;
- The officer was completing paperwork during the period;
- The officer was preparing the instrument during the period;
- The subject's mouth was not adequately checked at the beginning of the period;
- The subject produced an undetected belch;
- The subject regurgitated during the period;
- The time period was not documented properly, etc.

Similar to many others, this issue is best addressed with careful wording of the administrative rules. They must not be worded in such a way that strict compliance is impossible. Operators should be trained and prepared to testify that they used only one clock for the time determination – preferably the clock on the instrument, which will also correspond to the times printed on the document. Operators must be prepared to carefully document the time that observation began and avoid the appearance of "digit preference" (e.g., recording more 0's or 5's for the minute digit). Printout documents should show both the beginning of observation and the time of breath analysis. Instruments can also be programmed to require a minimum time period before sample provision and between samples. The operator/forensic scientist can also be prepared to discuss the exponential nature of the elimination rate of "mouth alcohol" and how the potential for bias decreases as a function of time and increasing end-expiratory BrAC [20]. Belching, detected or not, will not bias a test result because that portion of the exhaled breath, typically an earlier fraction of the exhaled stream, passes through the sample chamber and is replaced by the last portion of breath exiting the lungs.

J. Inconsistency Between Reported Observations and BrAC

The DUI arrest case report will generally include a summary of the officer's observations regarding the driving, field sobriety tests, and statements made by the subject. Often, the defense will suggest that the high BrAC (e.g., > 0.15 g/210 L) is inconsistent with the uneventful description of the field sobriety test performance. Particularly when Widmark's estimation reveals a large number of drinks necessary, the defense will argue that the apparent inconsistency must be due to an inaccurate breath alcohol result.

Responding to this issue must begin with the arresting officer writing a very detailed and thorough report. Standard and computerized report formats can be helpful in this regard. All observations, beginning with the driving and including all aspects of the field sobriety tests, must be recorded in great detail. Moreover, reports must be factually unique to each subject while avoiding vague and generalized statements. On occasion, the defense may request several DUI case reports from the officer to use for comparison and suggest that the same information is recorded for all subjects. The forensic expert can respond with testimony regarding the tolerance developed with alcohol and how alcoholics are able to conceal many of the overt signs of impairment. The correlation between signs and symptoms of impairment and BrAC is ambiguous in some respects. Usually this issue goes to the weight of the evidence rather than the admissibility.

III. ADDITIONAL CHALLENGES

Many other challenges occur that may be unique to a particular jurisdiction. Several of these include:

- The presence of tongue jewelry biased the result;
- Error records or aborted tests require full recertification of the instrument;
- Implied consent rights were inadequate;
- The discovery material provided was incomplete;
- The instrument warranty provided by the manufacturer is inadequate;
- There is great risk of bias due to other interfering sources such as radio frequency interference, endogenously produced alcohol, consuming bread products, the multitude of volatile organic compounds found in normal human breath, etc.;
- The threshold set for interference detection requires that this amount be subtracted from every subject's test result;
- Drinking after the accident (hip-flask defense);
- Variation in sequential simulator control test results;
- Variation observed between the subject's duplicate breath test results;
- All possible analytical errors must be summed and then subtracted from the subject's results, etc.

In addition, defense attorneys may request to photograph an instrument's location in an effort to compare with the officer's statements regarding compliance with pre-exhalation observation time. Again, these reflect only some of the multitude of challenges raised in DUI litigation. Moreover, many current challenges are only slight revisions of ones that have been in dispute for many years and often previously discredited. We must remember, however, that a particular set of jurors has likely not heard these issues before and the defense objective is to craft a specific issue that is compelling.

Most of these additional challenges, like the others, are best managed through adequate administrative rules coupled with a forensically sound measurement protocol. The administrative rules must be drafted so that only the minimum requirements are specified. Extra detail should be left to policy manuals. A measurement protocol following sound forensic practice that is fit-for-purpose [8] will surmount most of these additional defense challenges. Moreover, data collection systems can be used to generate plots that show evidence of statistical control for the instrument over time. Novel approaches to addressing the "hip-flask defense" through congener analysis, for example, have also been reported [23,24]. Finally, much can be learned from other jurisdictions experiencing similar challenges and their resulting case law.

The prosecutor's approach to the case will clearly depend on whether the issue is a pretrial admissibility hearing or whether the issue will go to the weight in front of the jury. In either case, a close working relationship must be established between the forensic scientist and the prosecutor so that all technical aspects of the breath-testing program are understood and a complete record is established. A networking of prosecutors within or between jurisdictions, like that offered by the National District Attorneys Association [30], is also helpful to address challenges. Internet sites can also be developed where relevant court decisions and case briefs can be posted for other prosecutors to obtain. Sharing relevant information between jurisdictions can be facilitated in this way.

CONCLUSION

Many factors contribute to the vigorous challenge of forensic breath alcohol evidence in the prosecution of drinking-and-driving cases. Forensic toxicologists should not be surprised, but rather expect and prepare for such challenge. Knowledge of the more common challenges, such as those discussed here, can help the toxicologist and program personnel prepare for such issues. For many of the issues, the prosecution response will be fairly uniform across jurisdictions. For others, the response will depend on local statutes, administrative rules, case law, policies, instrumentation, and procedures. In view of the multitude of legal challenges, the forensic scientist must remain professional, truthful, nonadversarial, and as objective as possible. Some challenges, clearly, are forensically meaningless. Others, however, may indeed be forensically relevant and reflect areas of our program that need improvement. We must be alert to these situations and prepared to change as part of our continual effort to improve the forensic quality and credibility of our scientific evidence.

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