Analytical and Physiological Specificity Issues in Breath Alcohol Analysis

Paul M Williams PhD
Lion Laboratories plc, Barry, Wales CF63 2BE, UK

ABSTRACT

Drink-drivers frequently allege that their breath alcohol reading was so high because some non-ethanolic chemical was in their breath at the time of the test. This paper reviews the author’s experiences and methodology in dealing with such matters in the British Courts on behalf of the Police.

Conceivable sources of breath contaminants are ingestion (with food, medication or smoking), endogenous production and occupational or environmental exposure. Under British Law the prosecution have only to prove that at the time of the test the subject’s breath alcohol level (BrAC) exceeded the per se limit: it is not required to prove the actual concentration which at that time existed. The forensic scientist should therefore consider the following questions, in this order: (a) is the alleged interfering substance ‘X’ volatile? (b) does the analyser used measure substance ‘X’ at all? (c) what is the analyser’s relative response between ‘X’ and ethanol? (d) what maximum breath level of ‘X’ could the driver have had? (e) could this have elevated the reading by the difference between the per se level (or the Widmark level as calculated from the driver’s admitted consumption) and that recorded by the instrument?

In most instances the case is solved well before question ‘e’ is asked. New analytical specificity requirements, such as those of OIML, while physiologically unjustified, should help reduce spurious defence claims at source.

INTRODUCTION

In the United Kingdom [UK], until 1983, it was only gas chromatography [GC] which had been the approved analytical method of determining whether a driver’s alcohol level exceeded the legal limits of 80mg/100ml in blood or 107mg/100ml in urine, per se.

In 1983, however, the relevant provisions of the Transport Act 1981 were enacted, so introducing evidential breath alcohol analysis as the principal method by which the Police would deal with suspected drink-drive offenders.

The legal limit [per se] was redefined by the 1981 Act as being 35mg/100ml of alcohol in breath [BrAC], with a statutory blood:urine option being available to drivers whose lower [of two] breath alcohol readings did not exceed 50mg/100ml. An additional ‘safety measure’ was also introduced into police practice, whereby a prosecution would not normally ensue where the lower breath reading did not exceed 39mg/100ml. And so, in 1983, the backdrop for a whole series of defence challenges had been set!
Although GC has such disadvantages as requiring lengthy and costly procedures, its two distinct benefits are its high [though not total] analytical specificity for ethanol and, secondly, the fact it is generally understood by most scientists. But some of these people did not, and still do not, properly understand the issues involved in breath analysis.

One of the principal areas of challenge has been in respect of analytical specificity, with the outcome that some undoubtedly guilty motorists have been acquitted on the ‘benefit of the doubt’ principle. In response, this author [Williams 1983] has researched the specificity issue, practically and by literature review, and has often been consulted by the UK authorities to give testimony in contested cases. This paper is based on those experiences.

THE ISSUE

The issue in such cases is whether a person could be wrongly convicted of driving with excess alcohol, simply because the presence in their breath of some substance other than alcohol has brought about a wrongfully high reading during the test procedure. This question was usually answered “Yes” by defendants, often supported by the scientists they instructed, but often without a fully considered approach to all the scientific issues involved.

In 1985, as a result of continued assertions from some of the defence scientific community, culminating in a 1984 UK press campaign, a major study [Paton 1985] was carried out, whereby samples of blood or urine were taken from motorists who had already provided breath for analysis, even where the lower reading was above 50mg/100ml. This showed no evidence of a potential for injustice resulting from evidential breath analysis.

It was also concluded in that study that potentially interfering breath contaminants existed only in cases where the subject had been deliberately inhaling the vapours from substances such as contact adhesives or lighter fluid. And yet, despite those findings, and further work published later, defendants continued to challenge breath readings on allegations of non-specificity of the instrument, usually assisted in Court by some ‘expert’ scientist.

THE APPROACH TO THE QUESTION

The approach taken by this author has evolved since 1983 through dealing with many such prosecutions brought under the British legislation. It is a feature of the British legal system that it is generally necessary for the prosecution to prove only two facts in order to secure a finding of guilt in such cases. They must prove that:

a. the person was driving, attempting to drive, had been driving or that he was in charge of the vehicle; and

b. the person had ‘consumed’ alcohol [before driving] in such quantity that, at the time the specimen [breath, blood or urine] was taken, it contained alcohol in excess of the per se limit.

Note: it is not required under British law for the exact level of alcohol in the specimen to be proved, only that the level was above the per se level, although the degree of the excess is usually taken into account when sentencing the convicted offender.
The system adopted by this author when dealing with ‘specificity cases’ actually takes the form of considering the scientific evidence by way of a series of five questions. For reasons of both logistics and convenience these are taken in the order here given:

1. Is the alleged interfering substance ‘X’ volatile?
2. Does the breath analyser used measure substance ‘X’ at all?
3. What is its relative response between ‘X’ and ethanol?
4. What maximum breath level of ‘X’ could the driver have had?
5. Could this level have elevated the reading from the per se level [or as calculated from admitted drinking] and that recorded?

These cover the scientific issues involved, so leading the investigator to the correct conclusion, taking into account two further important aspects of the British legal system:

a. the term ‘alcohol’ is not restricted to ethanol. Other alcohols, such as methanol and propanol, will also bring about impairment and are, therefore, covered by the legislation; and

b. entry of the alcohol into the suspect’s body by some route other than conventional drinking [such as by injection] still amounts to ‘consumption’ for purposes of proving the offence.

So, for example, the fact that a reading has resulted from the inhalation or injection of propanol does not constitute a defence under British law; the object of the legislation being to improve traffic safety, not to create a series of scientific ‘loopholes’ for defendants.

THE QUESTIONS: THEIR SIGNIFICANCE

The significance of each the questions is now addressed, with examples:

Q1. Is the alleged interfering substance ‘X’ volatile?

If the alleged interfering substance is non-volatile then it cannot vaporise, which means it cannot appear in the breath to be analysed by the instrument. Although these statements will seem obvious to most scientists, their logic seems frequently to escape the minds of lawyers and defendants - as well as certain ‘defence scientists’. If the answer to this question is negative, the investigator need proceed no further.

Most high molecular weight drugs which are taken in tablet form, and so often the subject of such defences, are plainly non-volatile and so are covered here.

Q2. Does the breath analyser measure substance ‘X’ at all?

If the breath analyser used in the case does not respond to the substance of concern then there can be no interfering effect. Fuel cell sensors, for instance, do not respond to acetone or hydrocarbons; but they are sensitive to acetaldehyde, formaldehyde and ether.

Infrared analysers, depending on the measuring wavelength used [3 or 9 microns], will be sensitive to substances other than ethanol. For instance, single wavelength instruments operating at 3.4 microns, with no secondary sensor, will detect acetonitrile, if present.

Trichloroethylene is widely used as an industrial solvent and workers exposed to its vapours sometimes claim that absorption into their bodies has resulted in its accumulation
and subsequent re-exhalation, with obvious alleged results. However, examination of its infrared spectrum shows it has no absorption at 3.4 microns, which means it cannot be detected by analysers operating at this infrared region, no matter what its level in the breath.

Some salbutamol-based bronchodilator inhalers, as used by asthmatic patients, contain a propellant gas which absorbs infrared light in the 9 micron region, but not at 3 microns.

Q3. What is the analyser’s relative response between ‘X’ and ethanol?

This will enable the scientist to determine the likely contribution which the alleged interfering material ‘X’ could make to the overall breath ‘alcohol’ reading.

For instance, although acetone will absorb infrared light at 3.4 microns, it does so with a sensitivity factor at least five times less than that of ethanol, while the corresponding ratio for acetaldehyde is of the order of fifteen times less [Jones 1986]. For methane the value is about ten to one, on a molar basis [Jones 1984].

Fuel cell sensors will detect carbon monoxide, but the breath level required to generate a breath alcohol [BrAC] equivalent reading of even 0.02mg/l BrAC corresponds to a blood level of 40% saturation - which would be fatal [Williams 1983].

Q4. What maximum level of ‘X’ could the driver have had in his breath at the time of the test?

This will involve reviewing the method by and the conditions under which the substance came to be in the breath in the first place, as well as any relevant biochemical or toxicological data about ‘X’ that may be available.

For instance, if the subject’s breath ‘alcohol’ reading is more than 10mg/100ml above the legal driving limit, and the relative infrared absorption coefficient between ‘X’ and ethanol is 10:1, could the subject realistically have had 100mg/100ml of ‘X’ in his breath at that time? Is such a level above the fatal level of ‘X’?

Toluene and white spirit are each used in various industrial processes and each absorbs infrared light at 3.4 microns. But humans do not exhale significant amounts of either, except after solvent abuse or in the unlikely but potentially fatal scenario of consumption. Where, however, a subject has been exposed to such vapours during the course of some occupational process, then the breath level during and immediately after exposure will be the same as the ambient concentration. But, since these materials have a low boiling point and are non-water miscible, they are very rapidly excreted from the body once exposure has terminated: thus, about 20 minutes following the end of such exposure, any contribution to the breath alcohol reading would be analytically insignificant. The same conclusions apply to both substances [Gill 1991, Denney 1990]. Even in cases of petrol [gasoline] ingestion, the effects on breath are both small and short lived [Dalley 1985].

Acetone appears in the breath of subjects with disorders in their carbohydrate metabolism system, but the levels are generally too low to be of significance even alone [US DOT 1985] while, when combined with alcohol, they are reduced still further [Jones 1988].

Q5. Could this breath level have elevated the reading by the difference between the per se level [or the Widmark level as calculated from the driver’s admitted consumption] and that recorded by the instrument?
Unless this question has already been answered, the scientist may now conclude his investigation. In most cases the defendant will claim they had consumed, prior to driving, alcohol only in such quantity as to give rise to a reading not more than half the legal limit, which creates an impossible gap to be accounted for by the alleged interferant.

Where the level of pre-driving alcohol consumption is unknown, it may be required to show that the interferant could not have made the difference between the legal limit and the subject’s recorded reading. In this author’s experience, the task is generally straightforward, since most breath readings are not borderline positive, but so significantly above the legal limit as to make the analytical gap an unbridgeable one; particularly when considered with the driver’s own account of pre-driving consumption which, as one senior British Judge so aptly put it, is “so often the subject of dubious testimony”.

CONCLUDING REMARKS

Breath analysis is widely used as the main if not sole means of dealing with drink-drive suspects. Unfortunately, the technologies and physiological principles are frequently not well fully realised or understood by scientists, with the result that wrongful acquittals have undoubtedly occurred. It is this author’s view that wrongful convictions following breath testing are extremely unlikely - provided the correct instrumentation is used, supported by the proper Police procedures and, where needed, subsequent forensic scrutiny of a high standard.

In an attempt to remedy the situation, many Governments now define detailed technical specifications for breath instruments, often with onerous demands on analytical specificity which, taking into account the physiological aspects of this science, should not theoretically be required. However, by making such demands of the instrumentation, the investigation should be terminated at a stage not later than Question 2 of this approach.

REFERENCES


Denney, R., Solvent inhalation and ‘apparent’ alcohol studies on the Lion Intoximeter 3000. JFSS 30(1): 357-361 [1990].


Williams, P. M., Lion Intoximeter™ 3000 - Court Manual, *Lion Laboratories plc* [1983].