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Ian R. Coyle
Bond University

David Field
Bond University, David_Field@bond.edu.au

Graham A. Starmer

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An inconvenient truth: legal Implications of errors in breath alcohol analysis arising from statistical uncertainty

Ian R. Coyle[1], David Field[2] & Graham A. Starmer[3]

Abstract

The general practice in courts throughout Australia is to accept without question the accuracy of what are popularly referred to as 'breathalysers', or breath analysis instruments as they are legally described. The possibility that they might be providing false readings is only considered if that possibility is raised as a matter of evidence by a motorist who has been breathalysed, and who now faces the prospect of legal sanctions as a result of what it is alleged was revealed by the breath analysis instrument. In this article, it is argued that the methodological and statistical bases for such an assumption is unsound, particularly when the blood alcohol level inferred from breath analysis is close to an important, legislatively proscribed, threshold such as 0.05% or 0.15%. It is an inconvenient truth that breath analysis overestimates blood alcohol levels for some individuals at these thresholds, with profound legal consequences.

Introduction

Apart from obvious sources of error such as blood in the mouth or smoking within 20 minutes of testing, it generally assumed that modern breath alcohol analysis (BAA) instruments such as the Dräger Alcotest 7110, currently used in Queensland, South Australia, Western Australia and Victoria, usually underestimate actual blood alcohol concentration (BAC), if properly calibrated and operated.

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[1] Ian R. Coyle, PhD, Visiting Professorial Fellow, Centre for Forensic Excellence, Faculty of Law, Bond University, Robina QLD & Principal Consultant, Safetysearch Forensic Consultants, P.O.Box 8386,G.C.M.C.,Bundall,QLD, Australia 9726. Email: safetysearch2001@yahoo.com.au

[2] David Field, Associate Professor of Law, Director, Centre for Forensic Excellence, Faculty of Law, Bond University, Robina QLD, Australia 4229. Email: dfield@bond.edu.au

[3] Graham A. Starmer, PhD, FRPharmS, Associate Professor, Psychopharmacology Research Unit, Sydney University, NSW, Australia, 2006. Email: gstarmer@pharmacol.usyd.edu.au

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This is consistent with the spirit of the law in Australia, and all common law countries, that the results obtained from a breath analysis system, which are presumed as a matter of law to be correct and not subject to challenge unless there is evidence of malfeasance, should not result in a wrongful conviction. When a scientific instrument may be said to belong to:

> 'A class of instruments of a scientific or technical character, which by general experience [are] known to be trustworthy, and are so notorious that the court requires no evidence to the effect that they do fall into such class, before allowing the presumption in question to operate with regard to readings made thereon' (*Porter v Kolodzeij*, at 78)[4]

a court will, at common law, be entitled to take what is called 'judicial notice' of its reliability. By this it is meant that the results, or readings, which are derived from such an instrument, may be relied on in evidence when this is relevant to the outcome of a case. In the case of a breath analysis instrument, this would entitle a judicial officer such as a magistrate in a drink-driving case to rely on the BAC indicated by the instrument being an accurate reflection of the *actual* BAC in the bloodstream of the accused.

But this may only occur when the device in question has been proved to be accurate over a number of years, and an even greater number of cases. Given the variety and proliferation of breath analysis instruments in use by the police forces of our various State and Territories, this is unlikely to emerge as a general rule overnight, and at the time of writing, has still not emerged.

In the most recent consideration of this issue by an intermediate level appeal court, the Court declined to 'take the leap and say that a breathalyser is now so well known and accepted that the presumption of accuracy applies to it' (*State Government Insurance Commission v Whyatt* at 470). A similar observation was made in *Chapman v Rodgers; Ex parte Chapman* in which the Queensland Court of Appeal upheld the finding of a magistrate that a breath analysis instrument had given an inaccurate reading.

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[4] The presumption in question is known generally at law as 'the presumption of accuracy of scientific instruments'.

Consequently, at strict common law, the current position is that each and every court which is presented with evidence generated by such a device should, in the words of the learned editor of *Cross on Evidence* (Australian Edition, at 3070) seek: '. . . evidence . . . as to its nature and function in order to [be persuaded] of its reliability' This was translated by the New Zealand Court of Appeal in *Holt v Auckland City Council* into what amounted to a warning to police prosecutors concerning a then new form of gas chromatograph that:

> 'until it can be considered that the functioning and trustworthiness of a newly developed device is a matter of common knowledge, those who rely on the equipment must carry the responsibility of establishing its accuracy' (at 128).

Undeterred by any of these considerations, most State and Territory governments have in recent years enacted legislative regimes which give 'presumptive' effect to the readings and print-outs of breath analysis devices in criminal cases in the absence of any challenge to them by accused persons.

Typical of these are the Road *Transport (Safety and Traffic Management) Act 1999* (NSW), s33, which provides that a certificate purporting to be signed by a police officer certifying that he used a 'breath analysing instrument' approved under the Act which indicates that a stated concentration of alcohol was present in the blood of the suspect at the time of the reading is 'admissible and prima facie evidence of' those facts, and s58 of the *Road Safety Act 1986* (Vic). The Victorian legislation states that a document purporting to be a certificate containing details of the concentration of alcohol in the breath of a defendant at the time of testing 'is conclusive proof' of that fact unless the defendant gives written notice of challenge not less than 28 days before the hearing at which it is proposed to tender that document, and indicates the nature of the 'expert evidence' which the defendant intends to adduce at the hearing. When he or she does so, then the document is downgraded so that it becomes merely 'admissible in evidence'. Similar provisions are made in the *Road Traffic Act 1961* (SA) s47K, *Road Safety (Alcohol and Drugs) Act 1970* (TAS) s23, *Road Transport (Alcohol and Drugs) Act 1977* (ACT) s41, *Road Traffic Act 1974* (WA) s70 *and Transport Operations (Road Use Management) Act 1995* (QLD) s80.

In most states and territories, the evidential significance of a reading in excess of whatever statutory minimum has been imposed under the legislation is that it justifies the police who conducted the test requiring the suspect to submit to further testing (e.g. a further breath test at the police station or a final blood test for analysis by gas chromatograph). But in Victoria at least, it has been held to constitute sufficient evidence by itself for a conviction under the relevant legislation.

The statutory provision in question is s49(1)(f) of the *Road Safety Act 1986* (VIC), which, so far as is relevant, states that a person is guilty of an offence if he or she, within 3 hours after driving or being in charge of a motor vehicle, furnishes a sample of breath for analysis by a breath analysing instrument; and (i) the result of the analysis as recorded or shown by the breath analysing instrument indicates that more than the prescribed concentration of alcohol is present in his or her blood; and (ii) the concentration of alcohol indicated by the analysis to be present in his or her blood was not due solely to the consumption of alcohol after driving or being in charge of the motor vehicle.

In what amounted to a significant test case on the meaning of this particular provision, the majority High Court in *Thompson v Judge Byrne* held that: 'The actual offence, as expressed, is not the driving or being in charge of a motor vehicle with the prescribed concentration of alcohol. It is . . . "failing the test"' (at 156).

In *Furze v Nixon* the unanimous Victorian Court of Appeal interpreted this as meaning that: 'paragraph (f) (i) does not refer, relevantly, to the concentration of alcohol in the blood; the offence is constituted directly by the indication given by the machine (albeit as to blood alcohol concentration) – and no more that that' (at 32).

The ongoing validity of the presumption which may be drawn from a reading generated by a breath analysis instrument under the Victorian legislation, despite the common law position, was recently confirmed by the Supreme Court of Appeal of that State in *R v Ciantar; DPP v Ciantar*, a case in which a motorist charged with culpable driving causing death challenged the

admissibility of a 'preliminary' breath test reading which indicated a BAC of 0.159%, and a subsequent breath test reading some 50 minutes later which showed a BAC of 0.136%.

Central to the defendant's case was the suggestion that prior to the first reading, but subsequent to a 'hit and run' accident in which he had been involved, he had consumed one third of a bottle of whisky. However, medical evidence called for the Crown and based on the two readings suggested that the falling BAC levels recorded over the fifty minute period suggested that he could not have consumed the whisky as he alleged. Indeed, on the assumption that the second reading had been accurate and that all the alcohol he had consumed prior to that time had been consumed prior to the accident, his BAC at the time of the accident would have been between 0.128% and 0.166%.

He appealed against his subsequent conviction on various grounds, one of which was identified, and rejected, by the Court of Appeal in the following terms:

> 'It was submitted on behalf of the applicant that a preliminary breath test device is not within that class of notorious scientific instruments of which the accuracy is presumed at common law and, consequently, that in order for evidence of the preliminary breath test results to be admissible at common law, it was necessary for the Crown to establish the scientific character and operation of the preliminary breath test device. It was contended that it failed to do so.
>
> We do not accept that contention . . . a court may admit the results of a test conducted with a scientific instrument on the basis of evidence from a witness expert in its use. It is sufficient if it is established that it is a scientifically accepted instrument for its avowed purpose and that the particular instrument was handled properly and read accurately' (at 8).

Similar decisions had been arrived at under the equivalent Tasmanian and South Australian statutory provisions (cf *Philpott v Boon and Mehesz v Redman*).

Do Modern Breath Analysis Instruments Underestimate Actual BAC?

Two main arguments are employed to support the proposition that breath analysis devices will normally *underestimate* BAC. First, the blood breath ratio (BBR), which is often referred to as the partition ratio, proscribed for use is typically 2100:1. That is, it is assumed that the amount of alcohol in 2100 litres of expired air from the lungs is the same as is found in 1 litre of blood. The majority of laboratory and real world drinking situations result in ranges of mean BBR from 2300:1 to 2411:1 (Jones & Anderson 1996; Norberg, et al. 2003). Thus, using a lower BBR for evidentiary purposes than typically applies is thought to provide sufficient scope for error.

Second, the actual reading obtained from a breath analysis system is usually reduced to take into account systematic and random error. The amount that the raw reading is reduced by varies between jurisdictions but is typically in the order of 6%. This is so for the Dräger Alcotest 7110 Mk V which is used in many states in Australia. The manufacturer's specifications indicate that the standard deviation of the Dräger 7110 Mk V is 0.001g/210 L or 0.01% neglecting the associated error for the calibration standard of less than 1% relative. Questions have been raised regarding the error associated with the calibration factor in breath alcohol analysis which involves using a standard solution to calibrate the breathalyser, (Labianca, 2002) but these can be ignored for the sake of the arguments put forward here. Assuming a normal distribution of BBR it may be calculated from this data that the 99% confidence interval for BAC at an indicated reading of, say, 0.15% is 0.127% to 0.173%. Considering that the BBR of 2100:1 programmed into the instrument underestimates 'true' BBR by, say, 10% this gives confidence that a false positive result is statistically improbable.

Or does it? Consider the argument that, since a BBR of 2100:1 underestimates actual mean BBR by 9% to 13%, the results favour the accused. This is true only if the mean BBR is considered. Obviously, it would be inimical to the interests of justice for the mean BBR to be the only reference point. Although there is no legal standard or guidance in any common law jurisdiction as to what, precisely, constitutes proof beyond a reasonable doubt it is arguable on moral and scientific grounds that at least a 95% confidence interval should obtain which would result in a 5% false positive rate. However, if it be legislatively mandated that there can be no defence to the results of a BAA instrument it is arguable that the confidence interval associated with venous blood sampling for BAC, 99%, should obtain.

This all seems simple enough: look up normal probability tables and calculate the confidence interval, based on the quoted standard deviation of BBR. It isn't. For example, Jones and Anderson (1996) report data from real world studies of some 799 cases involving drivers who were apprehended for driving under the influence of alcohol between 1992 and 1994. The data was adjusted for metabolism of alcohol between the time of sampling venous blood and breath analysis at a rate of 0.019g/100mL/h: this is equivalent to 0.019%. They report mean BBR's ranging from 2264 to 2421 with standard deviations ranging from 206 to 288. Assuming a normal distribution Jones and Anderson calculated that the 95% limits of agreement, or confidence intervals, (+/- 2 Standard Deviations) ranged from 1981 to 2833 across the three years sampled. Clearly, to argue, on the basis of this data, that assuming a BBR of 2100:1 *always* biases the results in favour of the defendant is fallacious.

There is another problem. The distribution of BBR cited in laboratory studies may be normally distributed up to 0.10% of BAC but there are strong methodological, physiological and psychopharmacological grounds for arguing that the distribution is asymmetric above this. As distinct from contrived studies conduced in laboratories, real world drinking studies almost universally demonstrate a highly positively skewed and/or multimodal distribution (Jones & Anderson 1996, Norberg et al. 2003). Considering the data, meagre though it is, for those studies which have attempted to control for common variables such as food intake, what evidence is there that the distribution of BAC is normally distributed? Norberg et al. (2003) provide data on 10 subjects in three conditions: overnight fasting; 50-60 minutes after eating a standard breakfast and 50-60 minutes after eating a standard breakfast after pre-treatment with aspirin for 65mg per diem/for 7 consecutive days. *None* of the blood alcohol/time profiles is normally distributed. The first two conditions produced highly skewed distributions. Only *one* of them (the third condition) shows any approximation to the Widmark model routinely used for backwards extrapolation of BAC, vis-à-vis alcohol elimination.

It is apodictic that using normal distribution tables or Z-scores to compute confidence intervals is nonsense with such distributions. While it is true that assuming a mean BBR of 2100:1 will bias results in favour of the average driver, it does not follow that this is true for all drivers. For some drivers, assuming a BBR of 2100:1 will *overestimate* BAC by up to 17% (based on a 95%

confidence level): but for which ones? From a forensic perspective, the implications of this are obvious and profound.

Then there is the problem that Jones and Anderson (1996) assumed a rate of alcohol metabolism of 0.019g/100mL/h. However, the 95% confidence level for metabolism (post absorption) has been reported to range from 0.009g/100mL/h to 0.029mg/mL/h (Jones and Anderson 1996). This is consistent with the range of alcohol clearance used in the long established Widmark Formula (Widmark 1932).

It is hard to see what other approach Jones and Anderson (1996) could have taken in allowing for alcohol metabolism when correcting for the time between venous blood sampling and BBR. Nonetheless it must follow that threefold variations in reported blood alcohol metabolism would introduce additional uncertainty. The 95% confidence interval reported by Jones and Anderson (1996) therefore has to be regarded with considerable scepticism. It is probably significantly larger than they have reported. This problem is compounded when the multiplicity of factors affecting intra and inter individual variability in ethanol pharmacokinetics is considered. To name but a few of the factors cited by Norberg et al. (2003), sex related differences related to absorption have not been fully investigated, the role of oral contraceptives on ethanol pharmacokinetics is not clear, the absorption of alcohol relative to the amount, type, quantity and time course of food intake is highly variable, and the effect of unrelated pathophysiological factors such as severe burns has not been considered.

What of the second limb of the argument, whereby since the 'true' (i.e. indicated) BAC as determined by the Dräger Alcotest 7170 Mk V and other similar instruments is reduced to allow for calibration, random and systemic errors (by 5 % or 6% depending on the jurisdiction), the results are biased in favour of the defendant? The first point to consider here is a fundamental statistical concept that is glossed over or misinterpreted in forensic cases.

There is always, in any instrument/measurement system no matter how precise, random and systemic error. Systemic errors include the precision of calibration, the error in the calibration

associated with the calibration solution and potential drift in the instrument (although the manufacturer states that drift is controlled for in practice this is not always the case). That is precisely why 'allowance' is made to reduce the indicated reading on BBR instruments. Although this is almost universally expressed in the pharmacological literature in terms of standard deviations (SD) or confidence intervals, it is more easily, and correctly, expressed in terms of the standard error of the mean (SEM). The SEM is the standard deviation divided by the square root of the sample size (N); it gives a figure around which the 'true' measurement will fluctuate because of random and systemic errors. Obviously, as N increases, the SEM decreases.

The majority of laboratory studies quoted in literature have N orders of magnitude lower than the studies of Jones and Anderson (1996) and Norberg et al. (2003). The downside of increasing N is perhaps not so obvious: statistically significant differences will more readily obtain which are often of minimal clinical or forensic significance. But this is of no import in the current context where defendants are often convicted on the basis of a BAC of say, 0.15% for 'high range' offences as compared to a cut off criteria of 0.149% in most Australian states for 'low to mid range' offences involving driving whilst exceeding the prescribed concentration of alcohol. From a legal viewpoint this has profound consequences as, typically, having a BAC of 0.15% or above is considered an aggravation of the offence and can result in a conviction for dangerous driving.

Consider that the standard deviation of BBR assumed by the manufacturers of the Dräger 7170, for example, is based on a normal distribution. Then consider that the distribution is positively skewed, as real world drinking data shows. Any significant deviation from normality is sufficient to render results of a BAC test from a perfectly calibrated instrument gravely suspect, at best, if the 99% confidence levels reported by the manufacturer are accepted. But by how much? There is no way of telling without knowing the actual distribution. Error there must be, but how much error is indeterminate in the absence of data on the distribution of BBR, vis-à-vis BAC, in the real world. Such real world data as there is does not support the notion that BBR and associated BAC are always normally distributed: in fact quite the obverse.

At the risk of simplification, consider a departure of normality of the BBR and associated BAC distribution such as to increase the standard deviation of the Dräger from 0.01% (as quoted by Dräger) to 0.0104% in the range between 0.10% and 0.15% BAC (we have no data on N and

thus cannot compute the SEM). At an indicated level of 0.0151% this would be sufficient to result in a corrected BAC considering a confidence interval of 99% of 0.149 resulting in a 'low to mid range' indication in the state of Queensland in Australia, rather than 'mid to high range'. Parenthetically, it should be noted that Dräger technical publications that we have been provided with incorrectly refer to a 99% confidence interval (i.e. 2.33 standard deviations for a normal distribution) instead of a 99.9% confidence interval (i.e. 3 standard deviations for a normal distribution). The calculations here are based on a 99% confidence interval.

It is critical to note that the increase in the standard deviation used in this example is only 4% of the standard deviation quoted by the manufacturers. This trivial increase in the standard deviation from a statistical viewpoint would not be unexpected when the distribution is highly skewed and multimodal.

This difference is most certainly not trivial from a legal viewpoint. To reiterate, it would mean the difference between a custodial sentence and a fine in this jurisdiction. At the risk of repetition it needs to be noted that any errors in BAA associated with the assumption that that BAA and BAC are normally distributed are, at best, additive to errors of measurement associated with the assumption that the BBR is, 2110±0.1, assuming a 99% confidence interval. These errors could well be synergistic: i.e. they could be multiplicative. Still, even if this proves to be the case, the overwhelming majority of convictions based on BAA would not be affected.

The problem of misunderstanding fundamental principles of statistics and experimental methodology is not confined to BAA. In the forensic pharmacological domain, it is argued that BAC can be 'reliably demonstrated' from the vitreous humor found in the posterior capsule of the eyes (Chao & Lo 1993). The formula quoted by these authors, once again, is based on mean BAC without adequate consideration of the SEM. Indeed the BAC derived from venous blood sampling is routinely cited as being accurate within 1%. We have been unable to find any Australian case in which the SEM has been quoted. Accordingly the same arguments as to statistical uncertainty at legally important thresholds apply to this methodology despite its unchallenged acceptance.

Additionally, there is another problem in BAA that the manufacturers and distributors of BAA instruments are largely silent on. It is a most important issue that has escaped the scrutiny of the courts, until recently. To avoid producing invalid results, evidentiary BAA instruments, of whatever type, utilise 'error detection' software. The problems associated with this software have been the subject of numerous legal challenges in other jurisdictions (Head & Workman, 2007). Essentially these challenges devolve around the source code used by the manufacturers. It is beyond the scope of this article to consider the problems that can arise in detail. Simply put, there is evidence that the Dräger software is unreliable with the result that invalid readings may flow from this source alone.(Head & Workman, 2007; www.duiblog.com, 2007).

Legal implications of Statistical and Methodological Errors in Breath Analysis.
What practical consequences flow from these errors? Clearly, there have been and will continue to be, miscarriages of justice if BAC is relied upon without careful discrimination at threshold values. The band width of known sources of potential error needs to be explicated in all forensic reports. This is not done at present. Rather, the obverse holds true.

There should, as a bare minimum, be a review of threshold BAA criteria in the absence of corroborative data. To quote from Norberg et al. (2003): 'More work is needed to document the variation in ethanol pharmacokinetics in real-world drinking situations' (p 26).

Such work will, we argue be greatly enhanced by a thorough appreciation of fundamental concepts of experimental methodology which seems to have been ignored, or not appreciated, by otherwise well informed commentators and scientists. More critically, such work is necessary in view of actual and mooted changes in legislation within Australia and elsewhere whereby a BBR of 2100:1 is, or will be, mandated. Clearly, this has the potential for grave miscarriages of justice to occur on the basis of the arguments espoused here.

In the light of the above, it may well be that a motorist who falls foul of the drink-driving laws of their State or Territory, on the basis of the reading generated by a breath analysis instrument, may wish to challenge the statistical processes and assumptions which underlie the accusatory print-out. How may this be done?

Traditionally, and normatively, there are various arguments employed in order to mount a defence against such a reading. It may be argued that the device in question is not one which is 'approved' (under subordinate Regulations or some similar process) for use for road traffic purposes. Alternatively, it may be argued that the police officer who operated the device did not do so in accordance with the manufacturer's instructions.

Sometimes the expert evidence adduced for the Defence is medical in nature, to the effect that the nature and quantity of the alcohol admittedly consumed by the accused should not have resulted in a reading at that level. Not only does this suffer from the major flaw that the court is being asked to accept the accused's own word as to how much he drank, what he drank, and when he drank it, but, as Harper J pointed out in *DPP v Phung* :

> 'As a check on the accuracy of the analysis performed by the instrument, it would only be of use where the divergence between the results of the analysis and the evidence of consumption is so marked that either the defendant is an abnormal human being in relation to the absorption and elimination of alcohol, or the machine must have produced a wrong result' (at 340).

This approach suggests the need for the existence of a wide disparity between the admitted consumption and the recorded BAC which will be of little value to the accused on the margin of a reading which is crucial to his case (e.g. 0.049%).

Many of the difficulties likely to be encountered in an attempt to challenge a breath analysis printout on the basis of the statistical unreliability of the workings of the device itself, in a case in which those readings were critically close to the legally significant margin of 0.05%, were highlighted in *DPP v Hore: DPP v Askwith* in which two motorists whose appeals were heard at the same time by the Victorian Court of Appeal sought to prove, by way of expert evidence, that the breath analysis instrument which had generated a reading of 0.075% (from H) and 0.052% (from A) was 'not in proper working order or properly operated'.

Their expert witness, Y, was described as a 'consulting analytical chemist', and he testified that he had conducted tests on both accused based on the type and quantity of alcohol which each admitted to having consumed on the days in question, and thereby generated data on the rate at which each of them absorbed and eliminated alcohol from their blood. His findings were that H's BAC reading should have been 0.034%, while that for A should have been 0.03%.

When asked to account for the discrepancy between his calculations and those generated by the breath analysis device, Y testified that either the accused were not to be believed on the issue of how much alcohol they had consumed, and/or over what period, or 'the instrument was not giving a correct indication of the actual concentration of alcohol in the blood'. The magistrate effectively accepted the latter explanation, and dismissed the charges against both accused. Unsurprisingly, the DPP appealed against both findings.

On appeal, the Victorian Court of appeal noted the comment made in *Thompson v Judge Byrne* that: 'Clearly, an analysis of blood which is seriously inconsistent with the analysis of breath conducted by the breath analysing instrument could, in a given case, cast doubt on the working order or proper operation of the breath analysing instrument' (at 154). However, it was then noted that while the original Bill which ultimately became the 1986 Act was being debated in State Parliament, it had been decided to delete another proposed provision which would have permitted evidence to be led of 'the general inaccuracy of breath analysing instruments of the type used'. In the event, it was the unanimous decision of the Court that the legislation: 'on its plain and ordinary meaning, operates to exclude evidence of the type given . . . by [Y]'.

However, the Court, by implication, indicated that the sort of evidence given by Y in this case could still be admissible for the purposes of the defence provided by s 49(4) of the Act which allows a person charged under s 49(1)(f) '. . . to prove that the breath analysing instrument used was not on that occasion in proper working order or properly operated', and this would seem to keep open the door for expert testimony as to any flaws in the statistical underpinning of conclusions arising from the use of such devices.

The Queensland case of *Pearce v Dennis* is further indication of the levels of pedantry which some courts will employ rather than allow the convenience of what might be termed 'guilt by

certificate' to be challenged. In this case, under legislation which preceded that currently in operation a motorist had sought to avoid the consequences of an adverse reading from a breath analysis instrument by reference to a previous unreported decision, *Pavich v Carroll-Walden*, which was said by the Court in the instant case to have led to the dismissal of the charge against the defendant in the previous case because:

> '. . the prosecution . . . had failed to prove that the breathalyser device used there had been so calibrated that it could perform, and could continue to perform, its function of properly measuring blood-alcohol content from a sample of human breath. To achieve this, it would have been necessary to use a thermometer and scales to measure a standard alcohol solution. For that purpose the thermometer and scales used would have needed to be verified under s10 of the *National Measurement Act 1960* (Cth).

> With great respect, however, [that] reasoning cannot be sustained. The fact that . . . the breathalyser or breath analysis instrument used to produce a certificate . . . is not proved to have been calibrated using equipment verified or authenticated under the *National Measurement Act 1960* (Cth) does not serve to discharge the onus resting on a defendant . . . of proving that the instrument was either defective or not properly operated. To prove that some sort of testing for accuracy has not been carried out is not to prove that the instrument in question is defective or not being operated properly. It simply means that there is no evidence on those matters. In the absence of affirmative evidence of defect or improper operation, the defendant fails to discharge the onus . . . The result is that the certificate . . . continues to have the evidentiary effect ascribed to it . . . , which is that the certificate . . . is conclusive as to the matters specified' (at 2-3).

In the light of all the above, it is not difficult to predict some of the judicial reactions which would be likely to confront any attempt to challenge a BAC certificate by what might be termed expert evidence as to psychopharmacology, experimental methodology and statistics. A sample of same might be:

> 'That's all very well, Mr X, but how can you argue from your statistical generality to a specific opinion that the breathalyser in this case was defective?'

'Very interesting, but what does your generalised conclusion tell this court about the *actual* BAC of the defendant in this case?'

'Is what you are telling this court about the potential unreliability of breathalysers generally accepted by your peers?'

'How many of these devices have you tested, in order to prove your theory?'

'What is the error rate of your calculations?'

Answers to all of these putative objections fall, to one degree or another, within the domain of an expert witness who is trying to persuade a court of something new. Parenthetically, it is worth noting that in a recent case a NSW magistrate refused to accept the psychopharmacological evidence sought to be adduced by one of the authors (IRC) on the basis that he had not operated the breathalyser in question! Among the many and, it has to be said, not entirely consistent tests which have been laid down over the years for the admissibility of expert testimony in areas which are not already 'notorious', in the sense of being well known and accepted by the judiciary, are those laid down by the U.S. Supreme Court in *Daubert v Merrell Dow Pharmaceuticals*, a class-action test case involving the pregnancy drug Bendectin, in which the well-formulated and researched conclusions of a minority of epidemiologists was denied expert witness status primarily because they challenged the received wisdom of the majority in their field of study.

What, inevitably, became known as the 'Daubert Test' for the admissibility of new scientific and technological opinion contains the following criteria, to which anyone seeking to mount an expert statistical challenge to breathalyser admissibility may expect to be subjected;

1. whether or not the technique or process has, or can be, tested;
2. whether or not it has been 'peer reviewed';
3. the known or potential 'error rate';

4.   whether or not the technique or process has gained general acceptance within the scientific community.

While it requires significant knowledge of experimental methodology and statistics to testify as to the error rate of a calculation designed to identify an error rate of a scientific instrument, this pales into insignificance at the prospect of being required to conduct thousands of clinical tests, have them peer reviewed, and then seek the blessing of those of one's peers who are probably fervently wishing that they had thought of it in the first place.

Conclusions

Once the mathematical certainty that BAA can overestimate actual BAC of breath analysis at the thresholds proscribed by legislation becomes general knowledge, court practitioners may anticipate being asked to find an expert witness who can scientifically oppose the admissibility of the BAA certificate evidence which has for many years dominated road traffic trials in Australia.

Alternatively, the various legislatures can save the prosecution from having to deal with this inconvenient truth by enacting legislation that unequivocally states that BAA (defined as a percentage, say, in terms of grams of alcohol per 210 L of breath) is absolute, unchallengeable, proof of BAC. Such 'reforms' have been mooted. Indeed, in other jurisdictions it is presumed that a BBR of 2100.1 obtains. In a decision that not only glosses over the inconvenient truth of potential errors of BAA at legally important thresholds but explicitly acknowledges that the prosecution should be spared the inconvenience of dealing with scientific fact the majority of the Supreme Court of California in *People v Brandsford* noted that statute "prohibited driving with 0.08 percent or more of blood alcohol as defined by grams of alcohol in 210 liters of breath' (at 885). The majority further noted that such an interpretation of the statute:

> '.. will increase the likelihood of convicting such a driver, because the prosecution need not prove actual impairment…Adjudication of such criminal charges will also require fewer legal resources because fewer legal issues will arise. *And individuals prosecuted under such a statute will be less likely to contest the charges* (emphasis added)' (at 891-892).

In a strongly worded dissent, Kennard, J opined:

> 'In short the....the defendants were charged and convicted of driving with alcohol in their blood, and not the crime of alcohol in the breath that the majority discovered lurking in the statute. Accordingly, the majority's conclusion-that evidence of the relationship between breath alcohol and blood alcohol is irrelevant to its new crime of driving with alcohol in the breath-has no application to these defendants because they were not charged or convicted of that crime'(at 900-901).

Whether the status quo, whereby the fundamental methodological problems associated with BAA remain unchallenged, or whether mooted legislative changes are adopted it is certain that grave miscarriages of justice will continue to occur based on the corruption of scientific methodology emblazoned in *People v Bransford*. It is to be hoped that this noxious argument does not prove contagious.

The problems we have identified with BAA and BAC do not end here. Most alarmingly, the almost universal acceptance of the Widmark formula, vis-à-vis backwards extrapolation to BAC levels at the time of an incident, are rarely challenged. Yet the same arguments espoused here apply to this approach. Thus, Gullberg (2007) points out that the uncertainty associated with estimates of BAC based upon the Widmark formula should include an estimate of twice the coefficient of variation of BAC (approximately 42%). This is not directly comparable to the SEM, and we have no data to enable us to draw a direct comparison. Nonetheless, whichever way one looks at this data it is clear that the arguments espoused here are not restricted in their generality. The forensic and legal implications of this are highly significant, if not paradigm shifting.

List of Cases

1. Chapman v Rogers; Ex parte Chapman (1984) 1 Qld R 542.
2. Daubert v Merrell Dow Pharmaceuticals (1993) 125 L Ed (2d) 469.
3. DPP v Askwith (2004) VSCA 192.
4. DPP v Ciantar (2006) VSCA 263.
5. DDP v Connor (2000) VSC 407.

6. DPP v Hore (2004) VSCA 192.
7. DPP v Phung (1994) 2 V.R. 337.
8. Furze v Nixon (2000) VSCA 149.Holt v Auckland City Council (1980) 2 NZLR 124.
9. Mehesz v Redman (No 2) 26 S.A.S.R. 244

10. Pavich v Carroll-Walden (no 115 of 1995), Brisbane District Court 27 March 1996, Judge Morley).
11. Pearce v Dennis (1997) QCA 239.
12. People v Bransford, (1994) 8 Cal. 4th 885; 35 Cal. Rptr. 613;884 P.2d 70
13. Philpott v Boon (1968) TAS S.R. 97.
14. Porter v Kolodzeij (1962) VR 75.
15. R v Ciantar (2000) VSCA 263.
16. State Government Insurance Commission v Whyatt (1984) 37 S.S.S.R. 454.
17. Thompson v Judge Byrne (1999) 196 CLR 141.

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