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DNA

Andrew Haesler SC[1]

As a lawyer and judge I want evidence presented in a way that makes my already difficult job easier. Like most people who have to determine complex issues I would love some expert to ease the burden of judgment by saying, "this is the answer". If only it were that easy. There's still a lot we don't know about DNA. For those who've heard me speak before I can still do no better than repeat the words of a once famous US poet Donald Rumsfeld:

> *"As we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say we know there are some things we do not know. But there are also unknown unknowns. The ones we don't know we don't know*."[2].

In a recent article by staff at the Victorian Police Service Centre a concern was expressed that ignorance about DNA testing (specifically secondary transfer) might limit sampling strategies, DNA profile interpretations and case investigations and "could also easily be exploited by defence councils."[3]

The converse is also true. Defence and others lawyers' ignorance (including I hasten to add that of judge's) of the analysis of crime scenes and DNA can easily be exploited by experts. Experts who, given our present law of evidence can express opinions based wholly or substantially on their training or experience without any requirement that it be reliable, peer reviewed or otherwise tested or even testable.[4]

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[1] Judge Andrew Haesler, District Court NSW. This paper draws heavily on an article DNA: Current Issues and Challenges by Professor Angela van Daal, Faculty of Health Science & Medicine, Bond University and Judge Andrew Haesler, District Court NSW, Judicial Officer's Bulletin [2011] Volume 23 no 7. The opinions expressed are those of this presenter. Other DNA papers can be found on the Public Defender webpage: http://infolink/lawlink/pdo/ll_pdo.nsf/pages/PDO_index

[2] Donald Rumsfeld, US Secretary of Defence, Dept. of Defence Briefing, Washington 12 Feb. 2002.

[3] M. Goray and others, Secondary DNA transfer of biological substances under varying test conditions, Forensic Science International: Genetics 4 (20101) 62-67.

[4] See s.79 Evidence Act 1995 (NSW and Commonwealth); R v Tang (2006) 65 NSWLR 681 at [137]; and the criticisms of that case in G Edmunds, Specialised knowledge, the exclusionary discretions and reliability (2008) 31 UNSW Law Journal 1 and The admissibility of incriminating expert opinion evidence in the US, England and Canada, *Judicial Officer's Bulletin* Vol 23 No 8 p 67.

Evidence of a match or consistency between the DNA[5] profile of a person (most often a suspect) and a profile derived from a crime scene stain and a statistical estimate as to the rarity of the profile is now generally accepted in all Australian Courts as evidence admissible to prove a fact in issue in the proceedings. Such evidence must be presented person with "specialised knowledge"[6] and supported by evidence as to the source and continuity of the sample analysed.[7]

That said DNA evidence and the apparent weight given to match results by statistical calculations still present significant challenges to the criminal justice system. These challenges affect, or in some cases afflict, how DNA evidence is gathered and interpreted and how it is presented and explained in Court. Given the often uncritical acceptance of DNA evidence and the attendant danger of miscarriages of justice, I want to discuss five areas which illustrate the problems courts face when presented by DNA profile match evidence:[8]

1. The efficacy of DNA typing from very low levels of DNA;
2. The possibility and impact of contamination;
3. The validity of convictions based solely on DNA evidence;
4. Judicial incapacity in dealing with statistics; and
5. Possible ways of recognising these problems and simplifying the presentation of DNA profile match evidence in criminal courts.

Low Template DNA (LTDNA) Analysis

The remarkable success of DNA typing has led to attempts to analyse increasingly smaller samples containing DNA, equivalent to less than twenty cells. This was known as low copy number (LCN) and more recently low template DNA (LTDNA) typing and has resulted in a new category of samples referred to as 'touch' or 'trace'. The standard DNA methods currently used require from 200 picograms (200pg) of DNA to 2 nanograms (2ng).[9] LTDNA typing is normally achieved with a slight modification of the testing procedure. It was first done at the Forensic Science Services in the UK in 1999[10] and concerns regarding its use have been expressed in the forensic science literature[11]. Part of the validation of any

[5] Deoxyribonucleic acid - DNA is found in all cells, except red blood cells.
[6] Section 79 *Evidence Act* 1995.
[7] *R v Karger* (2001) 83 SASR 135.
[8] There are many others, including privacy and genetic security issues. See Essentially Yours: The Protection of Human Genetic Information in Australia, *ALRC Report 96*, 2003.
[9] A nanogram is one thousand millionth of a gram. A picogram is one thousandth of a nanogram.
[10] Gill, P. et al. (2000) An investigation of the rigor of interpretation rules for STRs derived from less than 100 pg of DNA. Forensic Sci. Int. 112, 17–40.
[11] Budowle, B., Eisenberg, A.J. and van Daal, A. (2009) Validity of low copy number typing and applications to forensic science. *Croat. Med. J*. 50, 207–17.

forensic DNA method involves a determination of the limitations of the procedure[12]. Critically it is essential that there be an understanding of the least amount of DNA that can provide robust and reliable results.[13] As I understand it DNA analysis using less than 100- 200 pg (an amount equivalent to about 20-40 cells) can result in what are termed stochastic effects. These random sampling effects manifest as exaggerated artefact (stutter) peaks, allele peak imbalance, allele drop-out (not seeing one of the alleles) and locus drop-out (not seeing either allele at a locus).

Given the size of the sample analysed lack of reproducibility of DNA results is a hallmark of LTDNA typing. This is concerning because there is no way of knowing what the results might be obtained from replicate sample analyses. With the increased sensitivity of LTDNA analysis, there is of course a concomitant increased risk of contamination, which is further exacerbated because the samples are collected from often chaotic and certainly not sterile crime scenes. This greater propensity to contamination manifests as the appearance of peaks unrelated to the true DNA profile and is referred to as allele drop-in.

The problems associated with LTDNA analysis are compounded by the fact that most such samples have been shown to be mixtures of DNA from more than one person.[14] While many forensic laboratories have not adopted LTDNA analysis by modification of the standard protocol, they are often typing very low levels of DNA when they analyse mixture samples. Many mixture samples contain DNA mostly from one person (the major profile) and a low proportion from a second contributor (the minor profile). It is this minor profile that often has DNA from the equivalent of only a few cells and thus can be considered LTDNA. To accommodate the stochastic effects seen with such low levels of DNA, laboratories, I suggest, should conduct mixture validation studies to determine the peak threshold whereby a peak in a *mixture* sample can be assigned with confidence to the final DNA typing result. A value typically around 200RFU[15] in contrast to the common lower 50RFU peak threshold used for single source samples may be required. To date mixture validation studies have not necessarily been thorough and appropriate interpretation practices not uniformly implemented.

In Australia LTDNA DNA typing has on occasions been admitted as evidence. A controversial example was *R v Murdoch*[16] where the results of such tests conducted by the UK Forensic Science Service on the ties used to bind Ms Lees' hands, was allowed to go to the jury.

[12] Quality Assurance Standards for Forensic DNA Testing Laboratories, FBI Laboratory Services.
[13] I understand this has been determined to be an amount equivalent to about 20-40 cells or 100-200pg.
[14] This problem was discussed in *R v Hillier* [2010] ACTCA 3, see below.
[15] Relative fluorescence units - RFU are a measure of peak intensity.

Symptomatic of the problems associated with LTDNA typing were reports the DNA profile obtained from the evidence item included the profile of the laboratory director.

LTDNA DNA was notoriously criticised in the United Kingdom case *R v Hoey*;[17] a 2007 trial which followed a terrorist bombing in the Northern Ireland city of Omagh in 1998 that resulted in 29 deaths and wounding of a further 200 people. Weir J, in rejecting the LTDNA DNA evidence, was critical of the sample handling and the lack of appropriate protective precautions for typing of such low levels of DNA. The admissibility of the technique was later reviewed by the UK Court of Criminal Appeal, which held that generally LTDNA evidence would be allowed in evidence when there was more than 200pg DNA. The court said that careful direction and care as to how expert opinion was presented could allow the evidence to be fairly considered by a jury.[18] It was however accepted that where the DNA recovered was less than 200pg, the risk of random stochastic effects could impact on the results. Rather than saying bluntly, this evidence should not be led, the appeal court left it to the individual trial judge to consider the admissibility of the evidence based on an assessment of the expert opinion presented. One UK review of LTDNA noted any report should include the fact there were two unknowns, the nature of the original starting material and the time at which the DNA was transferred to the object and one known, the opportunity for secondary transfer was increased.[19] Given the number of caveats that should apply the use of LTDNA in Australia should be rare.

The problematic nature of interpretation of minor DNA profiles in mixture samples was highlighted in late 2009, when one Australian forensic laboratory ceased reporting DNA typing as a result of issues relating to mixture profile interpretation. An external review of the laboratory led to recommendations on standard mixture profile interpretation, including support for the use of 250RFU as the peak threshold value[20].

Contamination

Contamination can occur at the point of sample collection and handling or with analysis in the laboratory. The use of the sensitive PCR method has always required vigilance to protect against the potential for contamination.

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[16] *R v Murdoch* [2005] NTSC 76.
[17] *R v Hoey* [2007] NICC 49 (20 December 2007).
[18] *R v Reed & Anor* [2010] 1 Cr App R 23.
[19] Caddy et al, A Review of low template DNA analysis, Office of the Forensic Regulator (UK) 2008, pp 23-24 and recent comments by James Robertson, *Forensic science, an enabler or dis-abler for criminal investigation*, *Australian Journal of Forensic Science*, Vol 44 (2012) p.88.
[20] Fraser, J., Buckleton, J. and Gill, P. (2010) Review of DNA reporting practices by Victoria Police Forensic Services Division.

There have been several cases that have highlighted the perilous consequences of undetected sample contamination. They should each act as cautionary tales. The individualising power of DNA evidence is negated if the provenance of the sample is in question. The *Jama* case is an example of contamination at the time of sample collection, the *Hillier* case involved possible contamination in the police exhibit room while the *Leskie* and Gesah cases are illustrations of contamination within the DNA testing laboratory.

In the *Farah Jama* case a 19 year old Somali man was convicted of the rape of a 48 year old woman and gaoled. Mr Jama came under suspicion because a DNA match was found between him, and the 'victim's' vaginal swab. The 'victim' did not remember any assault. She believed she may have been drugged and raped but was unable to identify her 'rapist'. The evidence of her blackout was explicable by her blood alcohol level of 0.13% combined with ingestion of prescription medicine. She was found in a toilet locked from the inside. The evidence of Jama's involvement was also suspect. No-one recalls seeing a young dark-skinned man at the nightclub, which caters for middle-aged patrons and is located 15km from Jama's home. Jama's DNA was found on only one of four vaginal swabs, there was a surprisingly low level of sperm on that one swab and no semen was detected on her clothing. Additionally, Jama's fingerprints were not found in the toilet cubicle.

As it eventuated there was no rape, or in fact any sexual activity. A cursory investigation of the facts of the matter should have alerted investigators to the improbability of Jama being involved. When the matter was being prepared for appeal prosecution lawyers discovered that the day before the 'victim's' vaginal swabs were collected, vaginal swabs from another woman who had engaged in sexual activity with Jama were collected from the same hospital examining room. Jama's sperm was therefore present on the swabs collected prior to the 'victim' swab collection the following day at the same place. These swabs almost certainly contaminated the 'victim' swabs.

There is no doubt that undue weight was attached to the DNA evidence. Despite persuasive evidence that was inconsistent with the DNA, the prosecution proceeded to take the matter to trial and secure a conviction. The sample contamination was eventually uncovered, but not before the catastrophic consequences for those involved, Jama in particular. The enquiry into the matter by former Court of Appeal judge, the Hon Frank Vincent QC, was rightly critical of the failure of process at several levels[21].

[21] Victoria, Inquiry into the Circumstances that Led to the Conviction of Mr. Farah Abdulkadir Jama, 6 May 2010 (The Hon Frank Vincent QC). The journalist Liz Porter's award winning investigation into the background of the case can be found at http://about.theage.com.au/cmspage.php?intid=147&intversion=338.

The contamination in the *Jama* matter was beyond the control of the DNA testing laboratory since the sample was contaminated at the point of collection. This is not so in the *Leskie* matter. The 1997 disappearance of one year old Jaidyn Leskie led to an extensive manhunt. The toddler's body was found in a dam about six months later, in a well preserved state as a result of the icy waters. His bib, tracksuit pants and other clothing were also found. DNA testing was conducted on these items and presented at the 2003 inquest into Leskie's death. Surprisingly, the DNA typing obtained was the same as that of a female sexual assault victim, raped in another part of the state.[22] Her DNA was detected on the outer surface of a condom used by the rapist. She had never been to the Latrobe Valley. It emerged that the Leskie clothing samples and the rape samples were received into the laboratory within minutes and examined within a period of days of each other. The testing forensic laboratory insisted that this was not a result of cross-contamination, but was a coincidental match. However, it is much more likely that there was sample contamination within the laboratory, particularly given the close temporal receipt and analysis of the case items. The statistical probability of a coincidental DNA match at ten or more loci is vanishingly slim.

Because the *Leskie* matter was a coronial inquest, the adverse consequences were not as severe as the wrongful conviction of Jama. It is noteworthy that there was no evidence of poor laboratory practice in the *Leskie* case, which is perhaps an indication of the exquisite sensitivity and power of DNA technology.

While there was evidence of motive and opportunity the conviction of Mr Hillier for the 2002 murder of his wife was based largely on DNA analysis of biological material not visible to the naked eye, isolated from a pyjama top. It was only after two appearances before the ACT Court of Appeal and one before the High Court that at a second trials evidence was given pointing to the possibility of contamination in the police exhibit room; contamination that created enough doubt to result in an acquittal.[23]

A further example of contamination was seen with the 2008 arrest of Gesah for the 1984 murders of Margaret Tapp and her daughter. The Victoria forensic laboratory isolated DNA from the daughter's clothing and a comparison of this profile with the national DNA database resulted in a match with Gesah.[24] He was arrested, but shortly thereafter the charges were withdrawn because it became apparent that sample contamination had led to a 'false' match. In 1999 clothing from the Tapp murder was examined on the same day as items from another matter that had DNA matching Gesah. Further tests revealed that Gesah was not the

[22] Leskie DNA contamination 'illogical' The Age 17 December 2003.

[23] See *Hillier v R* [2004] ACTSC 81 & [2005] ACTCA 48 & (2007) 233 ALR 634 & [2008] ACTCA 3 & [2010] ACTSC 33.

[24] 'Charges withdrawn over murder of Margaret Tapp and daughter' The Herald Sun 6 August 2008.

source of other DNA found at the Tapp crime scene. This cross-sample contamination bears a striking resemblance to the apparent contamination in the Leskie matter.

The *Jama*, *Leskie, Hillier* and Gesah cases are stark reminders of the caution required in collection, handling and analysis of evidence items given the sensitivity of current DNA typing methods. They also illustrate why there cannot be blind acceptance of matching results no matter how reputable the laboratories which generate them.

A series of experiments conducted by the Victoria Police Forensic Science Centre have highlighted how easily DNA can be transferred from the object on which DNA was initially contacted to another which was not;[25] how DNA can be transferred from one part of an item to another while being stored as an exhibit;[26] and how even examination of fingerprints can transfer DNA.[27] When what we now know about the previously unknown is combined with the high probative value of DNA evidence, the need for appropriate vigilance by police, forensic scientists and the legal system is obvious. While DNA evidence is normally robust and highly probative it is not infallible and there is a need to guard against tendencies to explain away evidence inconsistent with a DNA result and for care in interpreting results, and, properly considering alternate scenarios.

Convictions Based Solely on DNA Evidence

In 2010 the High Court of Australia was asked to decide whether there is a rule of principle that where DNA is the only evidence incriminating an accused he or she must be acquitted. Special leave was refused.[28] In all States and Territories evidence of a DNA profile match between a suspect's sample and a crime scene sample is admissible as evidence going to a fact in issue in a case. There is no general rule saying how a jury or judge is to assess DNA evidence. There is no general rule saying whether or not such evidence alone is enough to establish the identity of an offender and thus secure a conviction.

In New South Wales the Court of Criminal Appeal has held that a DNA profile match could not in the absence of other evidence prove beyond reasonable doubt that the accused was responsible for leaving the crime scene stain:[29] Since those relatively early decisions, DNA

[25] M Goray et al, Investigation of secondary DNA transfer of skin cells under controlled test conditions, Legal Medicine 12 (2010) 117-120.
[26] M Goray et al, DNA transfer within forensic exhibit packaging: potential for DNA loss and relocation, Forensic Science International: Genetics (2011).
[27] R. van Oorshot et al, Beware of the possibility of fingerprinting techniques transferring DNA, J Forensic Science Nov. 2005 Vol 50 No6 1-6.
[28] F*orbes v R* [2009] ACTCA 10 & [2010] HC Trans 120.
[29] *R v Green*, unreported CCA NSW 26/3/1993; *R v Pantoja* (1996) 88 A Crim R 554 & *R v Milat* (1996) 87 A Crim R 446 at 447.

evidence has been considered on many occasions, but the specific issue has not been decided at the appellate level.[30]

Victoria's Court of Appeal, similarly, has held that DNA profiling establishes no more than that the accused *could* be the offender.[31] This point is taken up in Victoria's Judges' Bench Notes.[32] Although I note these did not prevent Mr Jama's conviction. In South Australia their Court of Appeal has dismissed appeals where DNA was the only evidence of the identity of the offender.[33] This is despite the direction from an earlier and authoritative decision of that court that a jury can only convict if the DNA is evaluated in the context of *all the other evidence*.[34]

In England there is no principle of law that DNA evidence of itself is incapable of proving guilt.[35] There is no rule about when it is safe to leave statistical calculations to a jury.[36] A judge can however instruct a jury that where the DNA evidence stands alone they could not convict.[37] The significance of the DNA depends on the evidence in the individual case and how it is to be assessed depends critically upon what else is known about the accused.[38]

United States courts have rejected the idea that DNA evidence alone cannot convict.[39] DNA evidence treated as highly reliable and better than visual identification evidence. However, it has been recognised that DNA often fails to provide the absolute proof it promises.[40]

Cases where DNA is the sole evidence of identity are coming before the courts and there have been demonstrated miscarriages of justice. How then are we to ensure fair trials? One response is to say: If DNA evidence is properly collected and observed and an expert, properly qualified, gives evidence of the analysis and results, that evidence should be admissible and a jury (or judge as fact finder) should be entitled to rely on that conclusion, as occurs with evidence of visual and voice identification and fingerprints. If any "additional"

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[30] The question was raised recently in *Talay v R* [2010] NSWCCA 308 but the appeal was dismissed on procedural grounds. At [65] Howie AJ, in an obiter comment, said he did not believe there was merit in the application.
[31] *R v Noll* [1999] 3 VR 704 at [25.
[32] At paragraph 4.13.2.2, Charge: DNA Evidence.
[33] See *R v Rowe* [2004] SASC 427 & R v Gumm [2007] SASC 311 at [32].
[34] *R v Karger* (2001) 83 SASR 135. A fine example of a standard direction can be found in R v Carroll [2010] SASC 156, (a case where there was some other evidence). The Queensland Court of Appeal in *R v Fletcher* (1998) 2 QR 437made similar points.
[35] *R v Adams* [1996] 2 Cr App R 467 at 469.
[36] *R v Watters* [2000] EWCA 81.
[37] *R v Reed* [2009] EWCA 2698.
[38] *R v Doheny and Adams* (1997) 1 Cr App R 369 at 373.
[39] *Rush* 672 NYS 2d 362.
[40] See *DA v Osbourne* 556 US – 2009.

circumstances are necessary they can be found in evidence about the type of substance from which the DNA is extracted and where it was found.[41]

To allow a jury (or a judge) to find guilt because of evidence of a DNA, profile match and supporting statistics assumes that (1) there has been no contamination in the collection or analysis of the sample and (2) in cases of DNA evidence only cases the statistical interpretation of the significance of the DNA match is evidence of the probability that the appellant *was* the source of the incriminating DNA rather than one of a number of circumstances that may be taken into account in reaching that conclusion. These assumptions are somewhat problematic.

Courts cannot ignore the human element, by which term we mean the dangers associated with the giving of expert opinion about ostensibly unimpeachable data. Courts cannot ignore the fact that we are dealing with such small samples that the possibility of secondary transfer or contamination and even corruption are ever present dangers. Contamination has already occurred, even with appropriate laboratory procedures in place.

Jury Directions

In 2002 journalists in the USA coined the phrase "CSI effect". It refers to the suggestion that jurors who watch fictional crime scene television programs such as CSI have changed their requirements for delivering a verdict according to the presence or absence of forensic evidence.[42] The CSI effect has two quite contradictory elements. The first is that jurors may be overwhelmed by the presentation of expert evidence and convict, because of a tendency to overrate DNA evidence. As a consequence the introduction of DNA evidence may result in more convictions than are warranted.[43] The second aspect is where jurors ask for or demand additional forensic evidence and refuse to convict where there is an absence of forensic evidence.[44] Other studies however were more positive. Despite jury difficulties understanding DNA evidence there appeared to be less risk that jurors would overweigh DNA evidence at least in the context of relatively weak DNA in a circumstantial case.[45]

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[41] The problem with this approach was illustrated by Mr Jama's case.

[42] Jenny Wise, Providing The CSI Treatment, Current Issues in Criminal Justice, vol. 21 no.3 p 383.

[43] Goodman-Delahunty J and Tate D (2006) DNA And The Changing Face Of Justice. *Australian Journal of Forensic Science*, vol 38, pages 97-106.

[44] Franzen R (2002) CSI Effect On Potential Jurors Has Some Prosecutors Worried. *Santiago Union Tribune* 16 December 2002.

[45] S. Dartnell and J Goodman Delahunty, Enhancing juror understanding of Probabilistic DNA evidence *Australian Journal Of Forensic Science* 38(2) 85-96 & K Edwards (2005) 29 Crim LJ 71, Ten things about DNA Contamination that Lawyers should know.

The danger caused by the seductive impact of DNA statistical evidence requires something be said at trial either as direction or warning.[46] A proper direction must be relevant to the particular trial and the evidence before the court. If a jury is to avoid confusing statistical evidence with the probability of guilt it is critical for them to appreciate three points:

1. The statistical evidence interpreting the significance of the DNA match is not evidence of the probability that the appellant was the source of the incriminating DNA. To so regard it would be to make an error.

2. The statistical evidence interpreting the DNA match is expert evidence that the jury could use in deciding whether it was satisfied beyond reasonable doubt that the appellant was the source of the incriminating DNA.

3. The statistical evidence is undeniably strong evidence pointing to a conclusion that the accused was the source of the incriminating DNA, but it is not direct evidence of that fact. And, as is obvious, the statistical evidence must be considered in the light of other evidence in the case. It is necessary for the jury to appreciate these points if they are to make proper use of the statistical evidence.[47]

It will be a rare case that the only circumstance identifying the accused and linking him to the crime is a purported DNA match as the facts of Mr Jama's case illustrate. In *Forbes* it is arguable that there was additional evidence. Such cases are however becoming increasingly more likely in high volume crimes such as break and enter.[48] Following *Jama* the Victorian DPP amended their prosecution guidelines: where DNA is to be relied on the prosecution should be reviewed in advance and only proceed if the DNA is clearly reliable and highly probative and or where it is supported by sufficient other evidence.[49]

In the *Jama Report* Justice Vincent noted[50] there was no formal bar to a conviction based solely on DNA evidence. A judge cannot withdraw a matter from a jury just because the

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[46] Doyle CJ in *Karger* did not favour a general warning.

[47] *Karger* at [16] and [17]. Australian Law Reform Commission, op cit n 45, Part J, Law Enforcement and Evidence Chapters 39–46, [44.50]. In the United Kingdom suggested guidelines can be found in *R v Doheny* [1997] 1 Cr App R 369 and in the Northern Territory in *Latcha v The Queen* (1998) 104 A Crim R 390. The Supreme Court of British Columbia has suggested that before DNA evidence is presented to a court it should be made sufficiently clear that:

- the estimates are not intended to be precise;
- they are the products of mathematical and scientific theory not concrete facts;
- they do not purport to define the likelihood of guilt;
- they should only be used to form a notion of the rarity of the genetic profile of the accused; and
- the DNA evidence must be considered along with all the other evidence in the case relating to the issue of identification.

[48] See for example *Talay v R* [2010] NSWCCA 308 and the decision of Magistrate Heilpern in *Police v Le Platrier* [2010] NSWLC 22.

[49] *Victorian DPP Prosecution and Policy Guidelines* 2.1.13.

[50] At p.45.

judge thinks that the evidence is unsatisfactory, not cogent enough or that a jury might have trouble with the expert evidence.[51] Where the DNA match is the only evidence identifying an accused a court could say that that element of the offence has not been proved and the matter can be withdrawn for want of proof. The view most consistent with authority, however, is that as there is some evidence of identity it should be left to the jury. That said, as Justice Vincent concluded:

> *"The better view is that a conviction should only be returned where there is DNA evidence and at least one other item of evidence present which is consistent with the guilt of the offender".*

Can an unfair trial result from the way statistical evidence supporting a DNA profile match is presented?

In November 2005 Ms Bayrak a member of Sydney's Turkish community was stabbed to death in her flat.[52] Suspicion focussed on her current and former boyfriends. Although the former boyfriend Mr Aytugrul had not been to the deceased's flat, a hair, which could have been his, was found in blood stuck to the deceased's thumbnail. Putting to one side a relatively minor, if interesting, disagreement between the experts called, each said the profile was relatively rare. All gave similar figures for persons other than Mr Aytugrul being expected to have a DNA profile matching that extracted from the hair (called at trial random occurrence ratio). They were between 1 in 2,000 and 1 in 1,000 in the general population and between 1 in 50 and 1 in 100 in the Turkish population. At the request of the trial judge, the defence expert expressed "1 in 1000" as an exclusion percentage of 99.9%. Aytugrul was convicted and appealed.

What was in issue in *Aytugrul v R*[53] was how expert opinion about the probability some other person other than the accused has the same profile as that in the crime scene stain was expressed. Reliance was placed on earlier decisions,[54] which had accepted that percentage figures "may mislead the jury and lead it to give the evidence greater weight than it ought to be given."[55]

The Court divided on how the presentation of the DNA evidence impacted on the fairness of the trial. Justice Simpson, with whom Justice Fullerton agreed, saw no unfairness in the way in which the evidence was presented. Her Honour noted that the DNA evidence was not objected to and was clearly admissible. She could not see how otherwise admissible

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[51] See *R v R* (1989) 44 A Crim R 404 and *R v Lisoff* [1999] NSWCCA 364.
[52] *Aytugrul v R* [2010] NSWCCA 272.
[53] [2010] NSWCCA 272.
[54] *GK v R* (2001) 53 NSWLR 317 and *Galli v R* (2001) 147 A Crim R 493.
[55] *Galli* at [50] and [72].

evidence could be said to be unfair simply because of how it was expressed. She acknowledged that this view had been expressed in earlier decisions but held that neither case stood for a proposition that exclusion percentages were never admissible.

Justice McClellan, in dissent, held that the way in which the equation was expressed could produce unfairness as percentages could give the impression that there is no possibility other than there is a proper match or there is no possibility other than that the accused is the source of the crime scene stain. He recognised that his reasoning was applicable both to the modest odds or when odds such as 1 in a billion were presented*:*

> *"Jurors may incorrectly assimilate a low likelihood ratio with a 0.0% chance that the crime scene DNA came from anyone but the accused."*

Justice McClellan[56] relied on a number of publications by JJ Koehler which suggest that statistics when framed in the language of probability that is, percentages, appear more persuasive than if framed in the language of frequencies, for example, one in a thousand. Percentages appear more probable, and, as they come closer and closer to zero, more compelling. Frequencies on the other hand allow for other alternatives.

In December 2011 the High Court heard an appeal where both the propositions put forward by Justice McClellan and Justice Simpson were systematically reviewed. The High Court reserved its decision and it is still pending at 12 March 2012.

Dealing with Judicial numerical dyslexia

Two recent cases from the ACT illustrate how judges can misinterpret comprehensive DNA profile match evidence carefully presented by experts.[57] In the first trial Dr Simon Walsh tried to explain how in a population of 18,000 using the 9 loci Profiler plus system there remained possibility of an adventitious match between two unrelated individuals despite the likelihood ratio (or random match probability) of such a match being in the billions! He used the term "not unexpected" which it appears totally threw the equilibrium of the judge hearing the case.[58] In the second, he was confronted by questions from a judge who wanted certainties not probabilities. Dr Walsh was moved to ask at a conference late last year:[59]

- What does a court require when an expert presents DNA evidence?

[56] At [89] –[95].
[57] *R v Meyboom* [2011] ACTSC 13 & *R v Whyms* [2012] ACTSC 7.
[58] *R v Whyms*.
[59] S. Walsh, presentation, To infinity and beyond: A critical look at DNA as the gold standard of forensic evidence interpretation, AAFS Symposium on evidence interpretation, Sydney, December 3-4 2011. There Simon Walsh pointed out that the figures presented in Meyboom indicated the chance of an unrelated person having the same profiler plus profile as Mr Meyboom made it far more statistically likely the judge would be hit by lightening on his way to court!

- Can expert actually meet those requirements?
- Can evidence be presented in a way that instils confidence in the conclusions expressed?
- How can expert evidence be improved?

Dr Walsh's questions are important and must be asked of every forensic expert. For my part I believe that while there is room for improvement DNA evidence can be properly and simply presented at trial if all involved understand its limitations. I have as much confidence a judge can understand the issues as 12 jurors. I am also acutely conscious that given the results of recent US review of Forensic evidence thee is much more danger in misrepresenting other forms of forensic identification evidence and that DNA is at the moment the "gold standard."[60]

To illustrate the different perspectives that apply when an expert's certainty collides with reasonable doubt, consider the two scenarios in the Appendix in the context of this mock cross-examination:

> Forensic scientist: "In my opinion the DNA profile results show this accused has the same profile as the crime scene sample and this profile is expected to occur in less than one in 23 billion unrelated individuals in the general population."
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> Defence lawyer: "Surely all you are saying is the profiles match?"
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> Forensic scientist: "Its more than that. I am putting a value on or giving meaning to the match."
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> Defence lawyer: "A ratio of 1 in 23 billion is simply a statistical conclusion?"
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> Forensic scientist: "No, it's a scientific conclusion that has statistical validity."
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> Defence lawyer: "But your conclusion is just a product of the application of the product rule?"
>
> Forensic scientist: "Yes, and those results provide extremely strong support for the proposition the crime scene DNA originated from the accused."
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> Defence lawyer: "Your conclusion can have no certainty?"
>
> Forensic scientist: "It is not a statement of certainty it is a statement expressing the degree of scientific and statistical support for my opinion there is a profile match."

[60] Strengthening Forensic Evidence in the United States: The Way Forward, *National Research Council* (2008).

Defence lawyer: “And, the modified product rule used in reporting DNA evidence conclusions has a number of assumptions underpinning it?”

Forensic scientist: “Yes.”

Defence lawyer: “So everything depends on your assumptions?”

Forensic scientist: “Yes, but those assumptions have been tested and validated.”

Defence lawyer: “If those assumptions are not valid the conclusion lacks validity.”

Forensic scientist: “Yes- I agree that the impact of all assumptions must e tested and validated.”

Defence lawyer: “So your results can never be certain?”

Forensic scientist: “I don’t profess to give a certain answer, just a scientifically valid one.”

Defence lawyer: “So science cannot even predict if someone else in this room has the same profile as the accused?”

Forensic scientist: “No.”

Defence lawyer: “It would not be unexpected that in a population of 2 million or even 200,000 a chance match might between two unrelated individuals occur at 9 loci?”

Forensic scientist: “No, it would not be unexpected.”

Defence lawyer: “And there would be an even greater chance of a match if the population contained siblings or other close relatives?”

Forensic scientist: “Yes.”

Defence lawyer: “How many profiles are on the data base on which the accused’s profile was found?”

Forensic scientist: “35,000?”

Defence lawyer: “And if each profile was tested against the other how many potential matches could there be?”

Forensic scientist: “35,000 x 34,999 = over a billion.”

Defence lawyer: “So there is a chance of a random match occurring in any database of that size?”

Forensic scientist: “Yes.”

Defence lawyer: “So how can you say it is my clients’ profile?”

Forensic scientist: “I’m not saying its your client’s profile. I’m saying your client profile matches that from the crime scene and the statistical analysis, founded as it is in tested assumptions, means it is highly unlikely another unrelated person has such a profile.”

Defence lawyer: “So there must be a doubt it his profile?”

Forensic scientist: “That’s for the jury to determine not me.”

I suggest an opinion about who ‘won’ this encounter may depend on the perspective of the observer. I hesitate to express an opinion about what the average juror or judge might think!

The scientific and legal communities are trying to meld a number of distinct although not always mutually exclusive interests that ultimately aim to ensure we have a working and safe community in which to live and prosper:

- The police investigator wants to answer the questions; “who done it?” They want information to aid that investigation or their theory of the case and are often disappointed when a court rejects such information as inadmissible.

- The forensic scientist wants to aid the police investigation and produce an appropriate outcome, i.e.: convict the guilty and acquit the innocent by fairly presented (scientifically valid) forensic evidence.

- The prosecutor wants to prove a case against a person beyond reasonable doubt.

- The defence lawyer wants to highlight any and every possible doubt.

- The Judge wants to ensure a fair trial so that the guilty are convicted and appropriately punished and the innocent go free.

- The jury just want to have enough information to make a fair and correct decision.

It is critical to recognise that each interest is narrow. Judges are not concerned with police investigations; for what is required for an investigation is not necessarily able to be used in court. Verdicts do not determine scientific certainly or other truths. While truth is a noble aim for any endeavour it presents too high a standard against which to measure legal proceedings where often severe punishment follows a guilty verdict.

In some of the commentary on the recent UK decision in *R v T*[61] there was talk of a "clash between law and science" following the court's rejection of the use of Bayes' theorem in a criminal trial. To address Dr Walsh's questions would require a separate paper but it is must be understood that criminal investigation is not like CSI on TV or a Patricia Cornwall novel, lawyers don't want experts to decide based on all the evidence who is guilty no matter whether their analysis is Bayesian or not. That's why we have police, prosecutors, juries and judges. "All we want are the facts."[62] That is, enough facts to determine the source of the incrimination evidence. We also want a clear explanation of the scientific facts: [63] And, if there is a controversy, the nature of that controversy. There is no clash between law and science. The law could do with more science and forensic science could do with a little more legal rigour. but one way of reducing the risk of misunderstanding is to avoid adding complexity where it is does not serve any interest at trial.

Simplifying the presentation of DNA evidence in criminal courts:

Since DNA evidence was first used in court judges have been saying: "The statistical evidence interpreting the significance of the DNA match is not evidence of the probability the accused was the source of the incriminating DNA".[64] Nevertheless, there is still a lot of time wasted and confusion about testing in court what is really indisputable. This can mean not enough time is spent on examining maters of real importance such as how did the accused's DNA profile get to the crime scene.

Law enforcement agencies have spent huge amounts of money increasing the size of databases. While this may increase the possibility of a cold hit I have since I was first involved in drafting the Forensic procedure Act had my doubts. Now we have such large databases the chance of an adventitious match is correspondingly increased. One response is to increase the discriminating power of the test and look at 13 or 21 loci. But if a Profiler Plus 9 loci "match" is not evidence of uniqueness, and the bigger the data base the greater the chance of a match all I suggest flows from this that guilt beyond reasonable doubt cannot be established solely by a profile match (even if accompanied by extraordinarily high statistics). This has and I suggest will remain the case until each of our individual genomes is sequenced. Accordingly there is scope for general agreement about how evidence of DNA profile matching is to be presented in court?

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[61] [2010] EWCA Crim 2439.

[62] Wikepedia tells us that this is what Sgt Joe Friday actually said, although I still prefer "the facts mam, just the facts."

[63] I once had a traumatic experience of having asked the question of an expert "Now Professor could you explain that in simple terms" receiving the only simple answer of the day, "No".

[64] Doyle CJ in *R v Karger* (2002) 83 SASR 135 at 140.

I want to put out for discussion a possible partial solution for presentation of DNA match evidence. The trick, I suggest, is to keep it simple. What I suggest is this:

> *Where there is a profile match between a crime scene sample and a nominated individual supported by a likelihood ratio over 1: 1 billion this provides extremely strong support for the proposition they have the same source, given certain assumptions: that is, not close relatives are not included, there is an allowance for general (or specific) population relatedness, there is independence of loci tested and the estimate of allele frequency is valid .*
>
> *Given that foundation an expert can then say one of three things:*
>
> 1. *A match means it is highly unlikely that another unrelated person has the same profile, or*
>
> 2. *The person can be excluded as having the DNA found in the crime scene stain.*
>
> 3. *The person can neither be excluded nor matched to the crime scene stain.*

So far as 1 is concerned this means that there always remain a possibility some other person may have the same profile. This possibility becomes much greater if they have a twin, other siblings or other close relatives. The proposition only has substance if based on sound and explicable statistical data and assumptions. It only has evidentiary value if qualified by the directions noted above. It is not evidence the accused left the crime scene stain only evidence in support of that proposition: evidence that needs some form of corroboration.

So far as 2 is concerned the nominated person cannot have contributed to the profile taken from the crime scene stain. This does not mean their DNA was not present, just that it was not found in the sample analysed.

So far as 3 is concerned, while much information such as partial DNA match, possible presence in a mixture or even possible familial matches or indicators of race or hair colour may be highly relevant to an investigation; what is good for the investigator is not always good enough for court. The courts have yet to fully explore the limits and limitations,

including admissibility and fairness, issues when circumstantial genetic evidence of identity is sought to be adduced in a prosecution case.[65]

On one view a 'not excluded' finding has no relevant probative value. On the other hand a case can be proved by amassing small threads of evidence, none of which need to be proved to any standard; threads which may only assume relevance when combined.[66] Should a jury or judge not be told that, as with the case of *Aytugrul,* that the profile found could occur in 1 in 50 people in the community? My preference is to say "no," such a figure really has no relevance or has the potential to induce unfair and prejudicial reasoning process.[67] I suspect the appeal courts will say as they did in the UK LTDNA case of *Reed* that as long as it is accompanied by careful direction such evidence is still both relevant and admissible.

Conclusion

DNA evidence can assist the prosecution establish the identity of an offender. A profile match even if supported by impressive statistics as to its rarity is not regarded by courts proof of identity. The sensitivity of DNA testing brings with it consequent dangers from contamination, including undiscovered secondary transfer of DNA and overestimates of the efficacy and reliability of the available technology. The potential probative force of statistics, given in support of a DNA profile match, means great care must always be taken in the presentation of the DNA evidence and how a jury is directed to use such evidence.

If there is a real and substantial risk that the way in which evidence is expressed can result in unfairness then fair and consistent ways of explaining the true import of the evidence and giving a jury a correct understanding about the relative rarity of the profile must be found. Serious consideration also needs to be given to questions of admissibility of some DNA evidence. If admitted the qualifications and assumptions behind it must be carefully explained and accompanied by appropriate directions or warnings.

That said; most DNA results on the Profiler Plus system from unmixed sources are clear and unambiguous and backed by likelihood ratios in the billions. While it is theoretically possible another unrelated person might have the same profile this is so unlikely that the result can be expressed with a degree of scientific certainty far in excess of other conclusions of fact regularly accepted by the courts.

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[65] Here's another suggestion for a future paper.
[66] *The Queen v Hillier* (2007) 233 ALR 634.
[67] See Report of the Australian Law Reform Commission *Evidence* Report 2 vol 1 at [957].

In such circumstances the statistical numbers become meaningless and a way must be found to simplify the presentation of such evidence in a way that recognises the strengths and failings of criminal proofs deriving from matching suspects with DNA recovered from crime scenes. The suggestions outlined above are only a start.

APPENDIX DNA Scenarios

Scenario 1:

A quite night in Orange NSW often involves young people drinking in Robertson Park. After one such quiet night a young girl went to the nearby police station saying she had been raped by a short baldy Aboriginal bloke called Sean.

A review of CCTV from the park showed a young man known to police as Sean. He was short and had a shaved head. While admitting to being in the park he denied any rape. He was arrested and refused bail.

After three months in gaol he was released. His DNA profile did not match to that from the semen obviously left by the young woman's attacker.

Three years later Leon was caught doing a break and enter in Orange and his DNA profile uploaded on the database. It came up as a cold hit match to that of the young woman's attacker. He lived in Orange. His alibi for the night was weakly supported. He too was Aboriginal. He denied the rape. He denied knowing the complainant or having any form of sexual relations with her then or ever. She on the other hand knew who he was but similarly denied ever having sexual relations with him.

The cold hit on Leon was replicated in a fresh sample taken from him. It was found to match DNA profile from the semen sample at all 9 loci on the Profiler Plus system. A statistical analysis using the NSW Aboriginal database came up with a 1 in 10 billion figure as to the likelihood another unrelated Aboriginal person in NSW would have the same profile. This was described as a "conservative figure" as the actual spreadsheet figures, applying the product rule with the allowances for subpopulation effects, gave a ratio in the 1: 330 billion range.

Evidence was given that a full sibling would have a 1 in 9,300 likelihood of having the same profile and an uncle 1 in 190 million.

At trial uncontradicted evidence was called to show that at the relevant time Leon was tall wore his hair long in dreadlocks. He also had a same age Uncle called Sean. A photo from the time showed Sean to be short and bald!

A jury acquitted/convicted Leon?

Scenario 2.

It was a cold July night in Fadden, ACT. Hearing noises from a home they knew to be empty neighbours telephoned the owner's son. He arrived to see a white hatchback car leaving the street. Inspection of his parent's home revealed broken glass, a break-in and missing property. Fresh blood was found on the broken glass.

A DNA profile from the blood matched that of a known offender Michael.

Experts gave evidence that there was a 1 in 23 billion chance that the profiles from the blood came from Michael as opposed to another unrelated person in the ACT.

Michael pleaded "not guilty."

At his trial before a judge sitting without a jury the prosecution established.

I. The blood and the broken glass were fresh and contemporaneous to the break-in.

II. A rechecking of all data supported the original profile match and supporting statistical analysis.

III. Michael owned a white hatch back.

IV. Within 12 hours of the break-in that hatchback was found to contain both Michael and some of the stolen property.

V. Michael had one sibling, a brother, who was not in the ACT at the relevant time.

The judge acquitted/convicted Michael?