Forensic databases: benefits and ethical and social costs

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Introduction: This article discusses ethical, legal and social issues raised by the collection, storage and use of DNA in forensic databases.

Review: The largest and most inclusive forensic database in the world, the UK National DNA database (NDNAD), leads the worldwide trend towards greater inclusivity. The performance of the NDNAD, criteria for inclusion, legislative framework and plans for integrating forensic databases across Europe are discussed. Comparisons are drawn with UK biobank that has started collecting DNA samples linked to medical records and, unlike the NDNAD, requires informed consent from volunteers, allows withdrawal of samples and only includes adults. The potential uses of research into genes associated with violent and ‘antisocial’ behaviour are discussed in the context of an increasing degree of surveillance in the UK.

Conclusion: It should not be assumed that the benefits of forensic databases will necessarily override the social and ethical costs, regardless of changes to the criteria for inclusion or the permitted uses of samples and profiles. The expansion of forensic databases raises issues of relevance to the medical profession.

Keywords: DNA profiling/ethical issues/forensic databases

Introduction

Forensic genetics applies the knowledge and techniques of genetics to policing and the justice system. Currently, DNA samples are taken from crime scenes, from suspects (which suspects and in what circumstances vary by country) and from ‘volunteers’ for elimination purposes. Depending on legislation in the country concerned, samples and profiles may be stored permanently or for a limited time, routinely searched for matches with crime scene samples, used for familial searching and for research relevant to crime detection. New techniques of DNA analysis, including ‘low copy number’ (LCN), can generate a profile from smaller and lower quality DNA samples. DNA evidence
can, of course, be used to exonerate as well as to inculpate suspects, and the US Innocence Project is reported to have cleared 195 convicted criminals in this way; the average time they had served in prison was 12 years.¹

Although genetic testing and the collection, storage and use of DNA data for medical research have been debated all over the world, there has been less public debate about the use of DNA data as criminal evidence. Public support has been presumed on the grounds that all law-abiding people want criminals to be caught and convicted and the ‘innocent’ have nothing to fear from DNA technology. Personal genetic information collected with consent for medical treatment or research may, subject to judicial authority, be accessed for police investigation in spite of the stated opposition of governance bodies. DNA samples that were collected without consent from suspects have been used for research in the UK, though not all research requests have been granted. Separately from current forensic uses, there is also current research into genes associated with violent and antisocial behaviour and there have been suggestions that this research could be used to inform those dealing with ‘at risk’ children and their families.² The collection, storage and use of sensitive and identifying personal data always raise ethical, social and legal issues. If it is argued that any connection with criminal investigation or control means that there is no need for the usual scrutiny, then there is a price to pay in terms of civil liberties, especially by those who are on the database despite not being guilty of any crime and by children.

The promise of forensic genetics

As the UK has the largest forensic DNA database in the world, with DNA profiles from around 3.4 million individuals (6% of the population) and 263,923 crime scene profiles, its success can indicate the potential of databases for solving crime and any concomitant concerns. According to the NDNAD Annual Report, the probability that a new crime scene profile loaded onto the database will match an individual’s profile already on is 52%.³ This figure will of course include matches with victims and others who have been at the crime scene for innocent reasons. Where DNA crime scene samples can be obtained, the detection rate for crimes increases, for example, for domestic burglary from a national detection rate of 16 to 41% and for theft from a vehicle from 8 to 63%.⁴ Only about 0.36% of crimes are detected through DNA, and this figure has remained constant despite the increase in the numbers of profiles stored from individuals (Table 1). The use of a mobile laboratory by the Forensic Science Service should increase the
speed with which crime scene profiles are loaded onto the NDNAD by performing DNA analysis at the crime scene and identifying individuals more quickly.

The ability to construct a DNA profile from lower quality and smaller amounts of DNA, even a single hair, has enabled the reopening of ‘cold’ cases. Family searching is used in selected cases to look for close matches that indicate a genetic familial link.

### Genetic profiling

A DNA profile in the UK is constructed from short tandem repeats (STRs) which are short sequences of non-coding DNA that consist of repeated sequences of between two and 10 DNA bases. The number of independent loci sampled together with the range of repeats gives a probability of one in a billion for a match between two unrelated individuals when 10 markers are used. Although this is a conservative overestimate, it cannot be interpreted as meaning there will be no random (false) matches. A random match is more likely where there are partial profiles and as the size of a database increases. STRs may be amplified from small amounts of degraded DNA, using the polymerase chain reaction. The stored DNA profiles consist of 20 numbers and an indicator of gender. Ethnicity is recorded by the police officers, choosing one of seven categories on the basis of the person’s appearance. Profiles based on six markers rather than 10 are still in the database but are upgraded if a match is found (this is possible because the full samples are retained). The estimated probability of random matches makes DNA evidence particularly powerful when presented in court but there is a danger that the statistics are misunderstood, i.e. taken as meaning that the chances that the particular profile is not that of the accused individual are a billion to one against. The USA FBI Combined DNA system (CORDIS) has

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<tbody>
<tr>
<td>Number of individuals' DNA profiles on NDNAD</td>
<td>2 099 964</td>
<td>2 371 120</td>
<td>2 802 849</td>
<td>3 534 956</td>
</tr>
<tr>
<td>DNA detections</td>
<td>21 098</td>
<td>20 489</td>
<td>19 873</td>
<td>20 349</td>
</tr>
<tr>
<td>Recorded crimes</td>
<td>5 920 156</td>
<td>6 042 991</td>
<td>5 623 263</td>
<td>5 556 513</td>
</tr>
<tr>
<td>DNA detection rate (%)</td>
<td>0.36</td>
<td>0.34</td>
<td>0.35</td>
<td>0.37</td>
</tr>
</tbody>
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*Table 1 DNA detection rate for recorded crime in England and Wales (2002–06).*

*Note:* The NDNAD covers the UK but the criteria for exporting profiles from Scotland are stricter due to Scottish legislation (see also the notes of Table 2).

*Sources:* Genewatch, [http://www.genewatch.org/sub.shtml?als%5Bcid%5D=548276; Compiled from official figures.}
used 13 loci since 1997. Sir Alec Jeffreys, who invented DNA fingerprinting, has suggested that 15 or 16 markers should now be used as the size of the database, and continuous speculative searching, may mean that random matches will arise even at these levels of probability. Cole and Lynch give examples of the construction of plausible cases around people on US and UK databases identified with serious crime and terrorism through cold hits, which were eventually found to be false. Those who are genetically related are, of course, more likely to share markers, with the likelihood of siblings sharing 10 markers being 1 in 250,000. Guidance by the Crown Prosecution Service in England and Wales is that there should be corroborating evidence for the DNA match although this is not required by law as it is in Scotland. The profiles do not provide health information at present but indicators for disease susceptibility may be discovered in the future in what has been called ‘junk DNA’. Although this would not help in solving crime, it would increase the amount of personal information that could be derived from the sample and could be relevant to researchers. Most European countries have forensic databases but the criteria for inclusion vary greatly. In general, the types of offence for which profiles will be included are restricted to the more serious crimes, and profiles are on the database only for a limited time. The age of criminal responsibility is between 13 and 16 in most European countries, and so younger children are not included. The UK database is the most inclusive in the world (Table 2).

Table 2 NDNAD—England and Wales: policy on DNA profiling, storage and use.

<table>
<thead>
<tr>
<th></th>
<th>Convicted offenders</th>
<th>Suspects</th>
<th>Arrested but not charged or charged but not acquitted</th>
<th>Young people</th>
<th>Volunteers (elimination samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious crimes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td>Minor offences</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td>Consent?</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Full samples retained</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Retained until death/ age 100</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Speculative searching</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Familial matching</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
</tbody>
</table>

Notes: Scotland exports profiles (not samples) to the NDNAD. Scottish profiles and samples are destroyed if the suspect is subsequently not charged or is acquitted, except for some serious offences where they are retained for 5 years. Volunteers may consent to comparison of their profiles with the crime scene profiles only or to retention on the database. Consent cannot be revoked later in England and Wales but can be in Scotland.
Familial searching

A further extension of the scope of forensic databases is achieved by searching for close matches that might indicate that someone on the database is genetically related to the crime suspect. Such familial searching may lead to a large number of people becoming suspects. There are obvious concerns about individual privacy and stigmatization, both of the individual on the database and the relatives, and effects on relationships within the family particularly where genetic links, or the lack of them, is unexpected. Haines points out that familial searching impacts disproportionately on those ethnic and social groups most likely to be on the database. With changes in family life and ideology, there is an emphasis on non-biological relationships but, at the same time, an emphasis on shared DNA ‘as fundamental to the definition of family relationships’. The attempt to solve crimes again overrides considerations of privacy, consent, protection of children and prevention of discrimination against particular ethnic and social groups.

Legislation

The UK government position on NDNAD retention is that ‘the measures taken to retain the [DNA] samples and fingerprints of persons who have been arrested, albeit not convicted, for a recordable offence are proportionate and justified. . . . People who [have not been convicted of an offence and] do not go on to commit an offence have no reason to fear the retention of this information’. There have been cases in which the profiles of the ‘innocent’ have been connected to serious crimes. The profiles of volunteers that are loaded onto the database are treated exactly the same as other profiles, i.e. they are included in speculative searching, may be used for research and for family matching. The only difference is that they do not have an arrest summons number that provides the link between NDNAD data and that held on the police national computer. The only profiles that are kept apart are those of police officers, and some other staff members who come into contact with crime scenes, that are collected for elimination purposes.

To allow the police database to expand in size, it was essential to change procedures for collecting DNA, both in terms of categories of people from whom it could be collected and the methods used. From the use of DNA testing for the investigation of serious crime, taken by a doctor and only with consent, the police are now able to take DNA samples without consent from anyone arrested for a recordable offence, that is, an offence recorded on the police national computer, which includes all but the most
minor offences, and to retain it indefinitely. The legislative changes that permitted the expansion are summarized in Table 3.10

The retention of samples from those charged but not convicted of an offence was tested by the cases of Marper and S which went through the Court of Appeal to the House of Lords, which upheld the judgement that such retention was ‘proportionate and justified’.11 This is referred to in the NDNAD annual report but it is not mentioned that ‘S’ was, at the time, a 12-year-old boy.12 A member of parliament began a campaign for the removal of the DNA samples of ‘innocent’ children and provides guidance on requesting removal by writing to the Chief Constable, who can permit removal but is expected to do so only in ‘exceptional’ cases.13 The case has now been taken to the European Court of Human Rights. It is further proposed, under a review of the Police and Criminal Evidence Act (PACE), that DNA could be taken on suspicion of more minor (non-recordable) offences, such as dropping litter, and be retained. DNA could be taken as a means of establishing identity. A consultation paper on the review of PACE suggests ‘removing the existing thresholds’ on gathering biometric information for identification purposes and searching the database for matches whatever the suspected offence.14

Comparison of forensic and health databases

The UK has two national genetic databases. UK Biobank and the NDNAD. The UK Biobank aims to store half a million DNA samples
from those aged 40–69, linked to medical records and other social and environmental data collected from participants. A pilot study has been completed and recruitment began in 2007. Participants are asked to give informed consent to have their data stored, with a right of withdrawal at any time and the removal of their sample. Assurances are given on confidentiality with the separation and encryption of data which identify the individual, and links made only ‘when appropriate’. The Biobank was announced in 1999 and has undergone a long process of scientific and ethical review, public consultation and pilot studies. In contrast to the NDNAD, the chosen age group excludes vulnerable groups; that is, children and young people, the elderly and the age group in which women are most likely to be child-bearing. There have been eight official public consultations on UK Biobank, with methods and results published on the website and many other studies funded under different programmes. All applications to use the data are subject to scientific and ethical review, through the usual procedures for research involving patients. The UK Biobank report acknowledges that the police could gain access to data held on individuals but this would require a court order, which UK Biobank would ‘rigorously oppose’.

In contrast, the NDNAD is being used for research without consent and has not had a public oversight body on a par with the Ethical and Governance Committee of the UK Biobank. The Human Genetics Commission (HGC) and GeneWatch have raised the absence of an independent ethics committee to review research applications to the NDNAD with the government. An ethics committee was only set up in 2007 and met for the first time in September. At least 19 research projects have been approved by the NDNAD Strategy Board. Of course, the reason for the different regulations surrounding a biobank designed for medical research and a biobank designed for forensic investigation is that there is the assumption that all right-minded citizens will support the collection and use of DNA to assist in crime detection. However, when about one million of the 3.4 million individuals whose details are recorded on the UK police national database do not have a conviction or caution, the justification for the difference in regulations becomes harder to maintain. Furthermore, the proposed exchange of DNA information from forensic databases across Europe to assist in fighting crime and terrorism is based on the assumption that those on the database have been convicted of crime, probably a serious crime.

The inventor of DNA profiling, Sir Alec Jeffreys has expressed concerns about the ‘mission creep’ of the forensic database. A database that was originally intended to help catch serious offenders when they re-offended has become a large-scale database of criminals and non-criminals and has already been used for different purposes, including
research and familial matching.\textsuperscript{18} It is estimated that the database already contains profiles of nearly one in three black men in England and Wales compared with 8\% white men, which means the extension of uses impinges much more on ethnic minorities (and men). Research on the database has, according to a parliamentary written answer, included research into ethnic profiling.\textsuperscript{19} Under current legislation, the database is expected to increase to contain the profiles of a quarter of the male population and 7\% of females, as currently an average of 40 000 profiles are added each month.\textsuperscript{20} Public opinion in the UK is not as overwhelmingly supportive as sometimes assumed in government statements. A survey by the HGC found almost all the representative samples agreed with the taking of DNA samples for those charged with murder and sexual offences, but support fell to around two-thirds for burglary and half for drunk driving. On the question of whether samples should be retained if the individual was subsequently acquitted, respondents were divided (48 versus 46\% in favour of removing samples), but among men, a majority wanted samples removed. Only 17\% thought the police should have access to the database for other purposes.\textsuperscript{21} In the Eurobarometer Survey across Europe, the public were split in responses to the more general statement ‘I would support police having people’s genetic information to help solve crime’ (44 against; 43\% in favour).\textsuperscript{22}

The inclusion of children and young people

The NDNAD includes DNA from those aged 10 and above, taken without consent and retained until death or age 100. Children are usually regarded as a vulnerable group and in need of special protection and consideration in research and in law, but on the NDNAD they are treated in the same way as adults. Over half a million children under the age of 16 are on the database. This is probably because the age of criminal responsibility is 10 years in England and Wales (8 in Scotland) and so children were simply included because they can be arrested and charged. In Europe, the age of criminal responsibility ranges from 7 in Cyprus to 18 in Belgium. In focus groups discussing DNA databases, children aged between 10 and 12 years talked about what should happen if someone was found to be innocent having been arrested and a DNA sample taken.\textsuperscript{23} The consensus was that the profiles should be removed and the samples destroyed. As one child commented, ‘If that was right [to retain profiles] then they should have everybody on the DNA database’ and another added ‘But if it’s like a criminal database, people who had committed crimes, then it [profile of an innocent person] shouldn’t be on there’. It has been suggested
that taking everyone’s profile at birth would be fairer than having a mix of convicted, acquitted and never charged, with certain groups overrepresented. For those children who have offended and so will remain on the database for life, both parents and children were concerned about stigma and not giving young people a chance to change. They suggested only taking profiles for serious offences, keeping profiles for a limited time or on a separate part of the database that is not routinely searched. Other European countries have some or all of these suggested safeguards. For example, in the Netherlands, profiles are stored for those charged with an offence carrying a prison sentence of 4 years or more (originally 8 years) and samples are removed if the person is not convicted. Profiles are kept for a limited time, depending on the seriousness of the offence. Most young offenders would be excluded from the NDNAD under these provisions.

Generally, children are seen as more malleable and capable of ‘growing out’ of criminal behaviour. The United Nations Guidelines for the Prevention of Juvenile Delinquency warn against the dangers of premature labelling of young people and recommend that:

...youthful behaviour or conduct that does not conform to overall social norms and values is often part of the maturation and growth process and tends to disappear spontaneously in most individuals with the transition to adulthood; ..., in the predominant opinion of experts, labelling a young person as “deviant”, “delinquent” or “pre-delinquent” often contributes to the development of a consistent pattern of undesirable behaviour by young person.

The permanent inclusion of children, even if they have committed an offence, does not comply with these guidelines. Apart from issues of stigma and discrimination of those who are still at school, there is also the fact that children may be unwittingly included in research projects and profiles used for familial matching.

**Behavioural genetics**

The current interest in behavioural genetics includes research into the genes associated with aggressive and ‘antisocial’ behaviour. Research is now looking for possible interactions between genetic and environmental factors affecting the probability of antisocial behaviour. The widely quoted study by Caspi et al. found an increased risk of antisocial behaviour in young men who had suffered severe abuse as children and had low levels of the monoamine oxidase (MAOA), a mitochondrial enzyme responsible for the breakdown of several...
neurotransmitters, including dopamine and serotonin, that affect brain function. Research projects on the MRC-funded Social, Genetic and Developmental Psychiatry Centre’s website, King’s College, London include a study of the development of behavioural problems in twins (TEDS), and SCOPIC (Social Context of Pathways Into Crime) focused on families in disadvantaged areas. The NDNAD has not yet been used for behavioural genetics research.

A recent survey of US and European genetic research scientists included questions on whether it was ethically acceptable to ‘reduce propensity for violence’ through somatic cell gene therapy or for parents to seek to ‘choose’ to do this for a baby. Over half the US respondents (51%) and 35% of the Europeans agreed with gene therapy to reduce propensity for violence. For parental choice, the figures were 40% US and a quarter of European research scientists. These figures indicate that European experts are more cautious but do not overwhelmingly reject either gene therapy or prenatal selection in this area. A US study of healthcare professionals and parents found that the professionals were opposed to the idea of behavioural genetic testing for propensity to violence unless there was effective medical treatment and were concerned about the dangers of labelling, self-fulfilling prophecies and stigma. Parents felt testing should be available, although they might not want to test their own child. Although they raised similar issues about stigma, some thought it would help parents understand their child’s symptoms and focused on possibilities of environmental changes rather than medical treatment. An Institute of Public Policy Review report argues that people should be free to choose to be tested for behavioural conditions; however, in the area of genes associated with criminal behaviour, it seems less likely that the health service model of individual informed consent will operate. Some of those accused of criminal offences have already sought to use behaviour genetic research in mitigation of their offence. Stephen Mobley’s defence team unsuccessfully asked for him to be tested for MAOA deficiency, citing his family history and linking his case to that of the Dutch family identified by Brunner et al. They hoped for mitigation of the death sentence he had received for murder but it was ruled that the genetic test did not meet the standard required for scientific evidence in the USA.

There are already schemes in place in the UK to predict and manage children who may commit offences. Children can be referred to these schemes because they are deemed ‘at risk’ before any offence is committed. Indicators of ‘risk’ in the government’s RYOGENS system, used by local authorities, include symptoms of poverty such as living in a high crime area, a lack of facilities/equipment and financial/housing difficulties as well as more obvious measures like exclusion from
school and substance abuse, learning difficulties, being bullied and living in a high-risk area. A UK government policy review proposes to extend existing systems and ‘establish universal checks throughout a child’s development to help service providers to identify those most at risk of offending’. It states that ‘by using intelligence on risk factors (such as conduct disorder or living in very low income families), high-risk individuals can be identified early and specific, tailored interventions used’.

The concern among some organizations working with children is over the amount of data collected on children, shared between different government agencies and used for different purposes. Genetic testing in the health service is based on informed consent, and the use of samples and data is governed by an established system of ethical review; however, in the field of behavioural genetics, the ideology of the health service meets that of the police and other government agencies.

**The balance between benefits and social and ethical costs**

The continuous searching of the whole database for matches makes each individual, whether a convicted criminal, a volunteer or an innocent adult or child, a suspect in criminal cases every week. The continuous surveillance of citizens also takes place through CCTV cameras on which the average person in the UK is reportedly ‘caught’ 300 times a day, and the use of Antisocial Behaviour Orders (ASBOs). These can cover nuisance actions that are not criminal but, if the conditions of the order are broken, can result in imprisonment. The legal definition of anti-social behaviour, from the Crime and Disorder Act 1988, is a broad one; ‘acting in an anti-social manner as a manner that caused or was likely to cause harassment, alarm or distress to one or more persons not of the same household as the complainant’. In the UK, there are concerns about the growth of surveillance of citizens and the difficulty of assessing what is a proportional response to the problem of crime and terrorism.

Current proposals are to integrate police databases across Europe with a biometric management system being established to control access. Information provided for new style biometric passports and proposed ID cards would be compared with police records. The government minister responsible for the ID card scheme defended these new proposals with the argument that ‘…surely no-one would suggest that we should put obstacles in the way of police investigating crime and bringing offenders to justice?’

Personal information is held on individuals by many agencies, including the health service. The success of large-scale population genetic
databases depends on individuals being motivated to freely donate samples and to allow access to their medical records. People therefore need to trust those responsible for the collection, storage and use of their personal data. The public are aware that personal data are easily shared, may be used for different purposes than originally stated and can be used in ways that harm individuals; however, trust in medical doctors is still high across Europe. The NDNAD potentially blurs the distinction between criminal and health-related databases since it includes large numbers of people who have not been convicted of any offence and has been used for research. Williams and Johnson have observed that the international trend seems to be towards expansion towards the UK model. Current and future implications for medical practitioners and researchers could include some involvement in the identification of children ‘at risk’ of offending, an increase in requests to provide personal medical information on individuals, requests for expert evidence in court cases, involvement in research projects based on forensic databases and the genetic profiling of all newborns. These developments could in turn affect the degree of confidence patients have in the guardianship of their personal data.

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