Biochemistry 118 Tara Ramachandra
Prof. Doug Brutlag Due: May 29, 2002
Final Paper

DNA Forensic Technology: Convicted by Man, Exonerated by Science

Man's scientific advancements demonstrate a realization of his greatest potential while uncovering his underlying fallibility. A procedure that can pinpoint an individual from a mere fifty-cell sample is also revealing the fact that the justice system, often deemed sacrosanct, can falter as well. Results from DNA fingerprinting, a technology which is less than two decades old, have been instrumental in overturning hundreds of invalid jury verdicts, exculpating many wrongfully-accused individuals. Countless examples such as the following excerpt indicate that this forensic tool has the power to exonerate those who might otherwise be serving life sentences for crimes they did not commit:

> On Saturday, June 22, 1996, front page headlines announced the release of Kevin Lee Green, who had been in prison for 17 years after being convicted by a jury of bludgeoning his wife and killing the fetus she carried. Green was released when DNA tests confirmed the confession of a second man who was identified by matches of his DNA, from a California statewide DNA database, to five other unsolved homicides from almost 20 years earlier. The police and prosecution were not expecting the confession to the Green case by the second man, were not investigating that case, and were not responding to requests for post-conviction relief by the family or attorneys for Green.
> ["Falsely Jailed: What Happened?" and "Prosecutors Crack the Case Using Old-Fashioned Detective Work," *Orange County Register*, June 22, 1996, page 1.]

JUDICIAL CONSIDERATIONS

Integrating DNA Technology into the Existing Judicial System

After hearing of several alarming stories such as this one, Attorney General Janet Reno pressed for the formation of a national judicial commission to investigate the uses of DNA testing. The breadth of issues addressed by the National Commission on the Future of DNA Evidence extends beyond Reno's initial inquiries into DNA's post-conviction uses, with topics ranging from crime scene investigation to laboratory funding to evidence collection.

The Commission's 1999 report, entitled *Post-conviction DNA Testing: Recommendations for Handling Requests",* divides applicable cases into five categories:

1) Biological evidence is available and exclusionary results can certainly exonerate the defendant.
2) Biological evidence is available, but exclusionary results may not be deemed exonerative by some reasonable individuals.
3) Biological evidence is available, but favorable results will be inconclusive.
4) No biological evidence is available (never collected, lost, destroyed or poorly preserved).
5) DNA testing would be frivolous.

Taking these criteria into consideration, the courts quickly realized the increased strength of evidence conferred by DNA testing, as exemplified in *State* v. *Thoma*s. The court held that "DNA evidence is such a potentially powerful tool to demonstrate actual innocence that even the most

unyielding procedural bars must give way." Given this decision, "consideration of fundamental fairness demands" the use of DNA testing (*Thomas,* 586 A.2d at 253-54).

BIOLOGICAL CONSIDERATIONS

Forensic Serology: Background

Blood analysis was first used in crime solving during the early 1900s, after Karl Landsteiner's determination of A, B, O blood types. Thirty years later came the discovery of Rh factor, which allowed for greater discrimination between blood samples. In the 1970s, laboratories began to use gel electrophoresis to separate variable blood proteins. Each of these advances provided investigators with increased means to exonerate the wrongfully accused and demonstrate correlation with potential perpetrators.

Finally, in the mid 1980s, Alec Jeffreys, a British geneticist, coined the term "DNA fingerprinting" in an article entitled "Individual-specific 'fingerprints' of human DNA" (Jeffreys). Even though only one tenth of a percent of the entire genome varies between any two individuals, enough variability can be found in these 3 million base pairs to positively identify an individual using the right combination of procedures.

Sources for DNA testing

Blood - Several different materials can be used to carry out the fingerprinting. Blood is typically the best specimen to use, although the surface from which the sample is acquired greatly affects the success of analysis. Blood is best obtained from glass, metal, hard plastics or lightweight cloth. Several extra procedures are required when examining blood from vinyl, carpet, denim and dense or colored fabrics. Concrete and soil are particularly difficult mediums from which to extract blood.

The unknowns are compared against samples called exemplars, which are taken from the suspect or victims. Liquid blood is the most reliable exemplar to work with, and most samples are collected and stored as drops on washed cotton sheeting. Sometimes, a non-invasive buccal sample, a cheek swab, is an alternate source. "Guthrie cards" may also serve as exemplars.

Semen - The most common evidence examined forensically, semen is identifiable for years after staining furniture or clothes. Since it remains in the vagina for 72 hours, testing of consenting sexual partners is also needed to verify findings. Differential lysis procedures are used to separate sperm cells from the "female fraction"

Tissues - Since the survival time of DNA from soft tissues is limited *post-mortem*, better results can be obtained from analysis of muscle or brain tissues. Testing is most effective, however, on DNA in the teeth and bones. Sometimes, when a victim's body is missing, bits of brain tissue that

have adhered to bullets or weapons can be used. In such cases, reverse paternity tests can be carried out to trace the victim to a particular family.

Hair – One to five hair roots are adequate for carrying out a RFLP analysis. Shed hairs can be examined by use of PCR mitochondrial sequencing. Such an approach was used to positively identify samples from Napoleon and remains from assassinated family members of Nicholas Romanoff, the last Russian Czar.

Saliva – Specimens from envelope flaps and stamps have been successfully used to pinpoint people, the most infamous case being the identification of men involved in the WTC bombings (Coleman).

Given the technology's rapid change in the recent past, most investigators split and save samples in the event that more accurate tests may become available down the line. Doing so also allows for retesting by opposing counsel or the defense to carry out one of the two types of fingerprinting methods, RFLP or PCR.

Restriction Fragment Length Polymorphisms

According to DNA forensics authority Bruce Weir, RFLPs are quite variable among individuals, with a typical RFLP having around 30 distinguishable types. The variable regions involved may range in length from 500 to 20,000 base pairs. One disadvantage of this method is that it necessitates a relatively large amount of non-degraded DNA, usually requiring at least 100,000 cells. Furthermore, the procedure involves X-ray exposure, which takes a week for each sample, causing the entire process to last several weeks.

The basic procedure involves digestion of the DNA material with the restriction enzymes *Hae*III, *Hin*fI and *Pst*I. This is followed by separation of the fragments by length. Next, the samples are treated with DNA probes such as MS1, YNH24, MS621 and TBQ7, which are used to determine fragment size variations at specific locations on the human genome. The corresponding regions for each restriction endonuclease are, respectively, DIS7, D2S44, D5S110, and D10S28. Finally, the results from the unknown are compared to those found from the exemplars.

Polymerase Chain Reaction—Nuclear DNA

Dr. Kary Mullis of Cetus Corp devised the PCR method of DNA amplification in 1984. Small segments of DNA can be rapidly replicated using this technique, which was first applied to forensics in 1986. Clearly, advantages of this technique include the fact that only trace amounts of DNA-containing material are necessary. Samples as small as 50 cells are adequate for generating reliable data (NIJ). Even degraded DNA can be used in the process, which involves amplification of the sample using *Taq* enzyme. Furthermore, the test can be completed overnight.

Like with serology examinations, exclusion with this procedure may eliminate an individual as a source. Still, it should be made clear that an inclusion does not necessarily pinpoint a particular individual, as there are only three to four variants.

One commonly used protocol, the AmpliType®PM PCR Amplification and Typing Kit tests the following five DNA regions: GC, GYPA, LDLR, HBGG, D7S8. Combination with another PCR kit has allowed for typing of six areas. Typically, results of such tests are examined as peaks in a graph or bands on films.

Polymerase Chain Reaction- Mitochondrial DNA

Analysis of sequence data from individuals' mitochondria allows for investigation of samples that would be inadequate for RFLP or PCR of nuclear DNA. The sequences of targeted hyper variable regions of the sample are then compared to the sequence from the person in question. Currently, the Armed Forces Institute of Pathology uses this sequencing method to identify war remains. Since mitochondrial DNA is conferred from mother to child, any member of the maternal lineage can be a source for the sample. Such familial linking was used to investigate the remains of the family of the last Czar of Russia.

Analysis of Results

An individual's results are "inclusive" if substantial homology is found between his blood and the sample. If the system only exams a few loci, a wrongfully accused person may be considered a "match", in which case additional testing should be performed. If the contents of the known sample do not match those of the accused at all, the result is deemed an exclusion. However, in order for the claim to hold up in court, additional testing should be carried out in this case as well. In the event of previous testing, if only PCR was carried out, perhaps RFLP should be tried as well. If RFLP was already carried out, unless there is large possibility of error in the previous test, reanalyzing is typically avoided.

The Future of DNA Testing

Increased sensitivity of PCR mitochondrial sequencing will soon allow for better analysis of DNA samples taken from hair shafts. In addition, the development of Y chromosome-specific probes will be useful for selecting out the desired component in mixed samples. Furthermore, in the event of multiple male donors of genetic material (e.g. gang rape), the ability to distinguish between different sets of DNA will be increasingly crucial. As Y-chromosomes are paternally inherited, such probes have the potential to connect a given crime to a specific lineage.

As has occurred with other technical advancements, it is likely that the apparatus used will soon be miniaturized, while maintaining or increasing sensitivity, speed and discriminating ability of

test. The varied uses of forensic DNA technology include identification of potential suspects whose DNA is a hit for specimens left at crime scenes, matching organ donors with recipients, paternity testing and identification of crime victims. Novel uses of the technology include authentification of rare wines and one-of-a-kind items such as souvenirs and memorabilia. For the 2000 Summer Olympics, for example, sections of DNA were obtained from several Australian competitors and added to ink that was used to mark official goods (Drell).

ETHICAL CONSIDERATIONS

Databasing

The 1994 DNA Identification Act authorized the storing of DNA fingerprint results in the Combined DNA Index System (CODIS) in either of two indexes. The test results from felony sex offenders and other violent crimes are stored in the Convicted Sex Offender index. Crime scene evidence analysis is stored in the Forensic Index. Whenever an unknown DNA sample is found, it can then be easily compared to the contents of either index. Individual states have different specifications for which types of crimes require entry into CODIS. According to the largest branch of CODIS, National DNA Index System (NDIS), a total of 4,179 investigations in 32 states have been aided by the data, including this case:

> A rape case was solved 6 years after it occurred because of a DNA databank. A Virginia woman was robbed and raped by a masked man who had dragged her from her house into a wooded area in 1989. The woman reported the attack and visited a hospital where a "rape examination kit" was completed and DNA and other evidence was collected from her body and clothing. For 6 years, she feared the man would come back, as he had threatened. Then a forensic scientist for the Commonwealth of Virginia notified her that the man who had raped her had been identified and was serving time for a separate offense. When run through Virginia's DNA databank, the inmate's DNA had produced a match or "hit" with the DNA sample of the woman's assailant collected years earlier. Later, the woman learned that her assailant had gone to jail only months after raping her. The necessary DNA evidence had been in the Commonwealth's possession but was not analyzed sooner because of a backlog in its DNA databank. By eliminating or at least reducing such backlogs, States will save victims like her years of suffering and allow them to begin healing much sooner.

Currently there are around 250,000 profiles from 39 states, but there is still a 600,000 sample backlog due to the costs of performing the analyses. (Drell)

Contribution and Access to CODIS

Most of the ethical concerns regarding the issue of DNA fingerprinting arise from uncertainty about future access to the contents of DNA databases like CODIS. The blood that is being stored in the databanks may provide insight into individuals' disease susceptibility, predispositions, legitimacy of birth and perhaps sexual orientation (Drell). Some say their fears might be allayed if the blood were discarded, but the fingerprints were kept. Others worry that perhaps one day, the supposed "junk DNA" that is used in fingerprinting might be shown to contain critical information about personal characteristics.

Another greatly debated topic stems from the question of whose information should be included. If all arrestees are mandated to provide DNA samples for the database, as has already happened in some states, this material may not necessarily be discarded if the individual is released without being charged. For instance, a 1999 Louisiana law mandates the collection of DNA samples from all those arrested in the state. Furthermore, law enforcement officials might carry out "investigative arrests" without probable cause, just to obtain a DNA sample from someone they believe to be a suspect in a potentially unrelated crime. This procedure would undoubtedly violate the fourth amendment which protects against unreasonable search and seizure.

One also has to wonder as to the practicality of further investigation in some crimes. First of all, the statute of limitations may have expired in many cases, rendering additional testing useless. Coupled with this question is another important one: who has a right to this "post-conviction relief"? The State cannot possibly provide this testing to any and every convicted individual who maintains his innocence. "The typical inmate making a post-conviction DNA request wants the following: discovery of evidence so that it can be tested, the right to present favorable test results in a judicial proceeding or in an executive proceeding for clemency, and the State to pay for the testing"(NIJ, xiv). As previously mentioned, the justice department has classified requests for post-conviction testing into five categories. In doing so, they lay out certain criteria that will help defense attorneys and prosecutors decide whether the testing is in their best interest and is a reasonable course of action given the particular circumstances of the case. These guidelines provide a basic standard, although more work needs to be put into more clearly defining candidacy for the testing.

As the Commission report states, "Finality is a fundamental value that can properly be ignored only in the extraordinary case" (NIJ 3). Who then decides which case is "extraordinary" enough to warrant revisiting? It is simply human nature to desire a concrete answer when a loved one is lost violently. Reopening cases indiscriminately would cause a great deal of suffering and anxiety on the part of victims' families. However, in so many recently reopened cases, it has become apparent that the original jury decision was completely wrong. It is in fact frightening to wonder how many innocent individuals have already suffered in the prison system or on death row due to faulty verdicts. Commented one judge, "Our system fails every time an innocent person is convicted, no matter how meticulously the procedural requirements governing criminal trials are followed. We would rather [permit the DNA testing] than sit by while a [possibly] innocent man languishes in prison while the true offender stalks his next victim" (*Thomas*, 586 A.2d at 253-54).

Works Cited

Asplen, Christopher H. “From Crime Scene to Courtroom: Integrating DNA Technology into the Criminal Justice System.” *Judicature.* November-December 1999. Vol 83(3).

“Codis.” Online. Available http://www.fbi.gov/hq/lab/codis/index1.htm. 22 May 2002.

Coleman, Howard and Eric Swenson. *DNA in the Courtroom.* Seattle: GeneLex Press; 1994 (Ch 2).

Drell, Daniel. “DNA Forensics.” *Human Genome Project Information.* Online. Available http://ww.ornl.gov/hgmis/elsi/forensics.html. 19 May 2002.

Jeffreys, A.J., V. Wilson, and S.L. Thein, “Individual-specific ‘fingerprints’ of human DNA,” *Nature*. 1985. 316 (76-79).

National Institute of Justice. *Postconviction DNA Testing: Recommendations for Handling Requests.* NCJ 177626. Sep 1999 (Executive Summary, Introduction and Biological Issues).

Reynolds, William Neal. “Interview with Dr. Bruce Weir.” Online. Available http://www.accessexcellence.org/WN/NM/interview_dr_bruce_weir.html. Jan 1995.

State v. *Thoma*s, 586 A.2d 250 (1991)

Unknown. “Falsely Jailed: What Happened?” and “Prosecutors Crack the Case Using Old-Fashioned Detective Work.” *Orange County Registe*r. 22 Jun 1996 (1).