

Use of DNA Forensics for Crime Solving

James D'Arpino; Samantha DiMaio; Michael Gutierrez;

Abstract—DNA is the sequence of chemical patterns which all living organisms are composed of. It has the power to individualize every being from another. This paper will discuss what DNA profiling is and how it is used for solving acts of crime. It provides an in-depth description of how DNA evidence is gathered and used in court procedures. Throughout history, there have been various court cases where DNA tests have been used by both the defendant and the prosecutor in order to help decide a persons innocence or guilt. Additionally, a couple of cases are examined where DNA profiling and the results following DNA tests were used. This leads into the discussion of whether this technology should be used as a crime-solving advancement, which brings into question the ethical reliability and accuracy of using DNA profiling to make a conviction. DNA profiling can be used to convict someone who is not guilty by manipulating DNA evidence at the scene of the crime or by mishandling of evidence by an involved party during the collection process. This paper also discusses the power of DNA profiling as a tool to help solve crimes, and how the various forensic technologies available today make this possible, such as polymerase chain reaction and restriction fragment-length polymorphism. Another example of new technologies is the invention of various DNA databases that are used to store DNA profiles. With the growing trend of collecting DNA, there is an ethical concern regarding the storage of a suspect's DNA samples in the National DNA database without their consent. It is in question whether these DNA databases should be kept for future use against potential suspects, however, both outcomes, positive and negative are analyzed. In the analysis of this ethical concern, the paper discusses two ethical principles, the principle of double effect, as well as the principle of utility. The paper concludes with the stance that DNA profiling is necessary for todays society to ensure the most accurate form of identification. Without DNA profiling, there is no way to accurately identify someone and link them to a crime. A jury cannot determine whether those convicted are innocent or guilty of a crime without a concrete identification process. Decisions that determine the future of someones life should not be made without a scientifically based conclusion. While DNA profiling is not perfect yet, it is a reliable tool used in many court proceedings, some of which can not proceed forward without DNA evidence such cases involving rape. Without the analysis of the

bodily fluids involved, there would be no clear way to prove or convict the suspected rapist aside from key witness testimony if there are any witnesses at all.

I. INTRODUCTION

At the core of all living things is their DNA makeup. DNA is the arrangement of chemical patterns in the cells of living organisms that scientifically individualizes every human being from one other. Humans have 99 percent of the same DNA, which means that 1 percent of that DNA makes us all unique individuals. The information in DNA is made up of four chemical bases. When a crime is committed, there is usually DNA evidence left on the scene from people involved or not involved in the crime. Any remains such as blood, hair, skin, teeth, and other human parts can be used to identify a possible suspect. DNA analysts collect the samples, perform tests, and provide them to the National DNA Database.

DNA testing forensic technology has been used for decades as a significant source of evidence in many criminal cases throughout history. Before DNA testing was available, blood types were used in court cases to narrow down individuals, however, it could not identify specific individuals. It has been used in thousands of court cases. It has proven the guilty, innocent and has convicted the innocent, guilty. The use of forensic technology to solve criminal cases has been questioned by many professionals. When the technology was first introduced in the courtroom, it contained many flaws, but most people saw it as a hope to bring forth justice. Other people scrutinized how reliable these technologies were and if they should have the power to decide if someone is guilty or innocent. Over the years, scientists have further developed DNA technology to provide more reliable and accurate results. However, the main arguments revolve around how it is used incompetently in the criminal justice system rather than the actual reliability of the testing.

A crime cannot be solved through human judgment. People need facts to contribute to their case. Scientific facts provide the truth because science does not lie. DNA testing gave people the ability to withhold scien-

tific evidence. Ethical concerns are introduced due to the people who manipulate this evidence for malicious means. People can use DNA evidence against others. Criminals can attempt to cover their DNA tracks and frame someone else for the crime. People can use DNA evidence to testify against someone who is innocent. When used ethically, DNA testing is a powerful tool that has the power to solve many acts of violence.

II. BACKGROUND AND RELATED WORK

A. *What is DNA Profiling for Crimes?*

DNA profiling is a forensic technique used by police that compares an individual's DNA with specific DNA evidence found at the crime site to determine the chances a person was present during the crime. DNA profiling can also be referred to as DNA fingerprinting, DNA testing or DNA typing [12]. DNA profiling was developed due to two breakthroughs in molecular biology, polymerase chain reaction (PCR) developed by Kary Mullis and restriction fragment-length polymorphism (RFLP) discovered by Sir Alec Jeffreys, a professor at Leicester University [12]. Jeffreys' discovery was used in the murder case regarding two rape victims that linked Colin Pitchfork's samples of blood to the murderers' DNA to solve the case [3]. Using a combination of these technologies, analysts can cross-reference DNA and match it to a suspect, known as DNA profiling [12].

B. *How is DNA gathered for criminal cases?*

DNA in criminal investigations is gathered by closely observing one group of DNA loci that contain Variable Numbers of Tandem Repeats (VNTRs) [1]. DNA gathering consists of multiple steps. First, the DNA must be extracted from the object [1]. If the DNA extracted from the scene is not large enough to be analyzed or is degraded in any way, PCR must be used to increase the sample size [6]. Once PCR expands the DNA, it must be cut into small fragments [1]. A portion of the fragments includes the VNTRs that are examined [1]. The fragmented DNA is placed in a small well at one edge of a semisolid gel [1]. Each DNA sample of a suspect is placed in a different well [1]. Once all the DNA is distributed to its own well, the gel is put into an electric field, which forces the DNA to move away from the wells they were placed into [1]. Once the DNA stops moving, the electric current is removed [1]. During this process, the DNA fragments have moved different distances and are denatured [1]. DNA denaturing is when a double strand in a fragment is

separated into one single strand [1]. Once the fragments have been denatured, the DNA is transferred to a nylon membrane [1]. This step is taken because the single fragment strands stick to this material better [1]. Once placed on the nylon membrane, a radioactive probe consisting of single-stranded fragments complementary to the VNTR to detect specific VNTR sequences and move towards them [1]. An autoradiograph is then taken, which is when the nylon membrane is put on a photographic film, which produces dark areas on the film corresponding to the DNA fragments pairs that the probe was attached to [1]. Once this is done to the DNA of the evidence and the suspects, the analysts can move onto comparing the results [1]. The autoradiographs are put side by side to compare the similarities in where the dark spots are taken, if they do not look similar, the suspect is usually not looked into any further, however, if there is a one hundred percent match or a very similar pattern between the evidence and the suspect DNA, then the suspect is looked into further or even convicted [1].

C. *How is DNA used in cases?*

In the court of law, DNA evidence is normally used to solve crimes in one of two ways. In cases where there is an identified suspect, a sample of that suspect's DNA can be compared to evidence from the crime scene [10]. The results of this test can help prove or disprove whether the suspect committed the crime he or she is being accused of [10]. In cases where there is no identified suspect, biological evidence from the crime scene can be collected and analyzed [10]. This DNA evidence is then compared to known offenders, whose DNA has been recorded into databases in previous cases, to help identify the perpetrator [10]. Crime scene evidence can also be linked to other crime scenes through the use of DNA databases [10]. For example, imagine a man was tried and convicted of sexual assault. When he was convicted, he was required to give a sample of his personal DNA. Following that, his DNA is profiled and then entered into a DNA database. Many years later, imagine another sexual assault occurred. An examiner worked with the victim and obtained biological evidence from the assault. This evidence was then analyzed, and with the resulting profile, is queried against a DNA database. A match was found to the aforementioned man with the same DNA profile. That man then is apprehended, tried, and sentenced for a second crime. In this scenario, the perpetrator is prevented from committing other crimes during the

period of his incarceration [10].

D. Case Studies

There have been thousands of criminal cases where DNA evidence plays a crucial role. In these cases, DNA has been examined and the results have been brought forward to court. Below are a few cases in which DNA results were used to testify in court. If testing indicates a link between crime scene evidence and an individual, it is often concluded that said individual left the stain and thus committed the crime [9].

1) *Case of Raymond Easton:* In 1999, Raymond Easton was wrongly accused of breaking into a home. Easton has advanced Parkinsons disease which affects his ability to move. He was arrested for allegedly breaking into a home that was over 200 miles from where he lived. He was charged because blood at a crime scene was matched with his DNA profile. The probability of a match is one in 37 million which made it highly likely that this was Eastons DNA. The DNA from the crime scene was compared against 700,000 profiles in the National DNA Database [9]. Only 4 loci were tested from the 6 loci available from the blood sample to obtain these matching results. Years later, as Eastons innocence was further proclaimed, the remaining 2 loci were tested where it became evident that the DNA was not a match with Eastons DNA [9]. In this case, the DNA was reliable because it provided an accurate match based on what was tested. The faulty claim was due to not enough testing and an inaccurate interpretation of the DNA analyzed.

2) *The DNA Field Experiment:* A report studying the impact and cost-effectiveness of DNA evidence in investigating property crimes gives us insight into whether collecting and analyzing DNA evidence results in a net positive effect in court cases. Biological evidence was collected five hundred crime scenes in U.S. cities between the years 2005 and 2007. Cases were assigned randomly to both treatment and control groups in equal parts. DNA gathering and processing were added to traditional investigations in the treatment group. As seen on figure 1, suspects were identified in around 31 percent of treatment cases and only 13 percent of control cases. Suspects were arrested in 22 percent of treatment cases and only 10 percent of control cases. It was interesting to note that across the case study sites, each additional arrest, arrests that would not happen without DNA evidence analysis, cost slightly more than \$14,000. The most cost-effective sites had additional arrests cost around \$4,000. This

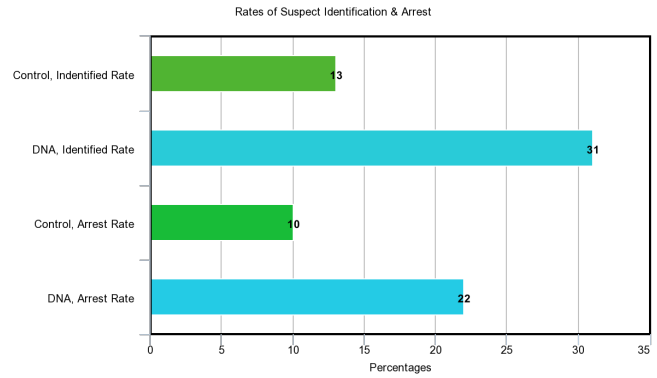


Fig. 1.

study makes a case for the expansion of DNA use as an investigative tool in courts of law [15].

III. ARGUMENTS IN FAVOR

A. Unsolved Cases

Before DNA profiling was used in criminal investigations it was significantly harder to find a determine who was responsible. During the 1800s there was a famous killer named Jack the Ripper that roamed the streets of London killing women by slitting their throats. Although people have given this serial killer the name of Jack the Ripper, nobody knows who he is. The police at the time had suspects but it was found unhelpful for the overall investigation. The case was never solved. With the installment of DNA profiling, cases like these are less common than they once were. Once an investigation has a list of suspects, analysts will take DNA samples from each suspect and compare it with the DNA evidence left at the crime scene. All of the DNA is compared within four hours, creating three possible outcomes [4]. The first outcome is finding out none of the suspects have similar DNA, which results in the investigators having to look in another direction. The second is narrowing the suspect list to one or two people which will significantly speed up the time taken to solve the investigation. The third outcome is finding a close DNA match and charging the suspect for the crime committed [10]. Using this technology has led to a 50 percent decrease in the amount of time needed to solve a case [2].

B. Reopening Cases

For many years, DNA profiling has freed innocent people from prison cells. This technology has allowed any DNA evidence found after a case has been closed, to potentially reopen the case. In fact, the first report of

police using DNA profiling was during a case in 1987 that compared DNA found on two different rape victims and murder cases that have been under investigation for over three years [7]. With this DNA, analysts were able to link both the rapes and the murders to one man. When DNA profiling confirmed who the murderer/rapist was, a man falsely convicted was released from all charges [7].

C. DNA Database

The success of DNA profiling led to police creating a database comprised of DNA from thousands of suspects. The reason for this database was to have a greater chance of matching a criminal to a crime. The police would gather the DNA found at a crime site and cross reference the DNA with the database to see if they could find a potential match. This allows police to identify potential suspects early in the investigation and sometimes even solve one [12]. For example, John becomes a suspect for a crime, his DNA will go into a database. If John were to commit a crime fifteen years later and leaves DNA evidence at the scene, the DNA at the scene will be cross-referenced with the DNA stored in the database. Once cross-referenced it will conclude that John was responsible without even needing to go through the process of a full resource-intensive investigation since their DNA was in the database fifteen years prior.

IV. ARGUMENTS AGAINST

A. DNA evidence Leading to Wrongful Convictions

There have been multiple cases throughout history where people have been wrongfully convicted due to DNA profiling mishaps. There have also been situations where valid DNA evidence has been mistakenly used to convict someone. The underlying problem in most cases has to do with the use of DNA evidence by experts to convict someone. However, they are manipulating the scientific results to help support their case. Prosecutors and defense attorneys have access to the forensic DNA results which they can present in their cases.

People in the courtroom have the power to change the story to present their case. In the 1970s, Gary Dotson was accused of harmful rape. Original testing showed Type B blood in the DNA sample found on the crime scene. Analysts testified that the person who raped the victim must also have this rarer blood type. However, it was later revealed that the victim also has Type B blood type. This meant that the blood could have been

mixed in the lab, or it was never the rapist's blood in the first place. This major reveal gave Dotson a chance to get further tested, which proved he had been wrongfully convicted. When this case first became public, it created scrutiny against using forensic technology to solve crimes [8].

An attorney stated that thousands of innocent people are in jail because of DNA testing. In 1990, Roy Criner was convicted of the rape and murder of a teenage girl. He was sentenced to 99 years in federal prison. It was not until seven years when the case was reopened and DNA that was left on the girl's body was re-tested. These new results did not match Criner's DNA. Even with this evidence, a 5-4 decision did not give Criner a new trial. It was not until a cigarette bud was found with both Criner's DNA and the DNA on the girl's body, that the vote was overturned and gave Criner a chance at freedom [13]. The criminal justice system is not very open to looking at new evidence in cases because it prides on finality and quickly solved cases.

B. DNA Reliability and Lack of Thorough Testing

Of the 1 percent of DNA all humans have in common, there are three million sites in the human body where DNA has variation. There are differences amongst individuals due to the arrangement or sequence of polymorphisms. If all three million sites were tested, then DNA testing would be extremely accurate and reliable. However, this would take very long and cost a lot of money. When DNA testing occurs in these criminal cases, not all the DNA makeup is tested, which is why mistaken identity matches are more likely [5]. This is evident in the case of Raymond Easton mentioned above. If all 6 loci were initially tested, Easton would have been cleared sooner [9].

C. Growing Concern of National DNA Database

In the late 1990s, the Forensic Science Service put together a National DNA Database that holds thousands of samples from crimes and identified individuals who match that DNA. Many people argue the morality of this database because it is collecting information about people that they have not consented to. Rather than facts, the database is collecting actual human DNA samples of blood, teeth, hair, saliva, etc. The database is building suspect profiles and matching them to suspected criminals. This information is being stored for future use against the potential suspects. [14]. People are concerned that with the growing collection of DNA, there is a greater possibility of exploiting this

sensitive information [11]. Even with the database, it is not guaranteed that the matches will be one-hundred percent accurate.

V. DISCUSSION

When discussing how DNA profiling relates to ethics, there are several considerations to keep in mind. DNA profiling in the court of law could be in direct violation of the Principle of Double Effect. It is imperative the DNA collection and analyses be treated with very special care because using DNA evidence to convict a person a crime could end up putting an innocent person behind bars, leaving the actual person free to possibly commit more crime. There are a series of unintentional consequences that could result from using DNA forensic technology. DNA profiling also touches the Principle of Utility. When convicted people are put into jail due to DNA profiling, there will be scenarios where the wrong person will be convicted. However, this does not occur nearly enough for court cases not to use DNA profiling. Overall, people are more likely to be rightfully, therefore DNA profiling shall remain to be in use because it benefits more people than it harms.

VI. CONCLUSION

DNA profiling at its current state has certain aspects which could be argued either in favor or against, however, the technology has helped criminal investigation in more ways than it has hurt. In the past there was no concrete way of determining whether someone committed a crime, it was all based on eyewitness testimony and blood testing. These testimonies could easily be unreliable. The eyewitness may not fully remember what they say, resulting in misinformation being spread about a case, which could steer criminal investigators in the wrong direction. This not only destroys the likelihood of the case being solved, but it also takes delays the speed at which the case is solved. Time is precious during an investigation because the more time spent trying to solve the cases gives the criminal more time to repeat what he or she has done. Blood testing was not accurate because it could not identify an individual, it only determined the blood type of the offender which alone, was not enough to convict a suspect.

Now, in a society that is riddled with crime, these techniques must be used to solve cases effectively. As technology advances, DNA profiling will only become faster and more accurate, which will result

in a significant decrease in the number of innocent people charged. Not only will the advancement of this technology prevent innocents from being wrongfully convicted, but it will also have the ability to release any innocent people from prison. Cases could be reopened and those in prison who have been wrongfully convicted can be freed. This has already happened when DNA profiling was added to criminal investigations. How else would the public know if someone was wrongfully convicted or not?

REFERENCES

- [1] Committee on DNA Forensic Science, *The Evaluation of Forensic DNA Evidence*, Washington National Academy Press, 1996.
- [2] M. Lynch, *Truth Machine: The Contentious History of DNA Fingerprinting*, Chicago: University of Chicago Press, 2008.
- [3] "DNA Technology and Crime", *Opposing Viewpoints Online Collection*, 2015, Available: Gale, <https://www.gale.com/>, [Accessed November 14, 2018].
- [4] "Fast Forensic Test Can Match Suspects' DNA with Crime Samples in 4 Hours", *NewsRx Health & Science*, p. 84, 2010, Available: Gale, <https://www.gale.com/>, [Accessed November 14, 2018].
- [5] "People v. Lindsey", *P. 2d*, Court of Appeals, 5th Div., 1993.
- [6] M. A. Jobling and P. Gill, "Encoded Evidence: DNA in Forensic Analysis", *Nature Reviews Genetics*, Issue 5, March, 2004, Available: <https://www.nature.com/nrg/>, [Accessed November 14, 2018].
- [7] A. Jamieson and S. Bader, *A Guide to Forensic DNA Profiling*, UK: John Wiley & Sons, 2016.
- [8] B. L. Garrett and P. J. Neufeld. "Invalid Forensic Science Testimony and Wrongful Convictions", *Virginia Law Review*, vol. 95, no. 1, March: 2009, Available: JSTOR, <http://www.jstor.org/>, [Accessed November 14, 2018].
- [9] C. R. Huff, M. Killias, *Wrongful Conviction: International Perspectives on Miscarriages of Justice*, Philadelphia: Temple University Press, 2010.
- [10] U.S. Department of Justice, *Advancing Justice Through DNA Technology: Using DNA to Solve Crimes*, Washington, DC: Office of the Attorney General, 2017.
- [11] S. B. Berson, "Debating DNA Collection", *NIJ Journal*, No. 264, November 2009, Available: NIJ, <https://www.nij.gov/>, [Accessed November 14, 2018].
- [12] "Inclusiveness, Effectiveness and Intrusiveness: Issues in the Developing Uses of DNA Profiling in Support of Criminal Investigations", *The Journal of Law, Medicine & Ethics: A Journal of the American Society of Law, Medicine & Ethics*, No. 2, vol. 34, p.234.
- [13] D. Lazer, "DNA and the Criminal Justice System: The Technology of Justice", *Journal of Clinical Investigation*, 2004.
- [14] D. J. Werrett, "The National DNA Database", *Forensic Science International*, vol. 88, Issue 1, July: 1997, p. 33, [Abstract], Available: ScienceDirect, <https://www.sciencedirect.com/science/>, [Accessed November 14, 2018].
- [15] J. Roman, S. Reid, A. Chalfin, C. Knight, "The DNA Field Experiment: A Randomized Trial of the Cost-Effectiveness of Using DNA to Solve Property Crimes" *Journal of Experimental Criminology* Issue 5, p.345, February:2009, Avail-

able:SpringerLink, <https://www.springerlink.com/>, [Accessed November 14, 2018].