

Rapid DNA: Applications and Considerations



CENTER ON POLICING
AT RUTGERS UNIVERSITY
Institute for Secure Communities

Abstract

On September 11, 2019 the Rutgers University Center on Policing held a listening session with key stakeholders to discuss the science and application of Rapid DNA technology. Included in the 40 attendees were public safety and homeland security professionals, including but not limited to numerous representatives from the New Jersey State Police and their forensic lab, FBI victim services, the Office of the Chief State Medical Examiner for New Jersey, multiple county prosecutor's office detectives, a former County Prosecutor, and representatives from the a leading manufacturer of Rapid DNA technology, the ANDE Corporation. The session was an opportunity to learn more about Rapid DNA technology, ask questions, and provide feedback to the service providers. The conference ended with a general consensus that New Jersey should explore the Rapid DNA applications in both the criminal justice and homeland security areas. This white paper was written as a result of the interest generated in this area and the attendees' desire to learn more about Rapid DNA.

Acknowledgments

The author would like to acknowledge the assistance and support received from colleagues in the practitioner, academic, and professional spheres. The author is grateful to those who aided in the research and writing of this report, including Ben Bawden of Brooks Bawden Moore, for his contributions to the document; Raymond Hayling, of HHW Group, for his assistance in organizing the listening session; Dr. Richard Selden, Chief Scientific Officer of ANDE, for his guidance on the technical aspects of Rapid DNA technologies; Linda Tartaglia, Director of the Center on Policing, and Thomas O'Reilly, Executive Policy Advisor of the Center on Policing, for their ongoing support and guidance during the writing process; and Megan Howard, Center on Policing intern, for her hard work on this initiative.

Author

Rosalyn Bocker Parks, Ph.D.

Research Project Manager

Rutgers University Center on Policing

Contents

Overview	2
The Science of Rapid DNA.....	3
Accreditation.....	8
The Application of Rapid DNA Analysis – Who Can Benefit?.....	9
Recent Applications of Rapid DNA.....	11
Future Expansions of Rapid DNA	12
Current Limitations of Rapid DNA Use.....	13
Considerations for Use of Rapid DNA Technology.....	14
Importance of Reliable Technology and Training	14
Privacy Concerns.....	14
Importance of Policy Prior to Implementation.....	15
Summary and Conclusions.....	17
Scientific Validity.....	17
Potential Applications.....	17
Importance of Policy and Legislation.....	17
Considerations for Responsible Use	17

Overview

Prior to the advent of Rapid DNA, the generation of short tandem repeat (STR) profiles, also referred to as 'DNA typing' or 'DNA fingerprinting,' was not performed outside the laboratory for a variety of reasons. The process requires highly skilled technical operators and a controlled laboratory environment. It also requires several specialized, sensitive instruments.¹

Rapid DNA technology was developed as a fully integrated system for the automated generation of STR profiles so that this process could be performed outside of traditional forensic laboratory settings. Development of the technology was also intended to improve forensic laboratory process flow.² The FBI defines Rapid DNA as the fully automated (hands free) process of developing a DNA profile from a reference sample buccal (cheek) swab without human intervention.³ More broadly, Rapid DNA can be defined as the generation of a DNA ID from a crime scene, disaster victim, or buccal sample in less than two hours, outside or inside the laboratory, by a non-technical or technical user.

Rapid DNA is intended to be used as an additional tool that augments rather than replaces conventional DNA analysis conducted in forensic laboratories. Whether in the field or in the laboratory, Rapid DNA may be used within the first hours of an investigation to help identify or rule out suspects. It may also be used to compare arrestee DNA profiles against the FBI's Combined DNA Index System database (CODIS) to determine whether the person's profile matches any profiles associated with outstanding criminal investigations.⁴

While results of Rapid DNA analysis from crime scene samples are not currently approved by the FBI for entry into CODIS, the technology is currently being used by many law enforcement agencies to successfully generate investigative leads by analyzing various sources of DNA from crime scenes including blood, saliva, bones, tissues, and touch DNA. Deployment of Rapid DNA technology began with American warfighters in the Middle East to identify terrorist suspects.⁵ Potential field uses include but are not limited to police booking stations, the battlefield, counter-terrorism, human trafficking, mass casualty incidents, and borders and ports.⁶

The ANDE Corporation is one of the five entities (and one of two still active) that worked on the development of Rapid DNA technology with support from the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), the FBI, and the Department of Defense.⁷ As the only group that has received military and FBI approval for operational use of their system, this white paper will focus

¹ Tan et al. "Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles" *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

² Ibid.

³ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Accredited-DNA%20Laboratory%20Use>

⁴ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁵ Ibid.

⁶ Tan et al. "Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles" *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

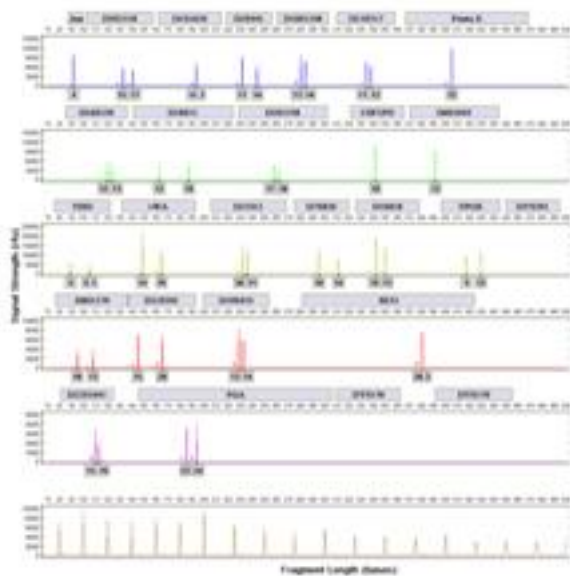
⁷ <https://www.dhs.gov/science-and-technology/news/2019/04/23/snapshot-st-rapid-dna-technology-identified-victims>

on the ANDE technology in particular and the potential applications, limitations, and considerations for use of Rapid DNA technology in general.

The Science of Rapid DNA

Forensic DNA typing analysis and data interpretation have been conducted in laboratory settings by highly trained and qualified scientific personnel since their implementation over 20 years ago. The science and technology behind Rapid DNA analysis have the potential to expand testing capabilities both within forensic laboratories and in the field. For the first time, Rapid DNA allows forensic STR analysis to be performed outside the physical boundaries of the traditional laboratory.⁸

Rapid DNA takes the resources of a forensic lab and condenses these components into an instrument approximately the size of a desktop printer, making it portable to the scenes of disasters or crimes.⁹ The ANDE Corporation's technology solution was developed with five goals in mind: 1) to make it fast, 2) to make it easy, 3) to make it portable, 4) to make it rugged, and 5) to make it generate data as good or better than that of the conventional laboratory process.



Representative DNA ID from the ANDE Rapid DNA Identification System

A muscle swab was subjected to Rapid DNA processing in an I-Chip. The system is capable of generating DNA IDs from reference samples, forensic samples (e.g. blood, bottles, cups, handled items), and disaster victim samples (e.g. bone, tooth, liver, lungs, brain).

⁸ Della Manna et al. "Developmental validation of the DNAscan™ Rapid DNA Analysis instrument and expert system for reference sample processing" *Forensic Science International: Genetics*, Volume 25, 145 – 156, November 2016.

⁹ <https://www.dhs.gov/science-and-technology/news/2019/04/23/snapshot-st-rapid-dna-technology-identified-victims>

Considering these objectives, ANDE designed its product to provide results in under two hours,¹⁰ made it easy for a lay person to operate the system after only 15 minutes of training, designed to a total system weight of 50 kg so it can be carried by two persons, designed it to withstand reasonable wear and tear,¹¹ and demonstrated in a major developmental validation that the system's data quality is at least as good as that from conventional technology.¹² The system is also quick to start up, as it takes only 20 minutes for the machine to come online and self-check all systems (once the system is turned on, it can remain on indefinitely without restarting).¹³ These features allow DNA profile analysis to be moved from the forensic laboratory setting and into the field for practitioner use,¹⁴ as this technology makes it possible for high quality profiles to be generated outside an accredited laboratory without need for calibration.¹⁵

The Rapid DNA analysis process using the ANDE system is straightforward. First, a sample collected on an ANDE swab is scanned on the ANDE instrument to link the sample to the results (non-ANDE swabs can also be utilized, but the RFID security feature is lost). Next, the swabs are loaded into the chip (4 crime scene swabs for an I-Chip or 5 buccal swabs for an A-Chip). Once this is complete the chip is loaded into the ANDE instrument and the door is shut. In under 2 hours the sample is processed and a report is generated to indicate whether the sample has been successfully processed or if the sample cannot be analyzed. Finally, successfully analyzed samples are compared against a database for actionable results.¹⁶ This comparison may be a database search and match (e.g. to see if a crime scene sample matches a suspect or convicted felon database), acclaimed relationship search (e.g. to determine if a claimed parent-child relationship is valid at a border crossing), and a familial search (e.g. to compare unidentified human remains to a database of family reference samples).

¹⁰ L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex1 16 high content DNA biochip cassette for use as an expert system with reference buccal swabs *Forensic Science International: Genetics* 29 (2017) 100–108.

¹¹ Tan et al. "Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles" *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

¹² Carney et al., "Developmental validation of the ANDE rapid DNA system with FlexPlex assay for arrestee and reference buccal swab processing and database searching" *Forensic Science International: Genetics* 40 (2019) 120-130.

¹³ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

¹⁴ Tan et al. "Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles" *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

¹⁵ L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex1 16 high content DNA biochip cassette for use as an expert system with reference buccal swabs *Forensic Science International: Genetics* 29 (2017) 100–108.

¹⁶ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.



The ANDE Rapid DNA Identification System

Cheek swabs or forensic samples are collected using the ANDE swab (left). The swab holder contains desiccant to dry out the sample for storage, and the cap contains an embedded RFID tag for sample tracking. The A-Chip (center) is a single use, disposable consumable which includes all reagents, materials, and waste containment required to perform fully-automated generation of DNA IDS. All required reagents are factory pre-loaded on the chip, which can be stored for up to 6-months at room temperature. Forensic samples are loaded into the chip, and the chip is inserted into the ruggedized ANDE instrument (right). There is no direct contact between the instrument and the sample or the reagents; all liquids within the chip are driven by pneumatic pressure. This closed system design, coupled with swabs that lock and seal into the chips and RFID tracking, minimizes the potential for contamination. All data processing and interpretation is performed by the on-board Expert System, and a non-technical user can be trained to operate the system in less than an hour.

In 2010, the FBI established the Rapid DNA Program Office to facilitate the development and integration of Rapid DNA technology for use by law enforcement. Working with the Department of Defense, the National Institute of Standards and Technology, the National Institute of Justice, and other federal agencies, the program office ensures the coordinated development of this technology among federal agencies.¹⁷

Since the establishment of the FBI's Rapid DNA Program Office, the science behind Rapid DNA has been validated in numerous peer-reviewed studies that have been published in scientific publications.

A 2013 study described the ANDE Corporation's Rapid DNA equipment and technology, noting that:

"...an integrated system was developed consisting of an injection-molded microfluidic [A-Chip], a ruggedized instrument, and expert system software. For each of five buccal swabs, the system purifies DNA using guanidinium-based lysis and silica binding, amplifies [26] short tandem repeat loci and the amelogenin locus, electrophoretically separates the resulting amplicons, and generates a profile. No operator processing of the samples is required, and the time from swab insertion to profile generation is [94] minutes. All required reagents are contained within the [A-Chip]; these consist of a lyophilized polymerase chain reaction mix and liquids for purification and electrophoretic separation.

Profiles obtained from fully automated runs demonstrate that the integrated system generates concordant short tandem repeat profiles. The reagents are stable for at least 6 months at 22°C, and the instrument has been designed and tested to Military Standard 810[G] for shock and

¹⁷ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Background-on%20Rapid%20DNA%20Efforts>

vibration ruggedization. A nontechnical user can operate the system within or outside the laboratory.”¹⁸

The swabs used in this system do not require refrigeration prior to analysis. In a 2017 study, most of the samples used were collected over a short period of time. As a result, some of the samples sat for up to 7 days before analysis. The passage of time and storage method did not affect the ability to analyze the sample using Rapid DNA. Based on these results, scientists stated that sample swabs can be stored at room temperature for up to 7 days prior to analysis with no effect on success when processed by the ANDE system.¹⁹ More recently, the swabs have been shown to be stable at room temperature for at least one year if stored in a tube containing desiccant (to prevent microbial overgrowth).

In 2016, eight laboratories participated in a study testing of over 2,300 swabs, and included samples from nearly 1,400 unique individuals. The goal of this extensive study was “to obtain, document, analyze, and assess DNAscan [ANDE’s system was branded as DNAscan at the time] and its internal Expert System to reliably genotype reference samples in a manner compliant with the FBI’s Quality Assurance Standards (QAS) and the NDIS Operational Procedures.”²⁰

During this study the DNAscan integrated Expert System (onboard analysis software package) was examined as part of the Developmental Validation. This system was found to have successfully interpreted over 2,000 samples with over 99.998% concordant alleles and a 91% first pass success rate. When appropriate, the system also flagged samples for human review and failed both mixed samples and samples with insufficient genetic information. These results demonstrated that the integrated Expert System makes correct allele calls without human intervention.²¹ This developmental validation was based on the CODIS 13 FBI standard and led to NDIS approval of the ANDE 4C system in 2016.

The results of a 2017 study indicated that “the instrument is reliable, reproducible, accurate, robust, and ready for a large scale, comprehensive developmental validation by NDIS-participating laboratories. The additional loci in the FlexPlex assay allow for improved STR profile sharing globally, increase the power of discrimination for identification matches, and improve the effectiveness of kinship analyses.”²²

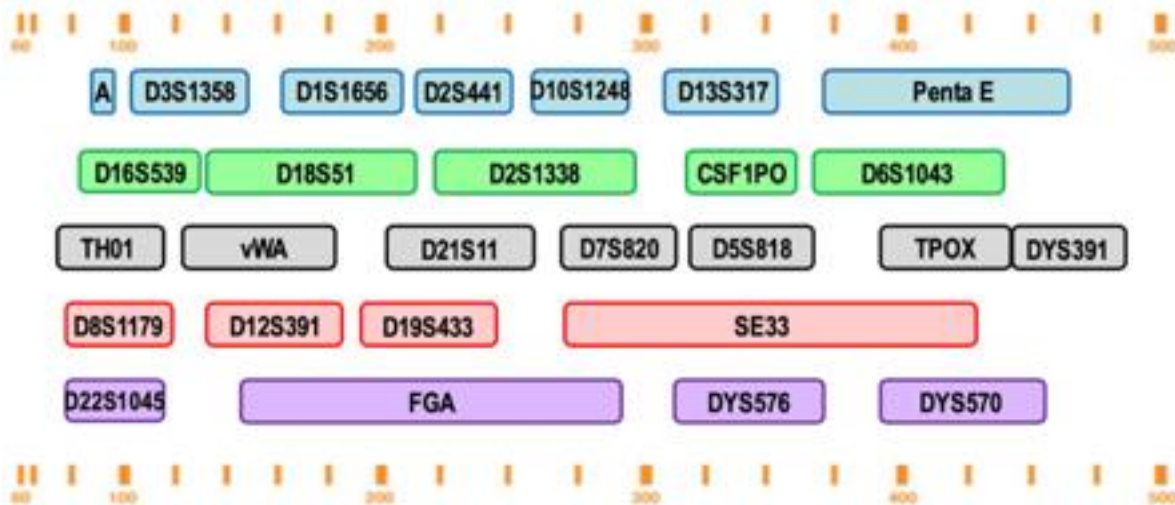
¹⁸ Tan et al. “Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles” *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

¹⁹ L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex1 16 high content DNA biochip cassette for use as an expert system with reference buccal swabs *Forensic Science International: Genetics* 29 (2017) 100–108.

²⁰ Della Manna et al. “Developmental validation of the DNAscan™ Rapid DNA Analysis instrument and expert system for reference sample processing” *Forensic Science International: Genetics*, Volume 25, 145 – 156, November 2016.

²¹ Della Manna et al. “Developmental validation of the DNAscan™ Rapid DNA Analysis instrument and expert system for reference sample processing” *Forensic Science International: Genetics*, Volume 25, 145 – 156, November 2016.

²² Grover et al. “FlexPlex27- highly multiplexed rapid DNA identification for law enforcement, kinship, and military applications” *International Journal of Legal Medicine* 2017 Nov;131(6):1489-1501.



Configuration of the FlexPlex STR assay

Flexplex is a 6-Color assay (including an Internal Lane Standard) that interrogates 23 autosomal STR loci, three Y-chromosomal, and Amelogenin. FlexPlex generates data compatible with databases around the world, including the CODIS core 20 loci, ENFSI/EDNAP Expanded European Standard Set, Australia’s National Criminal Investigation DNA Database, Canada’s National DNA Data Bank, China’s National DNA Database, Germany’s DNA-Analyze-Datei, New Zealand’s National DNA Profile Databank, and United Kingdom’s National DNA Database.

Results of a 2017 study conducted by the FBI indicated an overall success rate of 75% for the 13 CODIS core loci (a single failed locus was deemed a sample failure) and, more importantly, no incorrect calls were identified. This study reported that the technology could be confidently used without human interaction in both laboratory and non-laboratory settings to generate reference profiles. The authors noted that:

“Throughout the study, no contamination was observed, no incorrect allele calls were made and all artifacts were correctly flagged. Although the individual run ladders were consistently failed by the expert system throughout this study due to slight peak broadness at some of the markers, the system pre-loaded allelic ladder proved to be sufficient to correctly assign allele calls to all samples examined. Based on these observations the DNAscan/ANDE Rapid DNA analysis platform is a robust and reliable tool that consistently yields correct DNA profiles. Therefore, the system could confidently be used in an accredited laboratory for the rapid analysis of known exemplars and could be used by non-scientists in non-laboratory settings with appropriate protocols, quality assurance and quality control measures in place. This new technology can alleviate the laboratory workload and expedite exemplar analyses that could aid in the resolution of unsolved criminal cases.”²³

²³ L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex1 16 high content DNA biochip cassette for use as an expert system with reference buccal swabs Forensic Science International: Genetics 29 (2017) 100–108.

In 2017, the FBI changed to a CODIS 20 standard, and ANDE introduced the 27plex 'FlexPlex' assay to comply. The ANDE 6C system with FlexPlex chemistry was validated on 2045 samples from 1387 individuals on 13 instruments run by 6 different laboratories. In June, 2018, the system received NDIS approval, the second ever approval for a Rapid DNA system (ANDE's 2016 approval was the first). In a 2019 publication, the goal of this study was described as:

"... an extensive and comprehensive validation... to thoroughly evaluate and document the ANDE System and its internal Expert System to reliably genotype reference buccal swab samples in a manner compliant with the FBI's Quality Assurance Standards and the NDIS Operational Procedures. This study found that during this comprehensive developmental validation, the ANDE System successfully interpreted over 2,000 samples tested with over 99.99% concordant alleles. The data package described herein led to the ANDE System with the FlexPlex assay receiving NDIS approval in June 2018."²⁴

While it is important that Rapid DNA technology makes the appropriate matches between DNA profiles, it is just as vital that Rapid DNA analysis is able to identify reference and arrestee buccal swabs that contain any potential mixed DNA samples. Such samples are appropriately detected and failed by the Expert System.²⁵

Rapid DNA proponents stress the importance of working closely and in tandem with a partnering forensic laboratory. While neither ANDE's technology nor conventional laboratory DNA analysis can automatically interpret DNA results from mixtures, laboratory software is often able to deconvolute these samples to identify the individual contributors. Whether the mixed sample was processed by ANDE or conventional processes, mixture deconvolution software can readily be applied.

Accreditation

While Rapid DNA is a relatively new technology, its innovation has followed a path similar to other emerging technologies that faced skepticism early on, such as on-scene drug testing, breathalyzer testing, and electronic fingerprinting. After rigorous testing and accreditation, these technologies became widely accepted investigative tools and agencies worldwide have come to depend on them.²⁶

Effective June 1, 2018, the ANDE Corporation's Rapid DNA equipment and technology received National DNA Index System (NDIS) approval from the FBI.²⁷ The approval allows for "accredited NDIS laboratories to process DNA samples using the ANDE system and search the resulting ANDE DNA IDs against the FBI's Combined DNA Index System (CODIS) program, without manual interpretation or technical review."²⁸

²⁴ Carney et al. "Developmental validation of the ANDE™ rapid DNA system with FlexPlex™ assay for arrestee and reference buccal swab processing and database searching" *Forensic Science International: Genetics* Volume 40, May 2019, Pages 120-130.

²⁵ Ibid.

²⁶ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

²⁷ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Accredited-DNA%20Laboratory%20Use>

²⁸ <https://www.ande.com/press/archive/ande-rapid-dna-approved-by-fbi-first/>

Currently, arrestees that have committed previous unsolved crimes such as rapes and murders are released within hours of their arrest without being connected to the previous, unsolved crime. The reason is simple—it has not been possible to perform a DNA identification prior to release of the arrestee. The Rapid DNA Act of 2017 calls for DNA testing of arrestees in police booking stations with the goal of identifying arrestees wanted in connection to other cases while they are still in police custody.²⁹ Rapid DNA testing of arrestees has the potential to identify repeat criminals and dramatically reduce the rate of violent crime by identifying suspects quickly.³⁰ With over 20% of US women being sexually assault during their lifetimes³¹, DNA testing has the potential to dramatically impact the rape epidemic in the US. The Rapid DNA Act of 2017 requires NDIS approval of Rapid DNA Systems in order for them to be used in police booking stations.³²

Currently, the ANDE Rapid DNA system is the only system for Accredited Laboratory Use approved by the FBI.³³

The Application of Rapid DNA Analysis – Who Can Benefit?

Rapid DNA technology has applications in many fields and situations, and the reliability, validity, and adaptability of this technology makes it a dynamic solution. Rapid DNA identification and the use of rugged, field-deployable systems to develop STR profiles can be used to aid law enforcement, the military, immigration, and homeland security operations.^{34,35} Medical examiners and Offices of Emergency Management agencies have also begun utilizing this emerging technology as it has the potential to make multiple DNA profile matches in under two hours which can help in victim identification efforts.³⁶

Rapid DNA can be used to aid in disaster victim identification and has been used successfully to identify the victims of the Camp Fire in northern California in 2018 and the Southern California boat fire in 2019.³⁷ This technology can potentially clear backlogs of victim identifications in mass casualty incidents, and can be used to identify victims in mass graves.³⁸ A recent study performed in collaboration with the University

²⁹ Public Law 115-50: Rapid DNA Act of 2017 <https://www.congress.gov/115/plaws/publ50/PLAW-115publ50.pdf>
Accessed: October 16, 2019

³⁰ <https://www.ande.com/press/archive/ande-rapid-dna-approved-by-fbi-first/>

³¹ <https://www.rainn.org/statistics/victims-sexual-violence>

³² Public Law 115-50: Rapid DNA Act of 2017 <https://www.congress.gov/115/plaws/publ50/PLAW-115publ50.pdf>
Accessed: October 16, 2019

³³ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Accredited-DNA%20Laboratory%20Use>

³⁴ Grover et al. “FlexPlex27- highly multiplexed rapid DNA identification for law enforcement, kinship, and military applications” *International Journal of Legal Medicine* 2017 Nov;131(6):1489-1501.

³⁵ Tan et al. “Fully Integrated, Fully Automated Generation of Short Tandem Repeat Profiles” *Investigative Genetics* 2013, 4:16 <http://www.investigativegenetics.com/content/4/1/16>

³⁶ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

³⁷ <https://nypost.com/2019/09/05/officials-used-rapid-dna-tech-to-identify-california-boat-fire-victims/>
<https://www.abc10.com/article/news/local/abc10-originals/searching-for-the-dead-camp-fire-victims/103-ffe78a2a-1ba4-4e07-b0f2-0d56bce8ef02>

³⁸ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

of Tennessee determined the ideal tissue types of Rapid DNA analysis during exposure of human remains above-ground for one year. Not surprisingly, bone and teeth were the optimal samples for long-term analysis, and buccal swabs were effective in the initial days following death.³⁹

Rapid DNA can be used to prevent backlogs in other kinds of cases, including sexual assaults. The Kentucky State Police in early 2019 completed a successful pilot project which demonstrated for the first time the ability for Rapid DNA technology to analyze samples from sexual assault evidence kits (SAEKs) and generate investigative leads soon after victims reported to the hospital.⁴⁰ Adoption of this ANDE technology on a broad scale to quickly develop offender DNA profiles which can be compared to state DNA databases and eventually CODIS will help to prevent future buildups of sexual assault kit backlogs and lead to earlier apprehension of serial sexual offenders.⁴¹ Rapid SAEK processing is complementary to the arrestee testing described above.

The most immediate and potentially prolific use of Rapid DNA may be its use in the arrestee processing system. The automated production of point-of-collection reference STR profiles could eliminate the time delay for shipment and analysis of arrestee samples at centralized laboratories.⁴² Many US states and other countries have implemented programs to collect and index the DNA of suspects at the time of arrest much the same as they collect fingerprints at the time of arrest - for the purpose of identifying the arrestee. The ANDE Corporation is currently participating in pilot programs managed by the FBI in five states across the U.S. to evaluate Rapid DNA efficacy in the arrestee booking environment.⁴³

The FBI's Rapid DNA Program Office works "with state and local law enforcement agencies and state bureaus of identification through the FBI's Criminal Justice Information Services Division Advisory Policy Board to facilitate the effective and efficient integration of Rapid DNA in the booking environment."⁴⁴ The objective of the FBI's Rapid DNA initiative is "to link FBI approved commercial instruments capable of producing a CODIS core loci DNA profile within two hours to the existing CODIS infrastructure in order to search unsolved crimes of special concern while a qualifying arrestee is in police custody during the booking process."⁴⁵ In addition to streamlining the arrestee processing system, once the infrastructure to immediately search the Combined DNA Index System (CODIS) database from the booking station is

³⁹ Turingan et al. *Int J Legal Med* (2019). "Identification of human remains using Rapid DNA analysis"
<https://doi.org/10.1007/s00414-019-02186-y>

⁴⁰ <https://kentuckystatepolice.org/hq-4-10-19/>

⁴¹ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁴² L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex16 high content DNA biochip cassette for use as an expert system with reference buccal swabs *Forensic Science International: Genetics* 29 (2017) 100–108.

⁴³ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁴⁴ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Background-on%20Rapid%20DNA%20Efforts>

⁴⁵ <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/rapid-dna#Accredited-DNA%20Laboratory%20Use>

established, the collection and analysis of these samples would allow for comparisons against profiles from unsolved crimes during the normal booking process.⁴⁶

Some critics express concerns over the incorporation of Rapid DNA technology as a routine part of arrestee processing from a civil liberties perspective. When individuals are arrested, however, they lose certain rights: in nearly all cases today, they provide fingerprints, are subjected to body search, turn over personal property, lose freedom of movement, and have their name searched against a list of wants and warrants. Collecting a DNA ID is very similar to collecting fingerprints, and is much less intrusive than these other activities, yet can be considerably more effective at solving and preventing crimes.⁴⁷

Recent Applications of Rapid DNA

Recent applications of Rapid DNA analysis have highlighted the efficacy of this technology.

Following the Camp Fire wildfire in California during the fall of 2018, ANDE's Rapid DNA technology was used to positively identify 85 percent of the victims. Funded in part by DHS S&T, the Sheriff's Office of Butte County, California, invited the ANDE Corporation to assist at the disaster site to analyze DNA samples and match samples from victims and relatives. This tool proved particularly useful when dental records and fingerprints were unavailable for comparisons.⁴⁸ As the remains were highly degraded, often in the form of charred bone and ashes), these conventional biometric modalities were only successful in about and demonstrated in a major developmental validation that the system's data quality is at least as good as that from conventional technology.one-quarter of cases. The remaining three-quarters of the remains were identified using the ANDE system.⁴⁹

Rapid DNA analysis was also used in September 2019 to identify victims of the Conception dive boat fire that killed 34 people. The Sacramento County Coroner's Office used ANDE's Rapid DNA technology to compare genetic profiles of the victims with family samples collected using a cheek swab. DNA samples were collected from relatives across the country and around the world in an effort to identify victims and bring closure to families.⁵⁰ A single staff member generated DNA IDs from all but one of the remains in two days—the last set was identified the day it was recovered, a few days later. The Coroner has stated that the months or years families typically wait for identification of disaster victims is akin to torture, and Rapid DNA can quickly bring closure to grieving families.⁵¹

The federal government is working to incorporate the use of Rapid DNA technology into border security operations with U.S. Immigration and Customs Enforcement (ICE) and U.S. Customs and Border Protection

⁴⁶ L.I. Moreno et al. Internal validation of the DNAscan/ANDE Rapid DNA Analysis platform and its associated PowerPlex1 16 high content DNA biochip cassette for use as an expert system with reference buccal swabs *Forensic Science International: Genetics* 29 (2017) 100–108.

⁴⁷ *Maryland v. King*. (n.d.). *Oyez*. Retrieved December 11, 2019, from <https://www.oyez.org/cases/2012/12-207>.

⁴⁸ <https://www.dhs.gov/science-and-technology/news/2019/04/23/snapshot-st-rapid-dna-technology-identified-victims>

⁴⁹ International Symposium of Human Identification (2019). The ISHI Report 2019. Retrieved on December 13, 2019, from <https://promega.foleon.com/theishireport/november-2019/cover/>

⁵⁰ <https://www.latimes.com/california/story/2019-09-10/california-boat-fire-raising-sunken-conception-is-critical-step-as-investigation-widens>

⁵¹ Gin, K. (2019). California Wildfires: Rapid DNA Analysis. *Forensic Science Executive*: Winter 2019: 12, 14.

(CBP). In a pilot project in the spring of 2019, ICE successfully demonstrated the use of ANDE Rapid DNA technology to support validation of familial claims made by immigrant detainees. The goal of this work is to prevent human trafficking, a major problem in the US and worldwide. As of November 2019, DHS is moving to institute DNA sample collection for all immigrant detainees in order to more effectively determine whether detainee profiles match any profiles associated with unsolved crimes in the U.S.⁵²

Future Expansions of Rapid DNA

Expanded applications of Rapid DNA are still being explored. While results of Rapid DNA analysis from crime scene samples are not currently approved by the FBI for entry into CODIS, the technology is currently being used by many law enforcement agencies to successfully generate investigative leads by analyzing various sources of DNA from crime scenes including blood, saliva, and touch DNA.^{53,54} (see “Current Limitations of Rapid DNA Use” below). The ANDE system’s ability to analyze multiple samples at the same time in under two hours makes it a potentially vital investigative tool.⁵⁵ Certain professional associations have issued statements that urge caution with regard to law enforcement use of Rapid DNA – at present – for any investigative use beyond single-source reference samples.⁵⁶ However, agencies that are currently using Rapid DNA technology to generate investigative leads from crime scene samples by comparing results against local databases are seeing success. Rapid DNA could also be used in cases that would not routinely be analyzed in a forensic lab, such as property crimes.⁵⁷ The potential for investigative leads and resulting arrests could have a significant impact on property crime case closure rates.

Exonerating the innocent is also a critical benefit of Rapid DNA technology. DNA has become the primary tool used today to exonerate the innocent.⁵⁸ This technology can make it possible for investigators to rule out innocent suspects early in a case, and could potentially be used by conviction review units to exonerate wrongly convicted persons.⁵⁹

⁵² <https://www.federalregister.gov/documents/2019/10/22/2019-22877/dna-sample-collection-from-immigration-detainees>

⁵³ Federal Bureau of Investigation, Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group, 9-16-2019

⁵⁴ Scientific Working Group on DNA Analysis Methods Position Statement on Rapid DNA Analysis (2017) https://docs.wixstatic.com/ugd/4344b0_f84df0465a2243218757fac1a1ccffea.pdf

⁵⁵ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁵⁶ Federal Bureau of Investigation, Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group, September 16, 2019.

⁵⁷ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁵⁸ Heinrichs, George. DNA IDs and Privacy White Paper. ANDE Corporation, June 5, 2018.

⁵⁹ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

Current Limitations of Rapid DNA Use

The FBI has recently initiated the process for enabling the results of Rapid DNA analysis of crime scene samples to be entered into CODIS. In the meantime, however, a multi-stakeholder working group has been established to provide guidance and best practices (not requirements) to law enforcement agencies that want to use Rapid DNA to process crime scene samples for comparison against DNA profile databases other than CODIS.⁶⁰

Perhaps the most important limitation of Rapid DNA identification is related to mixture interpretation. The ANDE Expert System identifies mixtures (DNA IDs resulting from two or more contributors); the system informs the operator if any samples contain a mixture. When mixtures are detected by the automated Expert System, they can be analyzed by the conventional laboratory, just as is the case for laboratory-derived mixtures. However, there is a major benefit of the ANDE system's ability to identify a mixture quickly. Immediate feedback to evidence collection personnel offers the potential to improve and focus sample collection, a feedback mechanism lost when the samples are processed weeks or months later in the lab when the crime scene is no longer under law enforcement control.

Currently, a critical recommendation by oversight committees and manufacturers alike is that agencies should follow the conventional in lab process first, taking the first and best swabs for the forensic lab and using secondary samples for Rapid DNA processing.⁶¹

Even with these limitations, Rapid DNA is poised to play an important role in investigations by enabling faster lead generation using DNA samples. Accordingly and in parallel with the FBI's initial review of the Rapid DNA Identification of crime scene samples, several states have decided to utilize their DNA databases ("State DNA Identification System, or "SDIS" databases) to allow searching with Rapid DNA IDs. As the vast majority of crime is local, this approach has the potential to reduce crime while federal policies are developed. In this regard, it may be reasonable to allow the FBI's DNA database to be searched with Rapid DNA IDs as an initial step. Searching using Rapid DNA IDs (as opposed to entry of Rapid DNA IDs into the database) represents a negligible risk to the database while enabling suspect identification. Finally, it is important to note that the implementation of Rapid DNA will also allow forensic labs to focus on high priority forensic samples, and reduce time and resources spent on simpler identification samples which can easily be handled by Rapid DNA systems.⁶²

⁶⁰ Federal Bureau of Investigation, Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group, 9-16-2019

⁶¹ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁶² Scientific Working Group on DNA Analysis Methods Position Statement on Rapid DNA Analysis (2017) https://docs.wixstatic.com/ugd/4344b0_f84df0465a2243218757fac1a1ccffea.pdf

Considerations for Use of Rapid DNA Technology

While proponents of Rapid DNA technology see great promise in its advance, and while pilot programs, demonstration programs, and full implementations are multiplying quickly, limitations and concerns must also be taken into consideration and addressed through policy. Many of these concerns stem from the need to validate the reliability of the technology and the thorough training of its practitioners; privacy considerations; and policy implications.

Importance of Reliable Technology and Training

Critics and proponents of Rapid DNA alike note that the technology needs to be reliable and that the persons using it need to be trained on the equipment and software before use. Rapid DNA technology has undergone close scrutiny by the scientific community and has been repeatedly shown to be reliable and effective. However, while Rapid DNA technology works well on single-source DNA samples, samples that are mixed (e.g., containing more than one DNA source) would need to be analyzed in a traditional forensic laboratory. Training for those using the technology is just as important, as the mishandling of evidence could compromise prosecutions.⁶³

Privacy Concerns

Privacy concerns are another important area of consideration when undertaking a Rapid DNA program. Critics express concern about DNA databases insofar as DNA profile databases could be breached, mishandled, or used in a biased or otherwise illegitimate manner.⁶⁴ There are also concerns that the technology could be abused and used to test people without their informed consent.⁶⁵

Proponents of Rapid DNA analysis point to three main rebuttals when faced with these and similar arguments. First, they argue that DNA is without bias. A DNA profile will either match a sample or it will not, without social, racial, economic, gender, or any other bias. Second, The United States Supreme Court and the California Supreme Court both agree that collecting buccal swabs and generating DNA identification profiles to establish identity and to search against unsolved cases is not an unreasonable search under the Fourth Amendment to the United States Constitution or the California state constitution. Third, DNA records are not stored with criminal records. Instead, searches of DNA data merely serve as a “pointer” to the originating agency.⁶⁶ To reinforce these views, proponents argue that DNA profile databases should be viewed in the same light as fingerprint databases.

⁶³ <https://www.latimes.com/california/story/2019-09-24/rapid-dna-forensics-crime-police>

⁶⁴ Heinrichs, George. DNA IDs and Privacy White Paper. ANDE Corporation, June 5, 2018.

⁶⁵ <https://www.latimes.com/california/story/2019-09-24/rapid-dna-forensics-crime-police>

⁶⁶ Heinrichs, George. DNA IDs and Privacy White Paper. ANDE Corporation, June 5, 2018.

Another argument by Rapid DNA skeptics is that DNA analysis and data collection should only be conducted after the first conviction of a person, and then only for the most heinous crimes. There are several important considerations with this issue. First, a high percentage of criminals are repeat offenders. These individuals frequently have a history of escalating crimes as well. If DNA reference samples are only available after a conviction is final, it is possible that a criminal could escape arrest or conviction for a spree of previous crimes. They could also theoretically continue to escape identification and capture over and over.⁶⁷

Similar kinds of data are already collected by agencies without facing the same concerns as Rapid DNA analysis. Fingerprint databases are just one example. Fingerprints are useless without a print to compare it to. The same is true for DNA profiles.⁶⁸

There is irony in the popularity of the “23andme” and “Ancestry.com” DNA kits available to the public, which collect considerably more data than Rapid DNA analysis does. These popular kits generate hundreds of thousands of data points and extensive personal information because of the type of DNA processing used. By contrast, the STRs used in law enforcement – including those generated by Rapid DNA – is based on the fragment lengths of only 54 “junk” chromosomal locations-- and contain no information on an individual’s appearance or current or future health or behavior. In fact, a driver’s license, which is shared with others on an almost daily basis, provides more personal information than a DNA profile.⁶⁹ Rapid DNA may lead to a substantial decrease in sexual assaults, murder, and property crime, accelerate criminal investigations, and allow the exoneration of the innocent—leading to a protection of civil rights and liberties. The cost for these benefits—analysis of junk DNA regions that essentially represents a more accurate fingerprint—must be considered as privacy policies are developed.

Importance of Policy Prior to Implementation

Significant advances in DNA analysis technology and the proliferation of private databases of DNA profiles over the past decade have resulted in promising new applications for DNA in law enforcement investigations. Rapid DNA technology and forensic genetic genealogical DNA analysis and searching (FGGS) methods are two prominent examples.^{70,71} As agencies consider implementing these DNA tools to help them more quickly generate investigative leads and solve crimes, the policy environment must adapt to account for these applications.

It is important to have good policies and protocols in place prior to implementing any Rapid DNA program. Sound policy at the outset can mitigate both operational and legal risk. Any legislation regulating the use of Rapid DNA should be informed by effective policies developed by successful early users of the technology.

⁶⁷ Heinrichs, George. DNA IDs and Privacy White Paper. ANDE Corporation, June 5, 2018.

⁶⁸ Ibid.

⁶⁹ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁷⁰ Federal Bureau of Investigation, Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group, September 16, 2019.

⁷¹ United States Department of Justice, Interim Policy forensic genetic genealogical DNA analysis and searching. September, 2, 2019.

Public policy will likely continue to be driven by state and local agencies with increasing input from federal agencies. As agencies begin writing legislation, policies, and protocols, these organizations should consult proven policy development frameworks such as the IACP Technology Policy Framework to help guide them.⁷² Agencies should ask themselves critical questions including but not limited to:

- In what kinds of cases should Rapid DNA be used?
- Which practitioners should use it?
- Which practitioners should be responsible for collecting samples?
- Should data from Rapid DNA analysis be retained?
- How long should data from Rapid DNA analysis be retained?
- What is the threshold for deeming a sample is a match?
- What is the threshold for ruling an individual out as a suspect?
- What is the cost-benefit of using Rapid DNA for violent and property crimes?

The answers to these and other questions vary from agency to agency. Some organizations have indicated a desire to use Rapid DNA for a broad range of crime types, even vandalism, and as such this technology can become a much more common evidentiary tool. Many factors, including budgetary ones, must go into the decision-making process.⁷³

Case law will also likely guide policies surrounding the use of Rapid DNA. Evidence generated using Rapid DNA analysis has not yet been challenged in a criminal case (e.g. Daubert, Frye); to date, individuals have pled guilty to charges when informed that DNA evidence has been generated. However, there will eventually be a case where Rapid DNA will be used and it will be challenged in court. At that time, an expert will have to testify in court that the same DNA analysis process conducted in a lab has been conducted using the Rapid DNA technology. Prosecutors will have to work with ANDE Corporation and prepare extensively for this inevitability.

In response to an increasing number of state and local law enforcement agencies successfully adopting Rapid DNA technology for several purposes, including investigative lead generation purposes using crime scene samples, and in the absence of standards for these types of uses, the FBI created a task group (the “Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group”) to identify policy considerations. In September 2019, the task group issued a document titled “Non-CODIS Rapid DNA Considerations and Best Practices for Law Enforcement Use.” The document provides recommended (non-binding) guidance to law enforcement agencies that would like to implement Rapid DNA for investigative lead generation purposes from crime scene samples. The document provides guidance in several areas including administrative practices, Rapid DNA technology instruments and consumables, staffing, training and proficiency testing, crime scene samples, consensual reference samples, abandoned or surreptitious samples, sample assessment and acceptance, sample comparisons, reporting Rapid DNA results, metrics, and safety.⁷⁴

⁷² <https://www.theiacp.org/sites/default/files/all/i-j/IACP%20Technology%20Policy%20Framework%20January%202014%20Final.pdf>

⁷³ Byers, William; Davis, James; Schwandt, Melissa; Smith, Jeanne; and Squires, Keith, panelists. Panel Discussion. Rapid DNA Summit, 11 Sept. 2019, Center on Policing, Rutgers University, New Brunswick, NJ.

⁷⁴ Federal Bureau of Investigation, Non-CODIS Rapid DNA Best Practices/Outreach and Courtroom Considerations Task Group, September 16, 2019.

Summary and Conclusions

Scientific Validity

Rapid DNA is an important advancement of the current state of the art in forensic science and has been tested extensively by the scientific community. Numerous studies and academic peer-reviewed journal articles support the validity of the technology and its use. The ANDE Corporation's Rapid DNA System is also currently the only Rapid DNA Analysis System for Accredited Laboratory Use approved by the FBI.

Potential Applications

This technology has a broad range of applications. Rapid DNA identification and the use of rugged, field-deployable systems to develop DNA profiles can be used to aid the military, immigration, homeland security operations, and law enforcement. Rapid DNA can also be used to prevent backlogs of cases, including sexual assaults. The most immediate and potentially prolific use of Rapid DNA may be its use in the arrestee processing system. While results of Rapid DNA analysis from crime scene samples are not currently approved by the FBI for entry into CODIS, the technology is currently being used by many law enforcement agencies to successfully generate investigative leads by analyzing various sources of DNA from crime scenes including blood, bone, tissue, saliva, and touch DNA. Rapid DNA may be used within the first hours of an investigation to help identify or rule out suspects both in the field and in forensic laboratory settings. Importantly, Rapid DNA can also be used to exonerate the innocent.

Importance of Policy and Legislation

It is important to have good policies and protocols in place prior to implementing any Rapid DNA program. Sound policy at the outset can mitigate both operational and legal risk. Any legislation regulating the use of Rapid DNA should be informed by effective policies developed by successful early users of the technology. Clear policies guiding the use of the technology can mitigate the potential risks faced by users.

Considerations for Responsible Use

Critics of Rapid DNA technology have expressed concerns on several points. Many of these concerns stem from the need to validate the reliability of the technology and the thorough training of its practitioners; privacy considerations; and policy implications. Responsible use of Rapid DNA technology is paramount, and care should be taken to ensure that users follow the policies and legislation regarding its use. The potential of Rapid DNA analysis to dramatically improve public safety necessitates extensive effort in developing robust policies for responsible use.