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Understanding Familial DNA Searching: Policies, Procedures, and Potential Impact

Summary Overview

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I. Introduction

In recent years, jurisdictions across the United States have expressed a growing interest in the use of familial DNA searching (FDS) to aid criminal investigations. Proponents of FDS have cited its potential to aid the identification and conviction of suspects, prevent crime, resolve cold cases, exonerate wrongfully convicted individuals, and improve public safety; however, the practice has also led to some legal, ethical, and practical concerns. To date, little empirical work exists documenting current practices and outcomes of using FDS. The *Study of Familial DNA Searching* begins to fill these gaps in knowledge and provides important information on this emerging practice for jurisdictions trying to decide whether or not to implement FDS. ICF, with support from the National Institute of Justice (NIJ), conducted a multi-phase, mixed-methods study on FDS policies and practices in the United States. Through a series of components (see sidebar), this study provides a balanced examination of controversies and considerations from thought leaders on this topic; a national portrait of FDS policies and practices; an in-depth exploration of how it is used within states with varying philosophies and procedures regarding FDS; and a cost model about the expected expenditures and cost savings related to FDS.

Study of Familial DNA Searching Components:

- Systematic literature review
- Two expert roundtables
- Policy review
- National Survey of CODIS Laboratories
- Intensive state case studies
- Econometric cost model

II. Background on Familial DNA Searching

Since Sir Alec Jeffreys first discovered the technique of DNA profiling in 1984 in England, DNA forensic technology has rapidly gained popularity as an investigative tool for law enforcement (Bureau of Justice Statistics [BJS], 1991; *Andrews v. State*, 1988). Forensic DNA profiling identifies unique patterns in alleles and STRs (short tandem repeats) at specified locations (called loci) on an individual's genome. This allows for DNA matching between two DNA profiles to determine whether the two samples are likely to have come from the same

person (e.g., comparing DNA left at a crime scene with a suspect's DNA). Forensic DNA profile matching in the United States involves matching alleles at 20¹ specified loci that have been termed CODIS markers or core loci. These 20 loci only have non-coding regions of DNA (this DNA is also referred to as "junk DNA"), which means the DNA does not code for any known genetic traits and is unrelated to observable characteristics such as race, gender, or health (Gabel, 2010; McCarthy, 2011).

The use of DNA in criminal investigations has continued to increase due to scientific innovations and expanding legislation that authorizes DNA collection from increasingly wider numbers of those coming into contact with the legal system (McCarthy, 2011). Currently, all 50 states, the District of Columbia, and the Federal Government participate in the Combined DNA Index System (CODIS), software used to manage the system of databases storing DNA profiles collected at the local, state, and Federal levels (FBI, n.d.; Murphy, 2010). CODIS software allows crime labs to share and compare DNA profiles from evidence obtained at crime scenes to offender/arrestee samples, as well as across multiple forensic samples (e.g., to identify serial offenders) (FBI, n.d.; Durose, Walsh, & Burch, 2012).

Terminology:

CODIS: The Combined DNA Index System is software designed by the FBI to facilitate the sharing and searching of DNA profiles within and between jurisdictions across the country. CODIS has national (NDIS), state (SDIS), and local (LDIS) levels.

Familial DNA Searching: A deliberate search of a DNA database using specialized software (separate from CODIS) to detect and statistically rank a list of potential candidates in the DNA database who may be close biological relatives (e.g., parent, child, sibling) to the unknown individual contributing the evidence DNA profile, combined with lineage testing to help confirm or refute biological relatedness.

Partial Matching: A moderate stringency search of a DNA database using the routine search parameters within CODIS that results in one or more partial matches between single-source and non-degraded DNA profiles that share at least one allele at each locus, indicating a potential familial relationship between the known individual in the DNA database and the unknown individual contributing the evidence DNA profile. *Disclosing or proceeding with a partial match* would be to use information learned through partial matching in an investigation.

Lineage Testing: Additional genetic testing, such as Y-STR and mtDNA analysis, used to help confirm or refute biological relatedness between the known individual in the DNA database and the unknown individual contributing the evidence DNA. Y-STR analysis is the examination of STR patterns specific to the Y-Chromosome that is used to determine paternally derived relatedness among DNA profiles, whereas mtDNA is found in the mitochondria of cells and is used to determine maternally derived relatedness.

¹ As of 2017, the FBI is requiring 20 profiled loci for submission to NDIS. However, previously this requirement was 13 or 15 core loci.

CODIS is organized into separate indices for different types of samples: Convicted Offender Index, Arrestee Index, Forensic Index (for biological evidence collected from a crime scenes), and indices for unidentified human remains and voluntary samples collected from relatives of missing persons (42 U.S.C. §14132). CODIS is also organized into three jurisdictional levels, the National DNA Index System (NDIS) maintained by the FBI, State DNA Index Systems (SDIS) which are typically overseen by the state-level crime lab, and Local DNA Index Systems (LDIS) which have profiles from individual, local-level labs. Each level has different criteria for including DNA profiles in their system, with NDIS having the most stringent rules (FBI, 2005).²

CODIS software can be set to search at three different stringency levels: high, moderate, and low. High-stringency searches require all alleles to match exactly at all loci, while moderate and low stringency levels allow for the identification of partial matches (also referred to as near or close matches) (Steinberger & Sims, 2008). Traditionally, DNA profiling has been used to find exact matches between unknown genetic samples from crime scenes to those obtained from convicted offenders, arrestees, or crime scene samples from other cases (Ram, 2011). However, the ability to identify partial matches or close associations through lower stringency searches also makes it possible to identify potential family relationships, due to the inherited nature of DNA and the fact that family members have more genetic similarities than non-related individuals (Greely et al., 2006).³

Although lower stringency searches of CODIS can uncover partial matches fortuitously, it is not designed to identify familial matches. To overcome this, some jurisdictions have pursued separate software and genetic algorithms to specifically identify family relationships, implementing a technique called FDS.⁴ Lineage testing is an important additional component of FDS, as it further supports biological relatedness between the unknown evidence sample and

² For example, all samples uploaded to NDIS must generally include all 20 CODIS Core Loci, whereas LDIS and SDIS databases may allow profiles to be included in the database even if they have fewer loci profiled (FBI, n.d.).

³ According to the FBI, recent updates to the NDIS search parameters have reduced the number of partial matches.

⁴ Currently, most FDS software employs Identify by State, Likelihood Ratio, or some combination of these two statistical techniques to determine the strength of potential familial associations found during familial searching.

candidate samples identified through the database. These lineage tests reduce the presence of false-positives from a list of partial matches (see sidebar above).

Studies examining the efficacy of FDS (including lineage testing) with statistical simulations of data generally find that the technique reliably removes non-familial matches for certain family relationship types (Bieber, Brenner, & Lazer, 2006; Ge et al., 2011; Hicks et al., 2010; Myers et al., 2011; Rohlf, Fullerton, & Wier, 2012; Slooten & Meester, 2012). However, some studies have also identified the potential for false positives that exist despite the advanced abilities of the statistical FDS software (Pu & Linacre, 2008; Mueller, 2008; Reid, Lee & Lee, 2008).

Currently, FBI policy prohibits searches of NDIS with the intent of uncovering a familial match; therefore, FDS is limited to searches of SDIS and LDIS databases (Federal Register Vol. 73, No. 238; Ram, 2011).⁵ Ram (2011) combined legal analysis and informal conversations with laboratory respondents to provide preliminary information on variations in state policies related to FDS and the related technique of partial matching. Ram found, at the time of her study, that 4 states permitted both familial searching and partial matching (California, Colorado, Texas and Virginia), while 19 states permitted partial matching, either through explicit permission or lack of explicit prohibition. Emphasizing the similar outcomes of these two techniques, Ram questioned whether the distinction between FDS and partial matching was merely rhetorical. She suggests that the use of partial matching is a means for states to limit controversy by saying they are not using FDS while still attempting to identify familial relationships through partial matching. Our study explores this question further, but we ultimately arrive at a different conclusion due to differences in procedures, algorithm sophistication, and the routine versus intentional nature of these approaches (see the project White Paper for more detail).

While the U.S. has slowly adopted FDS over the past decade, other countries have embraced the practice to a larger extent. The United Kingdom (UK) was the first nation to use its database to search for familial matches and subsequently to convict someone following

⁵ The FBI does not offer FDS within NDIS due to the inefficiency of kinship matching when dealing with extremely large databases (e.g., over 10 million profiles) (FBI, n.d.).

identification through FDS (Haimes, 2006; Krinsky & Simoncelli, 2011). As of 2013, the UK had 38 convictions where FDS was used as an investigative tool (NDNAD Strategy Board, n.d.). Other countries with official policies regarding FDS include New Zealand and the Netherlands, although more countries may be using the practice without publicizing its use.

The limited acceptance of FDS domestically and internationally may be due in part to a number of ethical, legal, and logistical considerations that have been raised by various legal bodies, civil liberties activists, and scholars. Some of the ethical concerns raised in the literature touch on privacy and family issues, such as whether law enforcement should be investigating and labeling innocent family members as suspects based solely on questions of relatedness (e.g., in a case where there may be multiple brothers that need to be investigated and only one is guilty), whether an investigation can interfere with an individual's social identification with a family (e.g., if unknown paternity or adoption is discovered), whether the investigation can cause strained family relationships or reveal convictions that were previously unknown (e.g., the family was not aware that a member had been convicted of a crime and was in CODIS), and whether certain demographic groups with larger family units (e.g., due to religious or cultural reasons) may be disproportionately impacted by the practice (Haimes, 2006; Kaye, 2013; Kim et al., 2011; Murphy, 2010; Ram, 2011). Critics also share concerns about the overrepresentation of racial and ethnic minorities in CODIS and consequently the potential subsequent disparate impact of FDS on minorities (BJA, 2012; Greely et al., 2006; Grimm, 2007; Mares, 2011; Haimes, 2006; McCarthy, 2011, Murphy, 2010; Ram, 2011). Additional ethical questions arise with the widening scope of DNA collection beyond convicted offenders to arrestees or even the potential inclusion in local⁶ databases of victims, excluded suspects from other investigations, and lab workers (Epstein, 2008; Gabel, 2010; Innocence Project, n.d.; Pattock, 2011; Ram, 2011).

⁶ Local-level labs have more discretion to include other types of profiles in their LDIS databases, and policies on what types of profiles can be included vary by local jurisdiction. State-level SDIS databases, where the majority of FDS occurs, have greater restrictions and would not include profiles for individuals such as victims or suspects.

Legal concerns related to FDS typically relate to the Fourth and Fourteenth Amendments. The Fourth Amendment protects U.S. citizens from unreasonable searches and seizures and has been invoked in questioning whether family members of convicted offenders and arrestees should be subject to the same diminished privacy as their relatives in CODIS (who have more limited privacy protections due to being subject to state oversight for prior crimes (Epstein, 2008; Gabel, 2010; Innocence Project, n.d., Kaye, Mercer, & Jenkins, 2011; Murphy, 2010; Pattock, 2011; Ram, 2011)). The Fourteenth Amendment states that every person shall receive equal protection under the law, and some scholars argue that the racial disproportionality issue described above violates this protection, although other legal scholars claim that this is not unconstitutional since the disproportionate focus on certain racial groups is unintentional and not deliberately targeted (Epstein, 2008). Ultimately, proponents of FDS argue that the practice has indeed been legally vetted and does not violate constitutional protections, but no judicial rulings have occurred verifying the validity of these counter-arguments. Finally, both advocates and opponents raise practical concerns including availability of adequate resources (particularly with crime labs that are already plagued with DNA backlogs), additional costs, training needs, and the development/approval of policies.

FDS is an investigative tool that has the potential to solve more crimes and improve public safety. However, the concerns raised in the literature, as well as confusion over the definitions and processes of FDS, have resulted in limited implementation efforts. Much of the discussion around FDS has been limited to anecdotal stories, scholarly or legal debates, and scientific validation studies. However, very little empirical work has been done to document policies and practices, explore how the justice system operates in practice with FDS cases, or understand case-level outcomes of FDS. The current study seeks to fill these research gaps and provide information that can be helpful to jurisdictions making decisions regarding this emerging and evolving technology.

III. Methodology and Findings

This section describes of the components of the Study of Familial DNA Searching, including the methods used and a selection of data highlights. Research activities were approved by ICF's Institutional Review Board and NIJ's Human Subjects Protection Office.

1. Expert Roundtables

1.1 Roundtable Methods

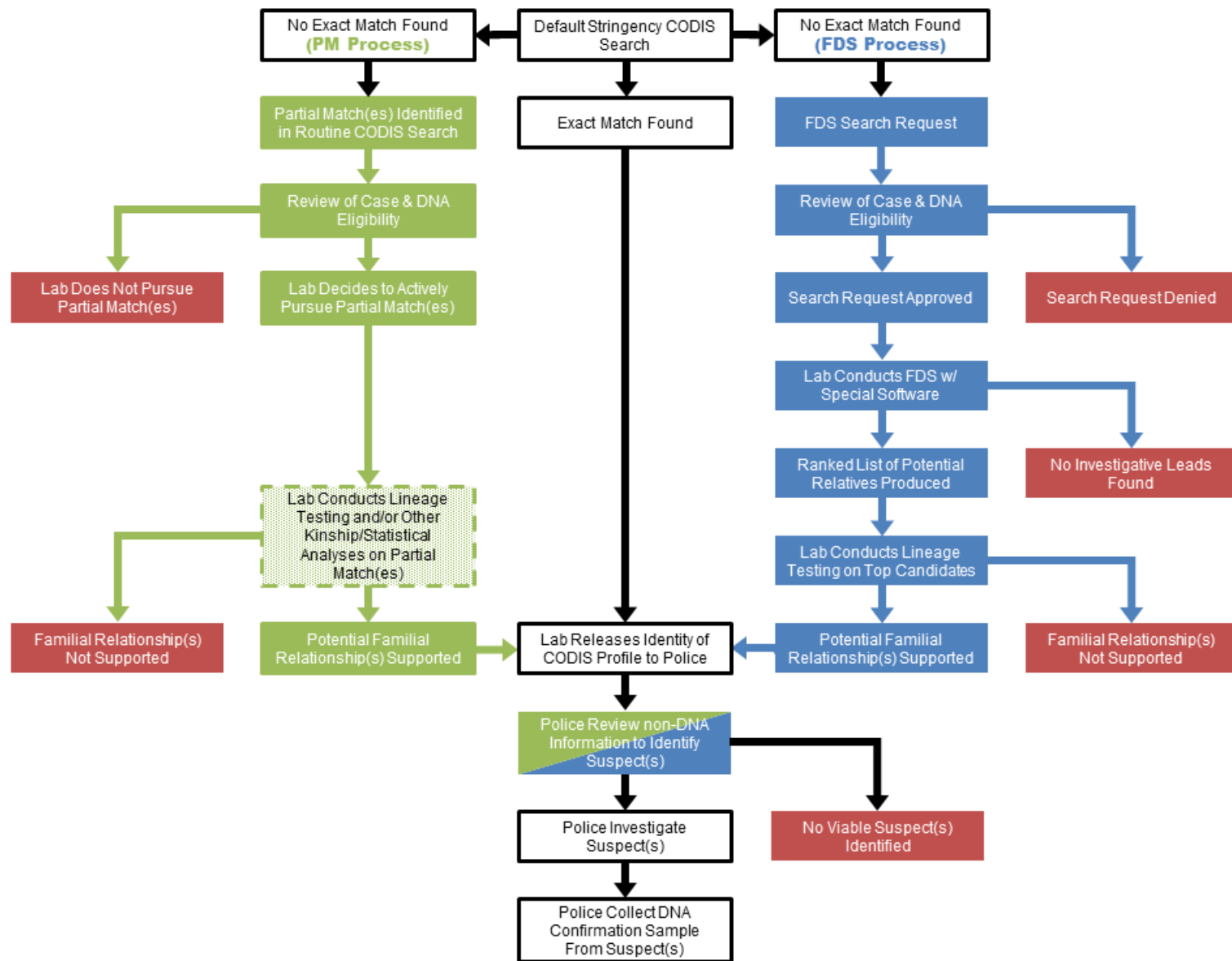
In March 2014, ICF convened a roundtable meeting in Washington, D.C. Invited experts were diverse stakeholders with a range of perspectives on FDS and included the following representatives: forensic scientists, law enforcement, victim services, prosecution, defense, judicial, and civil liberties professionals. To inform the study, ICF facilitated conversations about terminology, practices and processes (e.g., eligibility, oversight, lineage testing, release of information, investigative methods, court proceedings), costs and benefits, and research considerations (e.g., potential survey populations and case study sites, outreach and incentives, availability of data). A second virtual roundtable was held in January of 2017 to obtain feedback and insight on the project's findings and discuss dissemination.

1.2 Roundtable Highlights

The first roundtable had 13 participants and the second had 11. Two of the most critical products coming out of the first roundtable were definitions and terminology to guide the study (see terminology sidebar in *section II, Background*, above) and a beginning understanding of the details around the process of FDS. This knowledge was used to develop a diagram of the FDS process and how it is related to traditional exact DNA matching and proceeding with partial matches. This diagram was refined throughout the study with additional input from case study interviewees and other reviewers (see Exhibit 1). The information from the roundtable, along with additional information from the policy review, contributed to the study's white paper, *Understanding Familial DNA Searching: Coming to a Consensus on Terminology*, released in April 2016. Themes were also synthesized and reported to NIJ in a memo for each roundtable.



Exhibit 1: Familial DNA Searching and Partial Matching Processes



2. Policy Review

2.1 Policy Review Methods

Official policy, including legislation and written administrative policies, are key to understanding how programs are implemented. To capture this perspective, ICF performed a comprehensive review⁷ of existing statutes, administrative codes, regulations, municipal codes, court rulings, proposed and pending bills, and written administrative policies in all 50 states, the District of Columbia, the Federal government, and four U.S. territories.⁸ ICF tracked all written policies related to FDS or partial matching, including various features of the policies that fell within five major constructs: 1) Eligibility Criteria; 2) Oversight; 3) Search Procedures; 4) Pre-Release Investigative Practices and Court Procedures; and 5) Post-Release Investigative Practices and Court Procedures. Each of these major constructs was further broken down into three to seven sub-constructs which were also documented for each state. The review was completed in 2014, and ICF researchers only included publicly accessible documents in this search. Therefore, the number of agency policies may be underestimated, as some policies may not be available online or may have come into existence more recently.

2.2 Policy Review Highlights

Information collected from the policy review reveals the recent adoption of familial searching, as all identified policies were enacted in 2008 or later. Very little legislation currently exists on familial searching or partial matching, though this may change in the near future, as the research team identified proposed bills addressing one or both of these practices in several jurisdictions. Most determinations to either allow or ban familial searching have not been made through legislation, but instead at the agency level (see Exhibit 2 for a summary).

⁷ ICF used LexisNexis; the National Conference of State Legislatures DNA Laws Database; the American Society of Law, Medicine, & Ethics DNA statute grid; the DNA Resource webpage; the Denver DA's Office Familial DNA webpage; the Council for Responsible Genetics' policies webpage on FDS and partial matching; and general internet searches. Search terms included: Forensic and DNA; DNA w/3 Database or Analysis or Search or Test; Partial w/3 Match; Familial w/3 Search or DNA; Y-STR; Mitochondrial DNA; mtDNA; DNA Index System; CODIS; Candidate Search; Deoxyribonucleic Acid Testing; DNA Profiling; DNA Fingerprinting; Low w/3 Stringency; Moderate w/3 Stringency; Kinship w/3 Analysis or Match or Search; Trawl and DNA; Trawl and Database; Directed Trawl; Near Miss Match; Fortuitous w/10 Match; Deliberate w/10 Match. (The designation "w/X" indicates a search that finds the listed words within X words of each other.)

⁸ Territories included: Guam, Northern Mariana Islands, Puerto Rico, and U.S. Virgin Islands

In 2014, according to both legislation and *publicly available* written administrative policies, there were three jurisdictions⁹ prohibiting FDS and five¹⁰ explicitly allowing it via policy. In regard to partial matching, Alaska and Georgia prohibit the practice but remain silent on the use of familial searching, and five states¹¹ allow partial matching. Additionally, although the FBI's policy does not explicitly permit FDS or partial matching with the deliberate intent of finding family members, it does allow for inter-state information sharing in the event that a partial match happens to be identified in NDIS.¹²

Exhibit 2: FDS and Partial Matching Policies

	Legislation/ Statute	Proposed Bill	Rule/ Regulation	Agency Policy
Alaska	-	-	-	FDS/PM
Arkansas	-	-	-	FDS
California	-	-	-	FDS/PM
Colorado	-	-	-	FDS/PM
Georgia	-	-	-	PM
Indiana	-	PM	-	FDS
Maryland	FDS	-	-	-
Minnesota	-	FDS	-	-
New York	-	FDS/PM	PM	-
Pennsylvania	-	FDS	-	-
Texas	-	-	-	FDS/PM
Virginia	-	-	-	FDS
Washington	-	-	-	PM
Washington, DC	FDS	-	-	-
West Virginia	PM	-	-	-
U.S. Federal	-	FDS	-	PM

Altogether, the above policies represent 14 jurisdictions in the U.S. with explicit guidelines addressing FDS and/or disclosing or proceeding with partial matches. Of note, most of these policies do not address both practices, although this may be due to confusion over the difference between the two. Most agency policies included information about eligibility, oversight and decision-making authority, DNA sample specifications, lineage testing, and procedures and requirements for releasing information. In contrast, guidelines on investigation or court proceedings were rare. More information from the policy review can be found in the study's white paper.

⁹ Indiana, Maryland, and Washington, DC.

¹⁰ Arkansas, California, Colorado, Texas, and Virginia.

¹¹ California, New York, Texas, Washington, and West Virginia.

¹² See FBI guidance on partial matches and FDS at: <https://www.fbi.gov/file-repository/ndis-procedures-manual-ver4-approved-04272016.pdf/view>, <https://www.fbi.gov/services/laboratory/biometric-analysis/codis#Familial-Searching>

3. National Survey of CODIS Laboratories

3.1 Survey Methods

The primary purpose of the National Survey of CODIS Laboratories was to learn about key considerations and varied practices related to FDS and the related practice of partial matching across the U.S. The literature review, initial roundtable, policy review, and existing lab surveys helped inform the development of the survey. The target population was all CODIS labs at the local, state, and federal level, and survey topics included: lab/respondent background, legislation and policies, scope of use of FDS and partial matching, perceptions and opinions of FDS and partial matching (including benefits and concerns), and specific practices related to FDS and partial matching (e.g., eligibility criteria, search and lineage testing protocols).

Surveys were sent to lab directors with instructions to complete in coordination with their CODIS administrator, as needed.¹³ The survey was emailed to 133 labs and returned by 103 labs (77% response rate; 55 LDIS and 49 SDIS labs). The survey was also available in hard-copy format or completion by phone if preferred by the lab respondent. The ICF research team publicized the survey through national professional organizations, industry contacts, and communications outlets.¹⁴ ICF offered a dedicated helpline and email account to help with survey questions, a raffled incentive,¹⁵ and a variety of follow-up outreach to non-respondents or partial completers. The survey was confidential and aggregated to the state level to improve honest reporting, and results were analyzed using descriptive statistics and statistical comparison tests (e.g., chi-square tests, t-tests, ANOVA).

3.2 Survey Highlights

Respondents were asked whether their lab performs FDS and/or discloses or proceeds with partial matches. Twelve labs (12% of respondents) in 11 states reported conducting FDS, with the earliest beginning in 2008. Forty labs (39%) in 24 states (and Puerto Rico) reported

¹³ In the case of multi-lab systems, only the overarching lab director was asked to complete the survey.

¹⁴ Organizations included American Society of Crime Laboratory Directors (ASCLD), National Forensic Science Technology Center (NFTSC), Scientific Working Group on DNA Analysis Methods (SWGAM), and American Academy of Forensic Sciences (AAFS).

¹⁵ This study was proposed and approved prior to DOJ's new guidelines on incentives which prohibit raffles.

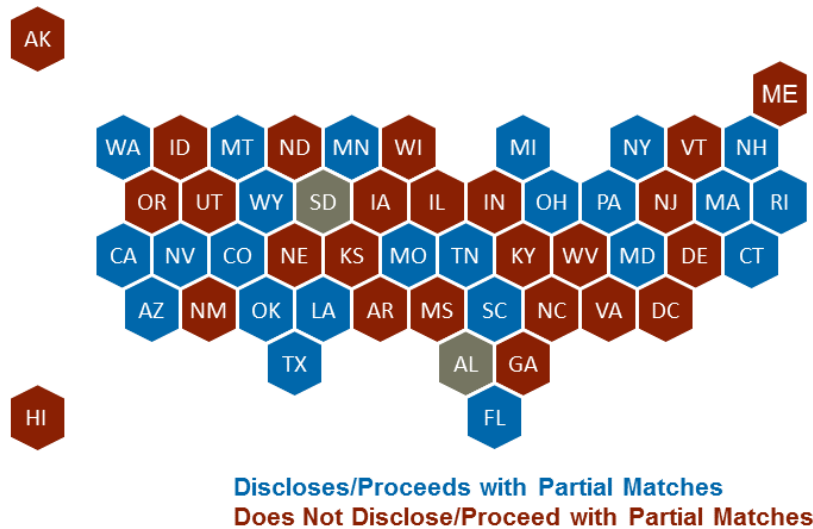
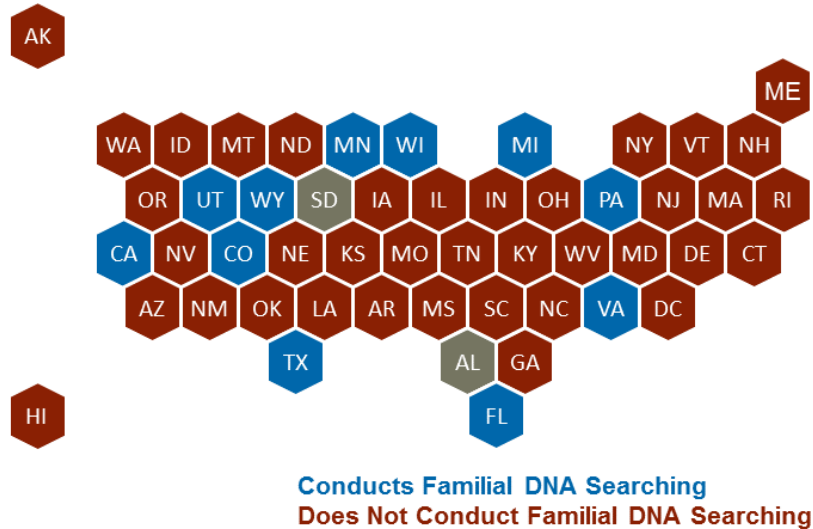
disclosing/proceeding with partial matches, and seven labs use both FDS and PM. Exhibit 3 shows which states reported at least one lab performing either FDS or

disclosing/proceeding with partial matches. Of labs that do not currently conduct FDS, the vast majority (75%) said they have discussed using it in the past, while nearly half (42%) are considering using it in future

investigations. When asked why their labs had not used FDS to this point, the largest portion (34%) noted the lack of clear guidelines on the practice, while about a quarter cited usefulness (26%), training (24%), or technological considerations (22%). Smaller portions had questions about FDS' cost (12%), noted that it was prohibited by their state (12%) or another entity (8%), or expressed civil liberty concerns (8%).

The survey asked about laboratories' perceptions of FDS and PM. Two items asked about the potential of FDS or PM to help identify suspects, and four questions apiece were combined

Exhibit 3: 11 states conduct familial DNA searching and 24 states disclose/proceed with partial matches



into scales measuring perceived institutional support for FDS and PM.¹⁶ Whether or not a lab used FDS or PM did not have a statistically significant impact on overall perceptions of the potential of FDS to solve cases, but labs using PM had a higher opinion of PM's potential than other labs. Laboratories conducting FDS perceived it to have more investigative potential than PM, while labs that do not conduct FDS gave similar ratings for both FDS and PM. Perceived institutional support for FDS was also significantly higher for FDS labs.

Laboratories that reported conducting FDS (n=10 state labs and n=2 local labs) provided additional information about the extent they've used this tool and practices related to its use.¹⁷ While the number of familial searches varies greatly by lab (0 to over 100), the number of convictions from FDS cases is low across all labs. Five labs reported having convictions resulting from FDS, but these were all for five or less cases. In terms of varying procedures, labs reported fairly consistent eligibility practices for FDS with common criteria including exhausting all other investigative leads (100% of labs using FDS), DNA sample specifications such as number of profiled alleles or being single-source (92%), commitment from police (92%) or prosecution (83%) to pursue the case, exigent circumstances/high public safety risk (83%), and particular crime types (75%). While labs tended to focus more on violent crimes, one lab reported that property crimes would also be eligible for FDS. Approval for a search came from multiple sources, including the crime lab (100%), a multi-stakeholder committee (33%), police (17%), and prosecution (8%). Labs reported using FDS with both convicted offender (83%) and arrestee (50%) profiles, and more rarely other types of profiles such as suspects, victims, missing persons, lab staff, or other forensic unknowns (8-42%). All labs using FDS reported following up the search with lineage testing. One-third of labs using FDS reported experiencing some challenges with the tool, including budget/resources, lack of victim cooperation, or the

¹⁶ Individual items included: "There is adequate collaboration among agencies in my jurisdiction to [perform FDS / disclose/proceed with a partial match]," "My laboratory is supportive of [using FDS / disclosing/proceeding with partial matches] during criminal investigations," "Laboratory staff in my jurisdiction receive adequate training related to [FDS / disclosing/proceeding with partial matches]," and "Criminal justice officials (e.g., police, prosecutors) in my jurisdiction receive adequate training related to [FDS / disclosing/proceeding with partial matches]." The internal reliability for both scales was adequate (Cronbach's $\alpha = .84$ for FDS and $\alpha = .77$ for PM).

¹⁷ Readers should interpret these results with caution due to the small sample size.

mere fact that they had not found any successful matches to date. No labs reported any legal challenges to FDS in courts for their jurisdictions/states. More information about the methods and findings can be found in *National Survey of CODIS Laboratories Brief*.

4. In-Depth Case Studies

4.1 Case Study Methods

ICF, in partnership with NIJ, selected four states for inclusion in the case studies after reviewing literature, state policies, and survey responses about FDS practices: Colorado, California, Wisconsin, and Maryland. ICF performed a mix of in-person and phone semi-structured interviews (n=56) covering the following topics: history of FDS in the state; policies, procedures and practices at the lab/investigation/prosecution/court stages; interagency collaboration; training; costs and needs; and perceptions including benefits and concerns or challenges. Interviewees included forensic scientists from state and local crime labs, police investigators, prosecutors, defense attorneys, judges, victim advocates, civil liberties and wrongful conviction attorneys, and policy-makers or other government policy staff. ICF also viewed demonstrations of the software or output reports from the software, when possible, and requested data on the number and characteristics of searches¹⁸ conducted.

4.2 Case Study Highlights

Each of the four states studied in this project illustrate a number of lessons that may be useful for other states or communities considering whether or not to use FDS. Some of the aggregated themes from these case studies were: (1) facilitators for initial implementation and obtaining buy-in include passionate key players, building off of the progress of other jurisdictions, and beginning with a strong vetted policy or a pilot to further refine procedures; (2) policies need to be clear, transparent, comprehensive, and legally vetted; (3) collaboration and communication are vitally important both for initial program development as well as advancing individual cases; (4) interviewed stakeholders desired greater training and education; (5)

¹⁸ Originally, the researchers hoped that there would be sufficient data to analyze predictor variables for the use and outcomes of FDS; however, the base rates were too low to perform this level of analysis.

variations in policies illustrate how these states balanced the power of FDS with protections, particularly in regards to eligibility, approval structures, scope of searches, procedures for sharing information, and investigation practices; and (6) a number of concerns need to be taken into account when developing or expanding an FDS program such as privacy, disproportionate racial impacts, potential for legal challenges or wrongful convictions, resources, and technology capabilities. More information about the methods and findings can be found in the *Study of Familial DNA Searching Policies and Practices: Case Study Brief Series*.

5. Econometric Cost Model

5.1 Cost Modeling Methods

To better understand the financial implications of using FDS, ICF partnered with an econometrician to describe and model costs and savings associated with FDS. First, potential costs were collected from discussions with expert advisors and case study interviewees. Next, a tool was created to estimate jurisdiction-specific costs. In considering the current state of FDS and available data on outcomes and costs, it was determined that a full cost-benefit model could not be developed at this time. Instead, a simulation tool was created that states can use in planning. Due to the small number of FDS cases which yield viable investigative leads, this tool's models are exploratory. ICF worked with its econometrician, partners/advisors, and case study sites to define the stages of the FDS process. Case data from Colorado, California, and Wisconsin served to build the model, providing estimates of the likelihood that a case will progress through each stage (e.g., lineage testing, releasing a CODIS identity to law enforcement); example cost information was collected from Denver's crime lab at each respective stage. In addition, the tool allows states and communities to enter jurisdiction-specific information to model potential costs for their own areas. The models use a Markov Chain model and transition matrix to model the likelihood of an FDS request moving through various stages or outcome states (e.g., identifying a potential family member). Costs for each stage account for the likelihood of an FDS request reaching that stage and are calculated per case request.

5.2 Cost Modeling Highlights

Project advisors and stakeholders reported a number of cost considerations. These included: chemistry costs for lineage testing (e.g., reagent kits for Y-STR); travel costs (e.g., for jurisdictions to travel to the state lab for meetings/trainings about the technique or to receive the results); and additional labor costs for software development, validation studies of the software, training, lab work (primarily the Y-STR testing since the search itself is near-immediate), and investigation (primarily researching existing records and creating family trees, although sources had mixed opinions on whether the investigation costs were significantly different from non-FDS cases). Our sources did not report needing additional equipment; however, interviewees resided in states that were already performing Y-STR analysis. This could incur additional costs for labs that do not already use Y-STR testing. Some interviewees shared questions or concerns about the future cost implications as the practice of FDS grows. Similarly, an extra start-up cost could include software if a state needs to purchase it instead of obtaining a free version.

Interviewees also shared potential cost savings from FDS. These savings were often associated with the promise of FDS solving cases more effectively. For example, stakeholders suggested that FDS removes the need for other resource-intensive investigative techniques such as DNA dragnets and saves investigative costs from future crimes prevented. Other interviewees stated FDS has no explicit financial savings, but that this is true for many investigative techniques and that the value is more in the social benefits of solving crimes. With the limited data on outcomes and costs, it is not possible at this time to estimate an exact cost or financial benefit to using FDS, but the cost model can be used to simulate estimated costs for jurisdictions that provide their own data.

IV. Conclusions and Implications for Criminal Justice

This study provides a comprehensive portrait of whether and how FDS is implemented across the U.S. It identifies the practices, procedures, policies, and considerations affecting states' use of this technology and provides information to other jurisdictions who may be



considering adopting or limiting FDS. The study used a mixed-methods approach to gather information about FDS and related practices such as partial matching. The literature review and two expert roundtables helped inform and guide the study. A national policy review examined statutes, administrative codes, regulations, municipal codes, court rulings, proposed and pending bills, and written administrative policies existing in 2014. The National Survey of CODIS Laboratories collected data from local, state, and federal CODIS labs about the scope and practices/procedures of FDS and partial matching, as well as perceptions of the tools. In-depth case studies examined how FDS works on-the-ground in four states and explored the nuances around the process, collecting diverse opinions from a range of stakeholders about the practice and the implications of its use. Finally, the study documented costs and savings associated with FDS, creating a tool that jurisdictions can use to estimate their own expected costs.

Through these various components, the study shares diverse viewpoints about FDS, including its potential benefits and challenges, promises and concerns, and logistical considerations. A few limitations are important to note, however. The most significant is that FDS is still an emerging practice and, given this, it is difficult to draw representative data from the limited available experiences of FDS. As the practice evolves, researchers should continue studying its impacts and revisit the conclusions drawn through this study. The responses from the National Survey of CODIS Laboratories revealed some confusion among respondents about definitions. To resolve this, ICF held follow-up discussions with selected survey respondents where potential confusion was detected, correcting responses as necessary if definitions or questions had been misunderstood. The survey had a high response rate (77%), but it is possible that those labs that did not respond could change the results of the study, especially if any of them perform FDS given the small sample size of FDS-using labs. However, from ICF's other background research, it is unlikely that these particular non-responding labs perform FDS.

For the case studies, ICF made extensive attempts to interview diverse stakeholders. In all states, this resulted in interviewees with varying opinions and concerns about FDS. However,

we were not always able to get all types of stakeholders for each state. For example, defense attorneys were exceedingly difficult to recruit, as they often were not interested in participating given limited knowledge of the practice or not wanting to discuss cases which had been lost. In the end, ICF was able to interview either a defense attorney or civil liberties attorney in all case study states, and sometimes both. However, this challenge may have resulted in a more limited representation of these viewpoints. Finally, as mentioned in the econometric cost modeling section, the base-rate of FDS cases was too low to perform more rigorous cost-benefit analyses; however, the information on potential costs and savings provided by interviewees and one pilot jurisdiction help to lay the groundwork for future cost analyses.

Ultimately, FDS in the U.S. is still in its relative infancy, and potential impacts will be better understood in the future as more cases undergo this technique. We hope that, in the meantime, the information gathered through this study will help lay an initial foundation of knowledge and inform discussions around FDS by sharing existing practices, leading concerns, and perceived benefits from those who have already begun to navigate these complex decisions.

Other products from this study detail the findings at greater length. Please see below for a list of these products where readers may find more information. Future products may be publicly released including a peer-reviewed journal article on the National Survey of CODIS Laboratories, jurisdictional cost estimating tool, and a policy review brief or article.

Additional project publications:

Bhati, A., & Debus-Sherrill, S. (2017). *Study of familial DNA searching policies and practices: Cost simulation tool user guide*. Fairfax, VA: ICF.

Field, M.B., & Debus-Sherrill, S. (2017). *Study of familial DNA searching policies and practices: National survey of CODIS laboratories brief* (Brief). Fairfax, VA: ICF.

Field, M.B., Seera, S., Nguyen, C., & Debus-Sherrill, S. (2017). *Study of familial DNA searching policies and practices: Case study brief series* (Brief Series). Fairfax, VA: ICF.

Niedzwiecki, E., Debus-Sherrill, S., & Field, M.B. (2016). *Understanding familial DNA searching: Coming to a consensus on terminology*. (White Paper). Fairfax, VA: ICF.



APPENDIX A: REFERENCES

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