Understanding Familial DNA Searching: Coming to a Consensus on Terminology

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I. Introduction

Since deoxyribonucleic acid (DNA) profiling was first used to obtain a criminal conviction in 1987, the use of DNA in criminal investigations has become a critical tool in the investigation and prosecution of crimes in the U.S. This significant shift in investigative technology has solved crimes, brought resolution to victims, overturned wrongful convictions, and increased public safety. The advancement and wider use of DNA profiling has been driven, in large part, by the development of the Combined DNA Index System (CODIS), software designed by the Federal Bureau of Investigation (FBI) to facilitate the sharing and searching of DNA profiles both within and between jurisdictions across the country (DNA Identification Act of 1994, 2006). As the use of DNA profiling and the associated body of knowledge and technology have grown, some jurisdictions have begun using DNA databases beyond traditional DNA matching, which relies on the identification of an exact match between DNA profiles. Due to the inherited nature of DNA and the fact that family members share more genetic characteristics than non-related individuals, DNA profiling has also made it possible to identify potential familial relationships between an individual in a DNA database and an unidentified individual whose DNA is found at a crime scene (Greely et al., 2006). This extension of traditional DNA profiling to identify family members is known as familial DNA searching (herein referred to as FDS). To date, FDS has been used most extensively in the United Kingdom (UK), where national protocols and procedures have been instituted to guide its use (Bureau of Justice Assistance [BJA], 2012). In recent years, jurisdictions in the U.S. have also expressed growing interest in adopting the practice. Proponents of familial searching have cited its potential to facilitate the identification and conviction of suspects, prevent crime, resolve cold cases, exonerate wrongfully convicted individuals, and improve public safety; however, its use also raises important constitutional, ethical, and practical considerations for forensic scientists, criminal justice stakeholders, and policymakers.

Study of Familial DNA Searching Policies and Practices

Supported by the U.S. Department of Justice, National Institute of Justice, ICF International (ICF) is conducting the *Study of Familial DNA Searching Policies and Practices*. This multi-phased study is designed to examine key considerations related to familial DNA searching and develop a national portrait of familial DNA searching policies and practices. As part of the study, ICF, in partnership with NIJ, convened an expert roundtable in March 2014, which brought together representatives from diverse stakeholder groups to engage in a candid discussion of various aspects of familial DNA searching, as well as important considerations for research and practice.

In order to encourage a balanced discussion, the 13 selected roundtable participants represented diverse fields of expertise and perspectives related to familial DNA searching, including the forensic community, law enforcement, legal and court professionals (i.e., a judge, prosecutors, defense and ACLU attorneys), and scientific and ethical working groups (see acknowledgements above for a full list of expert roundtable participants). Participants also represented varying jurisdictional levels (local, state, and federal) and a range of experiences related to familial DNA searching, such as research, software development, implementation, and policy and protocol development.

Scholarly literature, legislation, agency policy, and popular media have offered many different definitions and interpretations of FDS, which has created uncertainty as to its meaning and purpose. Recognizing the lack of consensus for a standard definition, this white paper will discuss terminology issues, identify key characteristics that distinguish FDS from other practices, outline the FDS process, and provide a unified definition to help alleviate confusion in the field. Additionally, the literature has varying reports on how many and which state or local jurisdictions are currently using FDS. While this paper focuses on terminology and processes, future project publications will explore the extent that FDS is used in crime laboratories across the U.S., variations in practices, outcomes and cost implications, and other considerations surrounding its use.

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II. A Review of Familial DNA Searching

The advent of familial searching is often linked to the use of varying stringency levels to conduct DNA searches. Although moderate stringency searches are the default search setting in CODIS, the 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 13 CODIS markers or loci (see sidebar), whereas moderate and low stringency searches allow for the comparison of profiles that may be partially degraded and/or contain DNA from more than one individual (i.e., mixed sample) (FBI, n.d.; Steinberger & Sims, 2008). Moderate and low stringency searches may result in the identification of "partial matches" in which two profiles, although not an exact match, show a sufficient degree of genetic similarity to indicate that a potential familial relationship may exist (Steinberger & Sims, 2008).

Background on DNA Profiling in the Criminal Justice System

DNA profiling refers to the identification of unique patterns in a person's genetic code at specific locations in their DNA. Patterns are identified in sequences of short tandem repeats (STRs), highly variable repetitive sequences that occur at fixed points on a chromosome (i.e., loci) (Gabel, 2010; Pattock, 2011). Once a DNA profile is built from the identification of STR patterns at multiple specified loci, **DNA matching** can determine whether two DNA profiles (e.g., one from a crime scene and one from a known individual) are likely to have come from the same person (Pattock, 2011).

DNA matching practices in the United States involve matching alleles (a genetic variation derived from a STR pattern at a specific location on a chromosome) at thirteen specified loci that have been termed "CODIS markers" or "CODIS Core Loci." At each of these CODIS markers, there are two copies of the chromosome (one is inherited from each parent), meaning that there are two sets of alleles at each location with its own STR pattern, and thus 26 points where one profile can be compared to another to identify matching genetic identities (Gabel, 2010). These thirteen loci are located on twelve chromosomes existing in both sexes and within the "non-coding" (also referred to as "junk") regions of DNA. Therefore, the selected alleles and STR patterns do not reveal any observable characteristics of an individual, such as gender or race (Gabel, 2010; McCarthy, 2011).

The ability to identify familial relationships through lower-stringency searches has led to the development of two separate, yet related, practices known as FDS and partial matching (PM). Existing literature on these practices often refers to them interchangeably, making it difficult to decipher if and/or how FDS and PM differ. To help shed light on these practices, this section walks through the key characteristics that distinguish FDS from PM and reviews the landscape of existing definitions offered by various sources.

Technology

Although lower-stringency searches of DNA databases can uncover partial matches fortuitously, they are not ideal for deliberately identifying familial relationships. This is because low stringency searches can generate hundreds or even thousands of partial matches, none of which may be biologically related (Greely et al., 2006). Furthermore, CODIS may entirely miss partial matches that are actually related (Forensic Technology Center of Excellence, 2015). According to Steinberger and Sims (2008), "CODIS, in its current configuration, is a very poor tool for finding familial relationships" (p.31). In other words, FDS must be conducted "outside CODIS" because the original CODIS software was not designed to detect these types of relationships.

Of the five states[1] with publicly available policy documents explicitly allowing FDS, four of these administrative policies mention the use of specialized software to conduct the search. For example, Colorado's policy defines familial searching as "a deliberate search for biologically-related relatives of a contributor of an evidentiary profile conducted with specialized (non-CODIS) software designed for this purpose" (Colorado Bureau of Investigation DNA Familial Search Policy, 2009, p.1). Virginia's policy

[1] Arkansas, California, Colorado, Texas, and Virginia.

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provides additional detail regarding the statistical analyses employed as part of the familial searching process, indicating that custom-designed software will be used to produce a ranked list of candidate profiles based on the likelihood that the two profiles are related. For each search session, a quality control search is also conducted using a synthetic profile to ensure that the software is functioning properly (DFS, 2012). Currently, most familial searching software employs Identify by State, Likelihood Ratio, or some combination of these two statistical techniques to determine the strength of potential familial relationships found during the search.[2] Jurisdictions may use different search threshold parameters, as the software accuracy can vary depending on the size and geographic reach of the database being searched (Forensic Technology Center of Excellence, 2015).

The importance of technology in distinguishing familial searching from partial matching was emphasized during the roundtable discussion; many participants indicated that the two terms (FDS and PM) cannot be used interchangeably due to this distinction. Roundtable participants indicated that specialized software is an essential component of the FDS process, as it allows laboratories to create a ranked list of all the potential familial relations identified through the search to determine which candidates are most likely to be related. Laboratories can perform kinship and/or additional statistical analyses[3] following the identification of a partial match to build additional evidence for a true familial relationship. When this process is added to PM, it becomes more similar to FDS; however, this is still distinct from FDS, which uses specialized software to statistically rank candidate profiles as part of the search process from the outset.

High profile cases described in the media sometimes cloud the understanding of FDS. For example, in 2005, police secured an arrest warrant for Dennis Radar (the "Bind-Torture-Kill [BTK]" serial killer) after matching DNA evidence found at several of the crime scenes to his daughter's DNA, which was obtained through a court order for her Pap smear specimen (Nakashima, 2008). This case is frequently presented in the media an example of familial searching; yet, there are critical differences that must be taken into account (Nakashima, 2008; Shapiro, 2007). In the case of the BTK killer, investigators had already identified Radar as a primary suspect in the case and just needed DNA from a close family member to confirm their suspicion. While this case used familial DNA to confirm a suspect's involvement in the crime, it is not an example of familial DNA *searching* in which DNA evidence from an unknown perpetrator is actively searched against an offender/arrestee DNA database to identify potential familial relationships.

[2] Identify by State (IBS) is a statistical technique that determines genetic relatedness or similarity based on the number of matching markers between two genetic profiles. Any potential familial relations identified through IBS are then ranked in order of the sample with the highest number of matching alleles. A limitation of this method is that it does not take into account allele frequency, the population size, or other factors that can impact profiles being related (Kim et al., 2011). Likelihood Ratio (LR), also called a kinship index, compares the probability of two profiles being from biologically related sources to the probability of them being from unrelated sources; however, unlike IBS, LR does not produce rankings of the results. This calculation requires population characteristics and takes into account that STR alleles vary with different frequencies; thus, the population being used in this analysis may impact the accuracy (Kim et al., 2011; Greeley, 2010; Ge et al., 2011).

[3] Some state/Federal jurisdictions that allow proceeding with a partial match, including Texas, Washington, and the FBI, recommend the use of kinship or statistical analyses (e.g., Y-STR, Expected Kinship Ratio, Expected Match Ratio,) following the identification of a partial match to verify that there may be a potential familial relationship between an evidence sample and a profile in the DNA database (Texas DPS, 2012; Washington State Patrol (WSP), Crime Laboratory Division, 2014); FBI Laboratory, 2014).

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Lineage Testing

In addition to the use of specialized software, FDS also includes an important secondary step of lineage testing. While familial searching software identifies a list of *potential* familial relationships, lineage testing, such as retesting of the Y-Chromosome STR markers (Y-STR) or mitochondrial DNA (mtDNA), is used to determine and help *confirm* biological relatedness between profiles. Because the majority of samples profiled are from males, the most common form of lineage testing is Y-STR analysis, the examination of STR patterns specific to the Y-Chromosome that is used to determine paternal relatedness among DNA profiles. To determine relatedness between a mother and child, mtDNA analysis is performed, which is found in the mitochondria of cells (Kim et al., 2011; Smith & Urbas, 2012). Because these are based on *either* paternal or maternal relatedness, some true family relationships may not be confirmed during lineage testing. For instance, if an individual has a different father from a half-sibling in the database, a family relationship would not be confirmed through a Y-STR test. Although lineage testing is not a perfectly iron-clad confirmation of relatedness, it is extremely accurate. Participants in the Forensic Technology Center of Excellence (FTCoE)'s four-part webinar series[4] about FDS asserted that no associations between unrelated individuals have been falsely identified during this process to date, as of 2014 (FTCoE, 2015).

Common Lineage Tests

Y-STR testing compares alleles located on the Y-chromosome that are identical among all paternally related males but highly varied among the larger population. Y-STR testing can only be used with male samples (as the Y-chromosome is specific to male DNA) but it is highly reliable as the mutation rate of the alleles is very low (Kayser, M., et al., 1997).

mtDNA testing compares genomic regions in the mitochondria (as opposed to traditional DNA testing which tests material from the nucleus) to determine maternal relatedness. Everyone sharing a common maternal lineage will have identical mtDNA profiles, but the mutation rate of mtDNA is much higher than traditional nuclear DNA (Kaestle, F.A., et al., 2006).

All five state jurisdictions in the U.S. with administrative policies explicitly permitting FDS[5] (and five of the six state/Federal jurisdictions explicitly permitting PM[6]) reference the need for lineage testing in their policy documents to confirm or refute biological relatedness between profiles. In line with the language in the aforementioned administrative policies, presenters in the FTCoE webinar series also emphasized the importance of conceptualizing FDS as a two-step process (with a database search followed by lineage testing), and this study's roundtable participants agreed that lineage testing is an essential component of the FDS process. However, many labs do not currently have the technology to conduct lineage testing.

Importantly, neither the initial FDS search nor the subsequent lineage testing is used as the final evidence for a case. In cases where lineage testing supports a familial relationship, a traditional investigation is then initiated to pursue the lead and ultimately obtain a confirmation DNA sample.[7] This confirmation DNA sample is used to test and confirm a one-to-one, identical match using traditional DNA testing techniques. The *exact match* of the crime evidence sample with the suspect's collected confirmation DNA sample is used as the final evidence for court cases.

[4] The FTCoE webinar series was a recent initiative to better understand FDS. Supported by the National Institute of Justice and hosted by the FTCoE, the webinar series held virtual discussions about FDS with panels of legal and forensic presenters. While the presenters were more heavily weighted towards proponents of FDS, the webinar series served as a forum for sharing practical experiences and information related to FDS from a variety of individuals across the country.

[5] Ibid 1, p.2.

[6] California, FBI, New York, Texas, Washington, and West Virginia have publicly available policies allowing PM. All except West Virginia incorporate lineage testing in the document.

[7] A confirmation DNA sample is collected from the suspect for direct comparison with the evidence sample. A confirmation DNA sample is required for all cases where a lead was obtained through a CODIS search (both traditional CODIS searches and FDS).

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Search Procedures

The various search procedures and parameters employed as part of the FDS process are also important to consider for developing a holistic understanding of this practice. According to expert roundtable participants, familial searching is largely being pursued through State DNA Index Systems (SDIS) as opposed to Local DNA Index Systems (LDIS) since SDIS includes the state's offender samples, SDIS typically has more samples in general, and SDIS has more stringent inclusion requirements. State policies generally reflect this finding, as seven of the eight[8] states permitting familial searching and/or partial matching limit the search to SDIS. Additionally, California and New York specify that only convicted offenders in their databases will be searched, while Colorado, Texas, and Virginia search both offender and arrestee profiles. However, LDIS searches have a unique option in searching across suspect profiles (as opposed to only convicted or arrestee DNA indices) if the LDIS database includes these.

Prior to conducting a familial search or pursuing an identified partial match, states permitting these practices often place restrictions on what cases are eligible. These generally include crimes posing a significant public safety threat, such as sexual assault, homicide, kidnapping, and other serious, violent crimes against persons. Many states also regulate the point in a case when either familial searching and/or an identified partial match can be pursued. For example, seven states[9] mandate that all other investigative leads must be exhausted, while six states[10] specify that the case must be active and/or unsolved.

Eight of the nine state/Federal jurisdictions that explicitly allow FDS and/or PM specify that the DNA sample from the crime scene must yield a single-source profile, while five also indicate a minimum number of core CODIS loci that must be present. According to the FBI's Scientific Working Group on DNA Analysis Methods (SWGDAM) Ad Hoc Committee on Partial Matches (2009), only partial matches that result from a single-source forensic profile with all available core loci should be pursued in order to reduce the identification of false positives (or unrelated profiles). These DNA profile specifications are important because they help illuminate possible alternate interpretations or misinterpretations of current terminology. In particular, roundtable members discussed how the term "partial match" might be confusing to the field when used in the context of FDS or PM because it can easily be conflated with a search involving a degraded or partial DNA profile.

Finally, expert roundtable participants discussed the importance of defining what is meant by biological relatedness. In other words, could familial searching go beyond immediate family members to identify suspects through more distant relatives, such as cousins, aunts, or uncles? The consensus among participants was that, although it is possible to detect more distant familial relationships, such a search with revised parameters would produce too many unrelated matches to justify the expended resources. Therefore, they suggested that FDS is most effectively used to identify first-degree relatives, such as parent, child, and sibling relationships. Administrative policies generally mirror these findings. Virginia's familial searching policy, for example, stipulates that although their familial searching software is capable of detecting half sibling relationships, only parent-child and full sibling relationships will be considered during the search process (Commonwealth of Virginia DFS, 2011; DFS, 2012). Alaska's policy, which does not take a stance on whether familial searching is permitted, generally states that familial searching is a search to identify *close* biological relatives of the forensic profile (Alaska Scientific Crime Detection Laboratory, 2013).

[8] Arkansas, California, Colorado, New York, Texas, Virginia, Washington, and West Virginia.
[9] Arkansas, California, Colorado, Texas, Virginia, Washington, and West Virginia.
[10] Arkansas, California, Colorado, Texas, Virginia, and Washington.

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The Fortuitous vs. Deliberate Debate

The lack of a consistent definition of FDS and PM has resulted in ongoing confusion in the literature as to whether these practices are actually distinct. As the agency with primary oversight of the National DNA Index System (NDIS) and management of the CODIS system, the FBI's policies on familial searching and partial matching serve as an important guide post for defining these practices. The FBI (n.d.) distinguishes FDS from PM as follows:

> "A partial match…is the spontaneous product of a routine database search where a candidate offender profile is not identical to the forensic profile but because of a similarity in the number of alleles shared between the forensic profile and the candidate profile, the offender may be a close biological relative of the source of the forensic profile. Familial Searching is an intentional or deliberate search of the database conducted after a routine search for the purpose of potentially identifying close biological relatives of the unknown forensic sample associated with the crime scene profile."

Legislation and administrative policies offer another lens from which to distinguish FDS from PM. Policies addressing FDS[11] are generally consistent in defining such searches as deliberate in nature. For example, Virginia's policy defines familial searching as "a deliberate search of the Virginia DNA data bank for biologically-related relatives (siblings, parents, and children) of a contributor of an evidentiary profile" (Commonwealth of Virginia, Department of Forensic Science [DFS], 2011, p.1). Similarly in Maryland, a state that legislatively prohibits the practice, familial searching is defined as "a search of the statewide DNA data base for the purpose of identification of an offender in connection with a crime for which the offender may be a biological relative of the individual from whom the DNA sample was acquired" (Md. Code Ann., Pub. Safety § 2-506, 2010).

By contrast, state/Federal jurisdictions[12] with policies related to PM do not specify whether such events are deliberate or fortuitous in nature. The only exception to this is the FBI's policy, which notes that "a partial match when seen at NDIS is a fortuitous event" (FBI Laboratory, 2014, p.76). Most PM policies generally define the practice as a moderate stringency candidate match between two single source DNA profiles having at least one allele in common at each locus indicating that a potential familial relationship may exist between an evidence sample and a profile in the DNA database.

The role of intentionality in uncovering partial matches has also been explored recently by practitioners and legal scholars. The FTCoE report states that "…PM is not intended to be a deliberate search; rather, it is an artifact of current direct match searches in the CODIS" (FTCoE, 2015, p.11). However, an alternative opinion has been offered from the legal community. As part of a national examination of state policies conducted in 2011, Ram documented wide variation among states regarding their use of and the distinction between FDS and PM. For the purpose of her analysis, Ram refers to familial searching as "deliberate partial matching" and partial matching as "fortuitous partial matching." According to Ram, this terminology is applied intentionally to draw attention to the functional similarities between these practices (i.e., both practices result in the identification of perpetrators' biological relatives). Despite these functional similarities, Ram found that 14 of the 19 states that permitted partial matching at the time of her study prohibited familial searching. Based on these findings, Ram contends that FDS and PM are actually the same thing, arguing that the distinction between the two may only serve rhetorical or political ends. Mirroring Ram's arguments, a legal analysis conducted by Barca (2013) also claims a false dichotomy between FDS and PM. Barca states that, "rhetorically, there is a clear distinction between

[11] Arkansas, California, Colorado, Indiana, Maryland, Texas, Virginia, and Washington, DC.
[12] Alaska, California, Georgia, New York, Texas, Washington, West Virginia, and the FBI.

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fortuitous and deliberate partial-match searches…in practice, however, the distinction remains murky" (p. 513).

Roundtable participants, in contrast, strongly argued that these are two different processes. They agreed that FDS is a deliberate process and also emphasized the differences in technology and lineage testing. When asked to define PM, many roundtable participants described it as a fortuitous event or passive observation that occurs during a routine, moderate-stringency search of CODIS in which two profiles, while not an exact match, share a high number of genetic markers that could indicate a familial relationship. A few roundtable participants' definitions also specified that partial matches are the result of low or moderate stringency searches of CODIS. This distinction spurred some debate regarding the role of intentionality in setting the search stringency and what is meant by a "routine" search of CODIS. The default search in CODIS is set to moderate stringency to account for varying types of profiles (e.g., mixed samples), and some roundtable participants believed it would be rare for a laboratory to manually change the search stringency settings to low or high stringency. One participant emphasized that the question is not whether laboratories are *doing* partial matching, since partial matches will automatically appear with default CODIS searches, but rather whether they are *paying attention* to and *pursuing* partial matches.

A remaining question, then, is whether laboratories may be intentionally conducting lower stringency searches for the purpose of identifying familial relationships through partial matches if they do not have FDS software or explicit support for performing FDS. In other words, are partial matches *only* discovered by mere chance or can they also be the result of an intentional search of a CODIS database for the purposes of identifying family members?

III. Definitions

In order to develop comprehensive and objective definitions of FDS and PM, the ICF research team compared and synthesized the definitions provided by expert roundtable participants with existing definitions identified in the literature, state legislation, and agency policies. The definitions presented below are compiled from these multiple sources and by consensus with the roundtable members.

> **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 (e.g., Y-STR, mtDNA) to 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.

Based on a review of the literature, coupled with themes from the expert roundtable, the above definition of familial searching draws on the general consensus that FDS is a deliberate or targeted search of a DNA database intended to identify close biological relatives of an unknown forensic profile. Central to this definition is the role that technology and lineage testing play in distinguishing FDS from PM. As

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evidenced by recent policy trends and assertions from expert roundtable participants, specialized software is critical for conducting true familial searches, whereas PM is conducted within CODIS as part of the routine search process, although it may be supplemented with additional lineage or statistical tests.

The roundtable also generated a discussion as to the appropriateness of the terms "partial match" and "partial matching" in general. Some participants felt that the use of the term partial match may be confusing to the field because it inherently is not a *match*. Despite critiques of this terminology, we use the terms "partial match" and "partial matching" in this white paper due to their broad recognition and use in the field. To account for the varying interpretations of this terminology, the definition developed for this study applies to only single-source, non-degraded DNA profiles, a distinction that has been widely accepted in state and federal policy. Furthermore, in contrast to the definition of FDS, which is described as a deliberate search, the definition of partial matching does not take a stance on intentionality. In other words, we leave open the possibility that the identification of partial matches during a routine search of a DNA database may be the result of a passive observation (i.e., fortuitous partial matching) or a search of the database where one seeks to find either exact or partial matches and is actively interested in both (i.e., deliberate partial matching). However, the process of CODIS searches is not necessarily different based on one's intent (unless the lab is changing its settings to have a better likelihood of finding partial matches). Although it may be rare, there is insufficient information on each state's practices to rule out deliberate partial matching altogether. For these reasons, our findings suggest that there are potentially three methods to identify potential suspect relatives through DNA databases: 1) familial DNA searching, 2) fortuitous partial matching, and 3) deliberate partial matching. These methods are separate from other familial testing approaches that do *not* use a DNA database, such as a one-to-one comparison of DNA samples through lab casework with a known suspect (e.g., comparing an evidence sample and a sample collected from the family member of a suspect).

IV. Familial DNA Searching and Partial Matching in Practice

To help describe the core components of FDS and PM and provide a better understanding of how these practices differ, Figure 1 depicts *typical* FDS (blue boxes) and PM (green boxes) processes. It is important to note that practices may differ by jurisdiction and that these diagrams are not intended to describe every unique or varying feature. The study's national survey of CODIS laboratories will provide more detailed information about practices and how these practices vary by jurisdiction.

The diagram begins with a standard CODIS search and demonstrates the progression through either the FDS or PM process. After the traditional CODIS search results in no exact matches, an official request must be made before a familial search can be performed, and a review of eligibility and a decision to advance to FDS is made *prior* to any searching. Once a request is approved, the lab will perform FDS, resulting in a list of potential relatives in the CODIS database, ranked in order of likelihood of relatedness. The lab will then conduct lineage testing on a selection of the top ranked candidate profiles to see if they can find support that a first-degree familial relationship actually exists. At this point, either all the candidates will be ruled out as first-degree relatives or the lab should find a single candidate who is supported as a true family relationship through lineage testing (unless there are multiple family members in the CODIS database related to the contributor of the evidence sample). The lab would then release the identity of the family member in CODIS to law enforcement. If a lab does not have the ability to perform mtDNA lineage testing, they may not be able to have a secondary check on familial relatedness for female suspects. The lab may instead release the identifies of all database offenders who placed highly in the ranked list generated by FDS.

For PM, the partial match is found through the routine CODIS search and, therefore, the eligibility review and decision to actively investigate based on this information occur *after* the match is found. If the

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decision is made to pursue this lead, this information may be released directly to law enforcement to inform an investigation. Similar to FDS, laboratories may perform lineage testing or additional kinship or statistical analyses before releasing the information.

Once the identity of the relative in the CODIS database is released to law enforcement, detectives perform additional investigation to try to determine which family member is the offender if there are multiple family member suspects (i.e., if there are 3 brothers). This may include constructing a family tree, examining official records (e.g., birth, death, school, marriage), and even reviewing social media profiles. In some cases the lab may perform this non-DNA research to further narrow down the suspects *prior* to releasing the identity of the family member in CODIS to law enforcement. Even at this late stage, the search could still hypothetically lead to no viable suspect being identified if, for example, a father's family tree reveals no known sons after a father-son relationship is identified through FDS or if a potential suspect passed away between committing the crime and the familial search.[13]

If a suspect is identified after this additional investigation, police must then gather evidence and collect the final confirmation DNA sample to test directly against the evidence DNA sample to confirm an exact match. Once a confirmation match is acquired, this will be the evidence used in court, and the case can subsequently follow a typical court process. Discussions in the literature and media sometimes fail to note that the familial searching process is only intended to produce investigative leads (that are later confirmed or refuted by the testing of the suspect's DNA sample) and that the familial association is *not* the evidence used to adjudicate a suspect. This fact does not necessarily discount other concerns and controversies about the method as a tool for investigative leads, but it does help assuage fears about false conviction based on FDS.

V. Conclusions and Next Steps

Recognizing the diverse and often conflicting information presented on familial searching, the expert roundtable conducted as part of this study provided a forum to develop a better understanding of this emerging practice and come to a field-derived consensus on terminology. Based on themes generated from the expert roundtable, coupled with existing literature and legislative/policy sources, the study offers the presented terminology and associated discussion of definitional factors to the field to help build a shared language around FDS and PM.

In order to provide an objective examination of key considerations related to FDS and develop a national portrait of FDS policies and practices, other phases of this study include a national survey of CODIS laboratories to document what jurisdictions are currently doing in practice; intensive case studies to explore state-specific policies, practices, and decision-making practices in-depth; and a theoretical model for weighing the different cost considerations related to FDS. The information gathered through this study can help guide jurisdictions in making informed decisions regarding the adoption and use of FDS and PM.

[13] If a potential suspect has died, it is possible that investigators would exhume the suspect's body to compare the suspect's DNA to the evidence sample, as was done with a recent case in France (Pham-Hoai, Crispino, & Hampikian 2014).

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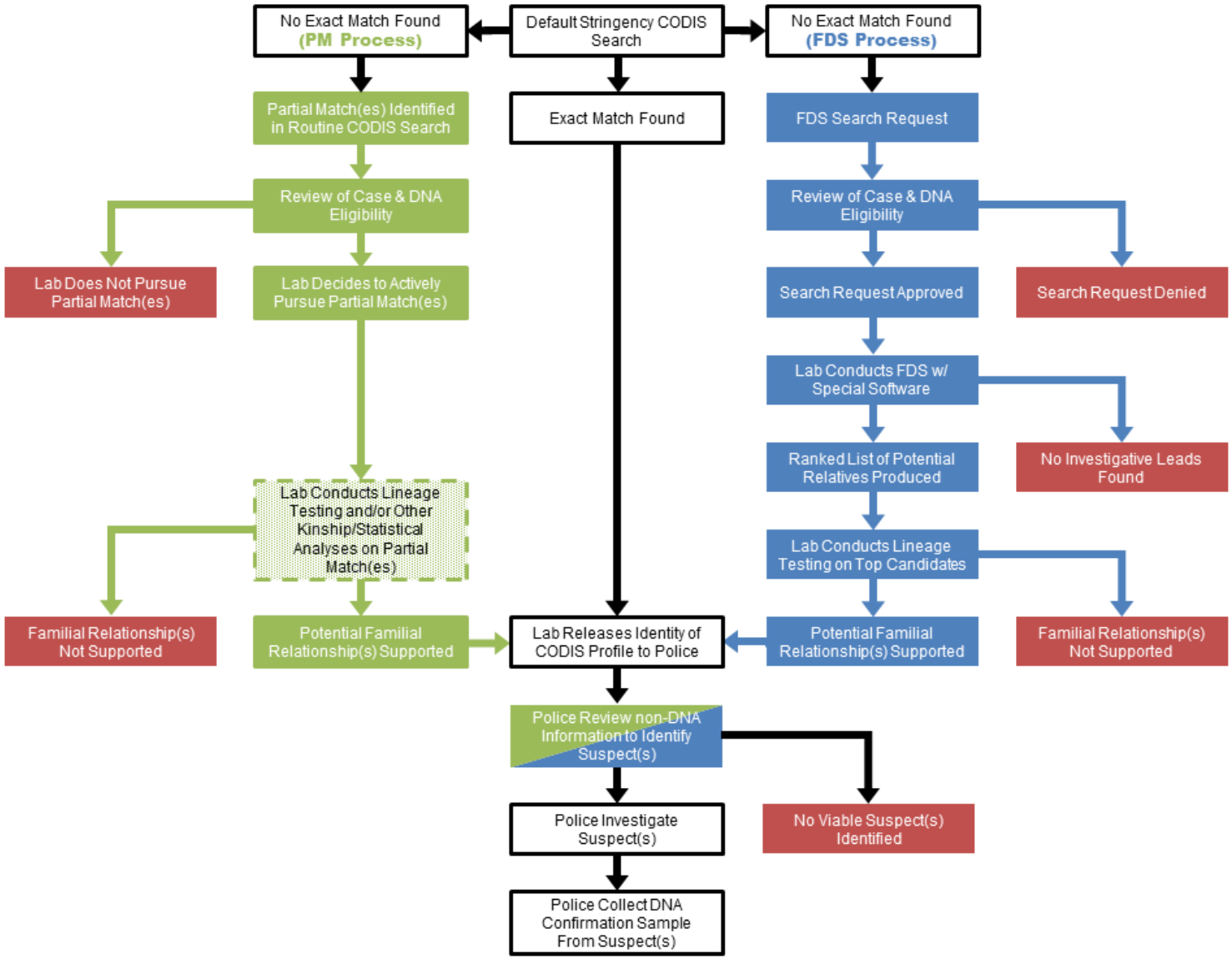
Figure 1: Familial DNA Searching and Partial Matching Processes



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