

Familial DNA Testing: Current Practices and Recommendations for Implementation

Allison Murray, Chandler Grant, Mackenzie Beyer, Angelica Wilz, Emily Williamson, Julia Maier, Lauryn Kesselring, Konrad Wojtas, Jozlyn Gibbs, Kevin Karakkat and Lawrence Quarino¹

Abstract

The following paper will describe the current use of familial DNA searching in the United States. Although each year more states are using the technique in criminal investigations, it remains an underutilized technique in part due to its controversial nature as exemplified by Maryland and the District of Columbia who have legislatively prohibited its use. The paper will compare and contrast the policy and procedures in states including California, Colorado, Florida, Michigan, New York, Ohio, Texas, Utah, Virginia, Wisconsin, and Wyoming where formal guidelines to perform familial testing have been established. Although these states have much in common with regard to familial testing, there are notable differences. Discussion will include criteria to conduct a search, administrative structure responsible for the search, search methods, protection of privacy concerns and civil liberties, and dissemination of results. The paper will conclude with author recommendations for a path forward.

Key Words: *familial DNA searching, current practices, search criteria and methodology, data verification and reporting*

Recently, the New York State Commission on Forensic Science approved the use of familial DNA searching in appropriate cases to help identify perpetrators of violent crimes [1]. New York was the eleventh state to formally establish guidelines for the utilization of this technique. In New York, the issue of familial DNA searching came to the forefront during the high profile investigation into the murder a New York City jogger, Karina Vetrano, whose family fought for the use of the technique when all other leads appeared exhausted in the investigation (a suspect was later apprehended and confessed to the crime). Other states such as California have demonstrated the value of the method when decades old cases such as the infamous Grim Sleeper case and the murder of Karen Klaas (ex-wife of Righteous Brother Bill Medley) were solved.

¹ Please address all questions to Lawrence Quarino, Director of the Master of Science in Forensic Science Program at Cedar Crest College, Pennsylvania (http://www.cedarcrest.edu/academics/forensic_science/index.shtm) or at email Laquarin@cedarcrest.edu .

The United Kingdom introduced the use of familial DNA searching as an investigative tool in 2002 and first used it in a successful prosecution in 2004. Since 2002, familial DNA searching has been used in the United Kingdom in approximately 210 cases. In the United Kingdom, a familial DNA search may be undertaken if the police believe that an unsolved case (usually a homicide or sexual assault) might generate an investigative lead and where DNA-rich evidentiary material believed to be from the true perpetrator is available. From 2003 to 2011, the Forensic Sciences Service Forensic Intelligence Bureau identified 41 perpetrators from 188 cases (22% success rate) using this technique. The possibility of success using familial DNA testing is likely to be high in the United Kingdom since the National DNA Database (NDNAD) which geographically includes England and Wales, is the largest per capita DNA database in the world [2, 3].

Familial DNA searching is a last resort method when all other investigative leads have been exhausted and a case has gone cold. In these cases, investigators believe to have DNA from the perpetrator, but do not have a suspect's profile to compare. In addition, the evidentiary DNA profile is not found in convicted offender/arrestee databases at the local, state, and national level. Familial DNA testing may be defined as a "deliberate search of a DNA database conducted for the intended purpose of potentially identifying close biological relatives to the unknown forensic profile obtained from crime scene evidence" [3]. Since relatives share a common ancestry they will tend to have a greater number of alleles at tested loci in common than non-relatives [4]. These partial match searches could indicate the presence of a sibling, child, parent or other blood relative in the searched CODIS database. There have been several suggestions aimed at increasing the probability of locating an unknown relative including modifying the search for rare alleles, requiring a high number of matching alleles, or utilizing a likelihood ratio that indicates relatedness. Searching for rare alleles may be problematic since one would not expect to find them often in a population. Similarly, a high number of matching alleles may not be helpful if the alleles that match are very common. The use of likelihood ratios seems to solve these problems by considering the frequency of all matching alleles and is in fact the most commonly used approach [4].

Dissenters of familial DNA searching argue that the search is a violation of the Fourth Amendment right to privacy and that it also unfairly targets certain racial and socioeconomic groups. This is due to the fact that a significant number of convicted offenders are either poor or disproportionately from specific racial groups [5, 6]. However, these dissenters often fail to point out that the majority of crime victims are from these same groups and that familial DNA testing could be of benefit to them. Furthermore, the possibility that this type of testing may identify biological parents of adopted children and thus may cause unnecessary harm to the child and disrupt the family dynamic (especially if the child was not aware of the adoption and may reveal actions such as adultery and incest) has been cited as a reason not to use familial DNA searching [5].

Currently there are no national standards in the United States for how states go about developing a policy for familial DNA searches. There are guidelines from the Scientific Working Group on DNA Analysis and Methods (SWGDM) about conducting searches, however, these

guidelines are sparse and give no indication on how a state should go about protecting the privacy of its citizens [7]. States often contact each other to share information about their policies or protocols and even reach out to Europe for guidance [4]. The primary purpose of this article is to provide a comprehensive review of the policies of the eleven states that currently conduct familial DNA searches, providing an in depth look at the criteria for investigation, the protocols for how searches are conducted and the privacy safeguards that are or are not in place as well as to offer guidance for the development of future states' policies and procedures. In addition to New York and California, the other states with formal policies allowing for familial DNA searches are Colorado, Florida, Michigan, Ohio, Texas, Utah, Virginia Wisconsin, and Wyoming. Maryland and the District of Columbia have both passed legislation prohibiting its use [8]. The authors seek to provide other states with a well-rounded and complete view of the issues surrounding such searches. The article will conclude with recommendations for best practices when developing a familial DNA search policy.

Current Practices in Familial DNA Searching

Currently the states that utilize familial DNA searches each have their own policy and protocols for conducting a search. There is a great deal of overlap in policy although nuances do exist. For instance, all user states require a full 13 core CODIS locus profile before a search is considered. Based on the statistical approach used however, some states require a minimum number of shared alleles. This is true in California and Michigan, where a minimum of 15 shared alleles is required [9-10].

In deference to privacy concerns, most states also limit the number of searches that are conducted. This may limit searches to cold cases where there is a dedication to prosecute and pursue, or to cases which will have an impact on public safety specifically homicides, sexual assaults, and serial crimes. Most states explicitly state the scope of familial searches in their policy and procedures manual although at least one state's manual makes no mention of such limits [11]. Also somewhat contrary to the norm, Wyoming may conduct a search on material from any crime that does not match any individuals in the CODIS database (biology/DNA unit supervisor, Wyoming State Crime Laboratory, *personal communication*, March 29, 2017). Florida also allows the method to be used for the paternal determination of children born to rape victims [12].

Most searches begin with a request from an investigating agency. Some states such as California, Texas, Florida, New York, and Utah require the approval from a review board before a search will be initiated [9, 13-16]. If a case is unsolved, the California Department of Justice will notify case investigators that a partial match of at least 15 alleles exists between an evidentiary sample and someone in the state offender database which likely will initiate the request [9]. In New York, a memorandum of understanding must be generated between the law enforcement agency, the district attorney, the director of the New York State Police Crime Laboratory or designee, and the Commissioner of State Commission on Forensic Science must execute a memorandum of understanding detailing the role of each organization (NY). California and Ohio

also requires similar types of “Memorandum of Understanding” between the parties involved in the search and investigation [9, 17]. Ohio includes language stating that any information provided by the work of the laboratory is an investigative lead and any name provided to the investigating agency is not the offender of the crime in question but likely a first-degree relative (e.g. brother, son, father) [17].

Once a search is initiated there are certain qualifications that must be met with regards to what kind of profiles are searchable. Most states will allow for mixture profiles to be searched if a clear major/minor component can be deduced although California requires that the profile be single-source [9]. Texas will allow the search of a major component of a mixture provided that no obligate alleles or ambiguous loci exist in the profile [13]. For samples that are eligible for familial DNA searching, software is utilized to compare the unknown profile against CODIS profiles. In all user states, searches are run against convicted offender databases. Some states like Colorado, Utah, and Virginia allow for search against the Arrestee Index as well [18, 11, 15]. A list is generated of convicted offenders that are most likely male relatives of the unknown profile. DNA profiles are examined using either the Identity-by-State (IBS) or Kinship Index (KI). States that use the IBS method look into comparing the number of shared alleles between the sample profile and the profile found in the DNA database whereas the states that use the kinship index look into comparing the probability that the sample profile and the database profile are either related or unrelated [19]. California, Colorado, Florida, Michigan, Texas, and Virginia incorporate both IBS and Kinship index method [9, 18, 14, 10, 13, 11]. Florida and Michigan use MPKinFS™ software which uses a combination of KI and IBS to determine a list of possible candidates [14, 10]. California uses a software called Ratiometer [9]. This program behaves in a similar fashion to MPKinFS™ and ranks individuals by KI for sibship and paternity and then selects those for further analysis [9]. Kinship Index is used exclusively in Colorado, Ohio, Wisconsin, and Wyoming to analyze the DNA profiles [18, 17, 21] (biology/DNA unit supervisor, Wyoming State Crime Laboratory, *personal communication*, March 29, 2017). Utah, Virginia and Michigan also require that quality control samples be run in addition to the unknown profile during the familial search [15, 11, 10].

The number of profiles that end up on the list of possible candidates also differs by each state. Utah looks at the top 40 candidates, Texas looks at the top 50, and Florida and California look at the top 168 candidates [15, 13, 14]. Michigan examines the top 80 parent:child candidates as well as the top 80 sibling candidates [10].

In all user states, any leads generated from a familial search are further narrowed down with the use of Y-STRs. Because Y-STRs are only found in males, this eliminates any females from familial DNA searching. However, females with a high kinship index could be further investigated by traditional methods. Texas even added a clause in their protocol stating that if a sample is not able to be Y-STR tested then the request to perform a familial search will be denied [13].

Some states explicitly allow for familial searching on an evidentiary sample at a later time if the initial search does not result in any probative information. In two such states, Florida and Virginia, familial DNA search can be repeated every 12 months on active cases to determine if any potential matches can be found [14,11].

States also limit access to information generated from familial searches. For example, Wyoming does not allow any officer involved in the case to have access to the list of possible matches (biology/DNA unit supervisor, Wyoming State Crime Laboratory, *personal communication*, March 29, 2017). This assures the protection of each individual's privacy and also limits any possible harassment or prejudice. Michigan also limits the access to report details with the use of a Familial Search Committee (FSC) [10]. The FSC decides which information is passed on and conducts thorough investigations on the possible family members to determine who should be contacted for a DNA sample. California also has a similar system and the use of the background investigation helps to eliminate candidates based on historical facts, relationships or circumstances [9]. The committee ultimately decides whether or not they will release the names they have investigated to the requesting investigative agency.

The final step of the search process involves the procurement of a DNA sample from the possible offender that has been identified through the familial search. Colorado requires a court order to obtain a DNA sample from a possible offender [18], however, many other states do not expressly state this requirement in writing in their protocols [11, 13, 14, 17]. Most are not specific on how the DNA sample is obtained from a possible offender. Colorado and Michigan require that in order to provide a report statement to law enforcement and that a court order be obtained before gathering suspect DNA to compare [18, 10]. For many of the states such as Colorado, individuals who are considered potential familial matches are not notified that they are a suspected candidate unless their profile comes up as a match to the evidentiary profile. This is used to help protect the family members especially in circumstances where familial relationships are unknown leading to family issues that could be avoided [18].

Most states require that final reports detailing the results of the familial search be either hand-delivered, mailed, or given in-person to investigators [9, 13, 15, 17, 18]. In California, the state Attorney General makes the final decision to release information only after discussion with the state committee in charge of familial searches [9]. Utah is one state that requires that reports be given in-person if they show a positive association [15]. Several states make no mention of how reports are to be disseminated in their policy and procedures manual [10, 11, 14].

Recommendations for Future Implementation

I. Criteria for Searches

With few exceptions, all states who currently conduct familial DNA searching only perform these searches on unsolved serious violent crimes where all investigative efforts have been exhausted. Limiting these searches to these types of crimes is likely due to the belief that in only these types of crimes should the concerns of law enforcement outweigh those of individuals. Many

have voiced their concern about unfairly targeting certain groups that are more likely to be arrested/incarcerated and thus more likely to have DNA profiles in databases [5, 6]. In addition, the belief that familial testing violates the privacy interest of innocent family members and is disruptive to the family unit has been extensively argued [5]. It seems to us that other types of safeguards can be put in place to alleviate these concerns without necessarily limiting the types of crimes that can be investigated. Given that one study found that at least 42.8% of jail inmates had close relatives who were also incarcerated [19], limiting these types of searches to certain crimes only weakens the potential effectiveness of these kinds of searches.

Perhaps a better approach is to develop an administrative structure that will ensure the protection of civil liberties. Requests from law enforcement agencies to conduct a familial search could be made to a centralized state familial search board or commission which is governed by either the state attorney general or a state board of forensic science similar to those established in Texas and New York. The state familial search committee should include the CODIS manager and lab director governing the SDIS (state DNA index system) laboratory, district attorneys, and members of the defense bar. We also believe that joint approval between the board and a judge (similar to the process of obtaining a search warrant) be obtained before a search is conducted.

As described in several states, clearly defined criteria accessible to the public must be met before approval can be given. This includes:

- A. Evidentiary DNA material has been searched in the traditional way through local, state, and federal CODIS databases,
- B. All other possible investigative measures have been exhausted resulting in no probative information,
- C. Evidentiary DNA material should be either single sourced or the dominant profile in a DNA mixture where the dominant component is at least 75% of the DNA in the mixture (3:1 in a two-component mixture),
- D. The profile to be searched must contain results from the traditional 13 core CODIS STR loci.

In addition, the profile to be searched must contain a quantity of DNA where stochastic effects are not an issue. At stochastic levels, the possibility of missing alleles at heterozygous loci make what may appear to be a full DNA profile less certain. Requests that do not meet any part of these criteria must be turned down.

Once approval is given, a Memorandum of Understanding (MOU) should be generated clearly describing the role of each of the individuals involved in the search process. At this point, any information generated from these searches should be limited to individuals listed in the MOU. Any person named in the MOU must successfully complete a training program designed to highlight personal privacy concerns and outlining sanctions for violation of policy. Laboratory personnel performing familial searches must also complete a training program on technical and statistical aspects. Searches should be allowed on any database sanctioned by state law.

II. Search Process and Data Verification

States should use validated software to determine relatedness. Ideally, uniformity between states is desired and a recommendation should be made from the Organization of Scientific Area Subcommittee on Biological Data and Reporting. At least one study which compared multiple search strategies concluded that both IBS and KI used in combination can provide greater accuracy [19]. If so, then both methods should be used.

In order to ensure that the results obtained through the use of the familial DNA searching are viable, it is recommended that a quality component be implemented into the search procedure. This may include the search for a known relative of a control individual placed in the database to ensure accuracy of result. Given that viable results are likely to occur only with parent:child or full sibling matches then examples of each should be part of the quality control procedure. Alternatively, this quality component could be accomplished during the validation process.

Potential matches should be confirmed as they are in all user states with Y-STR testing. Although not routinely performed in forensic biology laboratories, alternatively X-STR testing has shown promise for kinship analysis and could be considered [22]. This would require an extensive validation but X-STR multiplexes have been developed [23]. An obvious benefit to the use of X-STR testing is that both male and female suspects could be searched. As of now, searches are limited to male suspects.

Samples that match with haplotype testing should undergo a second DNA analysis (both autosomal and sex chromosomal analysis) to verify results and to ensure that sample mix-up although unlikely did not occur. Ideally, this should include new sample extractions but at a minimum separate PCR and fragment analysis should be performed.

III. Reporting of Results

Possible familial relationships confirmed with Y-STR or X-STR chromosomal analysis should first be reported to the familial search committee. Once results are accepted, an investigative arm of the committee should perform background investigations into all possible familial relationships to eliminate candidates based on historical facts or circumstances. The investigative branch should be law enforcement officials but who are not involved with the actual investigation. The committee should release the names of anyone not eliminated by the background investigation to signatories of the Memorandum of Understanding charged with investigating the crime. DNA samples from potential suspect should only be obtained through court order. Although some states have procedures preventing individuals to know they are being investigated, it seems to us that an additional legal screen is a better option than having police try and collect DNA samples from a suspect covertly. Chain of custody issues and well as the potential for contamination of sample has to be given preference.

In an age of digital piracy, we agree with those states that prohibit the reporting of familial DNA search results electronically. In order to ensure personal privacy, dissemination of results should only occur by hard copy or fax.

Conclusion

These recommendations, along with the review we have provided on current familial search strategies, should serve as a roadmap for states looking to develop their own protocols. Familial searching is an important tool that investigators can use in cases which have no other leads to follow. Although some states have informally used partial match search in cases for many years for investigative purposes and some states like Louisiana are considering adding familial searches to their services [24], this tool is sadly underutilized in most of the United States. Data also suggest that the approach is successful. Of the first ten cases (homicides and sexual assaults) selected as a pilot study started in March 2014 in Wisconsin, three yielded a suspect [21]. Many states may be hesitant to begin familial searches because of expense and resource requirements or for reasons well documented by members of academia and the defense bar [5, 6]. We believe that these fears can be alleviated in part by the recommendations proposed here but also by greater transparency. Some states are more transparent than others when it comes to informing their citizens about their search policy. States such as Texas, Virginia, and Colorado have information about their search parameters online and readily accessible to the public. However, states such as Wyoming, Michigan, and Utah are more protective over their protocols and do not have any easily accessible information online. In fact, a Freedom of Information request was needed to obtain the policy in Michigan. In order to assuage the privacy and other concerns of the public, it would be prudent for all states to make public their search parameters.

References

1. DeStefano, A.M. (2017, March 27). State panel of DNA experts approve of “familial” searching in NY, *Newsday*. Retrieved from <http://www.newsday.com/news/region-state/state-panel-of-dna-experts-approve-of-familial-searching-in-n-y-1.13321976>.
2. Liberty, A. (2015). Defending the black sheep of the forensic DNA family: The case for implementing familial DNA searches in Minnesota. *Hamline Law Review*, 88, 467-517.
3. Maguire, C.N, McCallum, L.A. , Storey, C., & Whitaker, J.P. (2014). Familial searching: a specialist forensic DNA profiling service utilizing the national DNA database to identify unknown offenders via their relatives – the UK experience. *Forensic Science International Genetics*, 8, 1-9.

4. Gershaw, C.J., Schweighardt, A.J., Rourke, L.C., & Wallace, M.M. (2011). Forensic utilization of familial searches in DNA databases. *Forensic Science International Genetics*, 5, 16-20.
5. Murphy, E. (2010). Relative doubt: familial searches of DNA databases. *Michigan Law Review*, 109, 291-348.
6. Greely, H.T., Riordan, D.P., Garrison, N.A., & Mountain, J.L. Family ties: the use of DNA offender databases to catch offenders' kin. (2006). *Journal of Law, Medicine & Ethics*, 34, 248-262.
7. Scientific Working Group on DNA Analysis and Methods. (2014). *Recommendations from the SWGDAM ad hoc working group on familial searching*. Retrieved from http://media.wix.com/ugd/4344b0_46b5263cab994f16aeedb01419f964f6.pdf.
8. Kim, J., Mammo, D., Siegel, M.B., & Katsanis, S.H. (2011). Policy implications for familial searching. *Investigative Genetics*, 22, 1-9.
9. California Department of Justice: Division of Law Enforcement. (2008). Information Bulletin: *DNA partial match (crime scene DNA profile to offender) policy*.
10. Michigan State Police. (2012). *Biology, procedures/training manuals, 2.7.1 familial search policy*.
11. Virginia Department of Forensic Science. (2012). *Forensic biology section procedures manual familial DNA testing*. Retrieved from <http://www.dfs.virginia.gov/wp-content/uploads/2013/09/210-D1200-Forensic-Biology-Section-Procedures-Manual-Familial-DNA-Testing.pdf>.
12. DNA Forensics News and Information about DNA Databases. *States Using Familial Searches*. Retrieved from <http://www.dnaforensics.com/statesandfamilialsearches.aspx>.
13. Texas Department of Public Safety. (2017). *Standard Operating Procedures CODIS*. Retrieved from <https://txdpslabs.qualtraxcloud.com/ShowDocument.aspx?ID=43050>.
14. Florida Department of Law Enforcement. (2012). *DNA Database Familial DNA Search Case Acceptance Policy*.
15. Utah Bureau of Forensic Services. (2016). *CODIS Procedure Manual*.
16. New York State DNA Subcommittee. *Familial Search Policy*. Retrieved from <http://www.criminaljustice.ny.gov/pio/open-meetings/6-16-2017-fs/Old%20Business.pdf>.

17. Ohio Bureau of Criminal Investigation. (2016). Familial Search Policy and Procedures. Retrieved from <http://www.ohioattorneygeneral.gov/Files/Briefing-Room/News-Releases/BCI/Familial-Search-Policy-and-Procedures.aspx>.
18. Colorado Bureau of Investigations. (2009). *DNA Familial Search Policy*. Retrieved from http://www.denverda.org/dna/familial_dna_database_searches.htm
19. Ge, J., Chakraborty, R., Eisenberg, A., & Budowle B. (2011). Comparisons of familial DNA database searching strategies. *Journal of Forensic Sciences*, 56, 1448-56.
20. Colorado Bureau of Investigations. (2009). *DNA Familial Search Policy*. Retrieved from http://www.denverda.org/dna/familial_dna_database_searches.htm.
21. Honkanen, J., Schroeder, A., Hahn, A., Naugle, J., & Willkowske. (2015). *Defining and refining a familial DNA search program – the Wisconsin experience*. Proceedings from the Twenty-Sixth International Symposium on Human Identification.
22. Bobillo, C., Marino, M., Sala, A., Gusmao, L., & Corach, D. (2008). X-STRs: Relevance in complex kinship cases. *Forensic Science International: Genetics, Supplement Series*, 1, 496-498.
23. Prieto-Fernandez, E., Baeta, M., Nunez, C., Jimenez-Moreno, S., & de Pancorbo, M.M. (2015). A new X-STR multiplex for forensic purposes, *Forensic Science International: Genetics, Supplement Series*, 5, e283-e285.
24. Mustian, J., (2017, April 16). State police crime lab eyes familial DNA searching, a controversial crime-solving tool, *New Orleans Advocate*. Retrieved from http://www.theadvocate.com/new_orleans/news/crime_police/article_0dd1fd72-1b0c-11e7-829a-1be06412d0c8.html.