TrueAllele® Casework: Family DNA Interpretation and Kinship Applications

Some criminal cases involve multiple family members contributing DNA to evidence items. These cases present challenges for DNA interpretation since related individuals have similar genetic types. However, TrueAllele® Casework probabilistic genotyping software can easily interpret DNA mixtures involving family members. The software can also use DNA from family members to infer a missing person's genetic type, calculate the probability of paternity, or search against evidence to find familial database matches.

DNA inheritance

Family members share DNA, as it is an inherited genetic feature. Closer relatives share more DNA, while more distant relatives share less DNA. For example, parents share half of their DNA with their children, and grandparents share about a quarter of DNA with their grandchildren.

DNA mixtures of family members

In some forensic cases, more than one family member contributes DNA to the same evidence item. These DNA mixtures of family members typically contain fewer data peaks, as some of the allele (DNA repeat number) peaks are shared by the related individuals. Crime laboratories may find these family mixtures challenging to interpret using limited methods and provide inconclusive identification results. TrueAllele Casework easily separates these family DNA mixtures into contributor genetic types.

Kinship genetic types

TrueAllele can also build an unknown family member's DNA genetic type using known family member DNA. This kinship application is useful in paternity and mass disaster cases, when DNA from an alleged father or missing person is not available. When more known family member DNA is available, TrueAllele infers a more complete kinship genetic type for the unknown person. These kinship profiles can be used for TrueAllele DNA database applications, finding familial links to crime scene DNA evidence.

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Case examples: related individuals

TrueAllele Casework has been used in about 100 cases involving related individuals. The computer has separated casework DNA mixtures containing a parent and child, two siblings, and multiple family members. Results from these family DNA mixture cases have withstood admissibility challenge. Case examples for these family DNA mixture cases are featured below.

Father and daughter mixture case

A father was accused of molesting his daughter over a six-year period. In the course of the investigation, police collected the victim's bra and the suspect's t-shirt. The local crime laboratory developed mixture data from the evidence. However, the lab was unable to calculate DNA statistics due to limitations of their statistical methods for samples involving related individuals.

Prosecutors in the case reached out to Cybergenetics for TrueAllele Casework interpretation. The computer readily separated the father's and daughter's genetic types from the two-person mixture data. TrueAllele then calculated inclusionary match statistics tying the victim to the suspect's clothing and the suspect to the victim's bra.

Cybergenetics testified at the trial about these results. The defendant was found guilty of rape by forcible compulsion, involuntary deviate sexual intercourse with a person younger than 16, statutory sexual assault, and incest. He was sentenced to 40 to 80 years in prison.

Mother and son mixture case

In a Massachusetts case, a 14-year-old boy told police that his mother had forced him to have sex with her while she was intoxicated. A probable semen stain on the mother's pajama pants was analyzed by the local lab. Much like the previous case, the lab could not come to statistical conclusions due to the relationship of the victim and suspect. After withstanding an admissibility challenge, these family mixture TrueAllele results were presented at trial.

Siblings mixture case

On April 15, 2013, a bombing took place at the Boston Marathon. After an investigation, police developed brothers Dzhokhar and Tamerlan Tsarnaev as suspects. After a shootout, Tamerlan was killed, while police detained his brother, Dzhokhar.

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A large amount of DNA evidence was collected, including a glove recovered from a vehicle believed to have been involved with the crime. Cybergenetics received DNA data from this glove, which contained a mixture of at least five contributors. TrueAllele was able to resolve the glove mixture and produce inclusionary match statistics to both brothers in the tens to hundreds of thousands, statistically linking them to the evidence.

Five family member mixture case

On July 18, 2009, police in Sydney, Australia, entered the blood-soaked home of Min and Lily Lin. They found Min, his sister Irene, wife Lily, and the couple's two young boys (Henry and Terry) dead. The cause of death for the family was a combination of asphyxiation and blunt-force trauma.

Shortly after the crime, investigators swabbed a brown stain found on Min's brother-in-law's (Robert Xie) garage floor. The crime lab analyzed the garage floor swab and found that the evidence data contained a mixture of at least three related individuals. This DNA data made interpretation using traditional methods difficult. However, TrueAllele separated out the mixture data into contributors, finding that garage floor swab produced inclusionary match statistics to all five victims.

The TrueAllele results from this complex family mixture were admitted as evidence after an admissibility hearing in 2014. Cybergenetics testified in 2015 and 2016 in front of a New South Wales jury. Robert Xie was convicted after his fourth trial and was sentenced to five consecutive life sentences in prison without parole.

Homicide of father and mother by son

In 2011, police and prosecutors accused James Yeckel of killing his father and mother using his father's shotgun. Police collected a spent shotgun shell from the alleged murder weapon as evidence. The crime lab produced DNA mixture data from this evidence that contained at least three people. Due to both the number of contributors and the relationship of the victims and suspect, the crime lab's manual interpretation methods could not provide information. TrueAllele was able to resolve this mixture calculating inclusionary match statistics for both the father and son, while excluding the mother as a DNA contributor.

TrueAllele kinship applications

TrueAllele has also been used to infer kinship DNA genetic types in paternity, missing persons, and mass disaster cases. Examples of these TrueAllele kinship applications are featured below.

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Paternity

TrueAllele Casework can help in cases of disputed parentage. In a recent case, a family challenged an inheritance claiming that an alleged child was not the true child of a deceased family member. Lawyers asked Cybergenetics to use TrueAllele to infer the true biological father's genetic type using the child and biological mother's DNA types. The inferred kinship profile was then compared with DNA from the deceased. TrueAllele calculated an inclusionary match statistic (paternity index) between the inferred parent kinship profile and the deceased alleged father, statistically establishing that the deceased was the child's biological father.

Missing person

TrueAllele inferred kinship information can also be used to identify missing people after events such as mass disasters. Following a fiery bus crash in South Africa, the South African Police Service (SAPS) recovered victims' bodies that were burned beyond recognition. Identification records did not exist for the passengers involved. Although the police collected DNA from the victim remains, it was not helpful as there were no victim reference profiles on file for comparison. However, police also collected DNA from 15 family members who thought their relative might have been on the bus.

The police wanted to use the biological relatives' DNA to identify the victim remains, so in 2009, SAPS reached out to Cybergenetics for help. The police sent the DNA profiles from the victim remains and the possible relatives, along with the assumed biological relationships between the relatives and missing people. None of the missing people were related to one another, and each inferred kinship genetic type would be constructed using just one family reference. TrueAllele calculated match statistics between the missing person DNA profiles and the inferred kinship profiles. Nine of the 15 victim remains were statistically associated (with statistics in the hundreds to the tens of thousands) with a kinship reference. These results helped bring some closure for this disaster event.

Mass disaster

TrueAllele has also been used in larger scale mass disasters including identification of victims from the World Trade Center attack in 2001. Investigators collected over 18,000 victim remains from the scene. The forensic task was to associate these victim remains with the 2,700 missing people. In order to complete this task, TrueAllele inferred victim kinship reference profiles from personal effects and from family references. These kinship victim profiles were then compared with the DNA profiles from the victim

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remains to find associations and identify the unknown. TrueAllele Database assisted in this task, inferred making thousands of comparisons to find match information.

Familial search database

Sometimes DNA from a suspect is not present in a DNA database. In these cases, police or crime labs can conduct a familial search of the database. In this type of search, traditional DNA evidence profiles are linked to a suspect's family members (parents, children, siblings. etc.) whose profiles are present on the database. This type of database is different from an ancestry or genealogy database, which uses different types of DNA information.

Investigators used familial search to help solve the Grim Sleeper serial killer case that involved at least ten California murders from 1984 to 2007. Police arrested Lonnie Franklin, Jr. in connection with these murders after finding a family DNA database hit between the evidence and Franklin's son. His son's DNA profile was on the DNA database due to felony weapons charges, while Franklin's DNA was not present on the database.

TrueAllele Database (TADB) supports familial searching applications. First, TrueAllele calculates kinship profiles from individuals uploaded to the TADB. For example, a typical database process may generate parent/child and sibilng profiles for each reference present on the database. Then, these kinship profiles are available for comparison to the database evidence genetic types. By uploading these inferred kinship profiles, crime scene evidence may provide match information to a sibling profile derived from a subject. This match would alert the user to further investigate the subject's siblings for possible connections to a case.

Conclusion

Using limited interpretation methods, crime laboratories have struggled to resolve DNA mixtures involving family members. However, TrueAllele Casework easily separates family mixture DNA data, providing useful match information. The computer can also infer a person's DNA profile from their family members, which allows investigators to compare a person's profile to the evidence when no DNA is available from the individual in question. These kinship profiles are also useful to identify the missing or for conducting familial searches of a database. Overall, TrueAllele reliably interprets evidence data containing DNA from multiple family members.

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Frequently Asked Questions

When considering TrueAllele probabilistic genotyping for family mixture interpretation or kinship applications, consider the following:

Is the system validated?

> TrueAllele has been extensively validated on mixtures of up to 10 contributors. Over 40 validation studies have been conducted, including studies involving mixtures of family members. Eight of these studies are published in peer-reviewed scientific journals.

Can TrueAllele handle mixtures of close relatives?

> Case examples demonstrate that TrueAllele can successfully resolve mixture of first-degree relatives such parent and child and siblings.

Can it use family reference and pedigree information to generate genotypes for comparison?

> TrueAllele can incorporate user-provided pedigree information to more precisely infer an unknown person's DNA profile.

Can the creation of kinship genotypes be automated and searched in a database?

> TrueAllele Database can quickly compare kinship-derived profiles with other reference and evidence data. Further, the creation of the kinship-derived profile can be automated where any reference uploaded to the database automatically generate parent/child or sibling profiles for comparison.

If you have additional questions, please email Cybergenetics at **info@cybgen.com**, or call us at **412.683.3004**.

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