Slide 1:

(Introduce yourself, your title/background, and thank the audience for allowing you to present)

Today I will be presenting Evolutions in Crime-Solving: The Impact of Investigative Genetic Genealogy. My hope is that this presentation will provide an overview of how IGG works and how it may be used to resolve cases at/in (agency or region where you are presenting).

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This presentation was developed by the Ramapo College Investigative Genetic Genealogy Center, which provides pro bono investigative genetic genealogy services, educational programs, and research to advance the field of IGG.

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You may have heard of investigative genetic genealogy, as it is a groundbreaking and newsmaking tool for resolving cases of violent crime and unidentified remains cases. But how does it work?

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First, investigative genetic genealogy - or IGG - goes by many names. I will refer to it as IGG in this presentation, but you may have also heard this field called forensic genetic genealogy or forensic genealogy.

IGG utilizes advanced DNA testing techniques along with traditional genealogy and genetic genealogy research to develop investigative leads in violent crime cases and unidentified human remains cases.

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IGG entered the public's perception in 2018, when a number of long-cold cases were solved with this new technique. IGG research began in 2017 and was performed by several pioneering practitioners, each of whom are leaders in the field today. In April of 2018, Marcia King, formerly known as "Buckskin Girl" was identified by the DNA Doe Project, led by Colleen Fitzpatrick and Margaret Press. This proved to the public, and to law enforcement agencies, that long-unresolved cases of unidentified human remains could be solved with IGG.

Just two weeks later, Joseph DeAngelo - known as the "Golden State Killer" was arrested after Dr. Barbara Rae Venter led an investigative genetic genealogy team to identify him. This catapulted IGG into the public consciousness.

In July of 2018, John D. Miller was arrested for the abduction, rape and murder of eight-year-old April Tinsley in Indiana. CeCe Moore and Parabon Nanolabs had conducted the IGG work in this case and the 59-year-old was sentenced to 80 years in prison - as a result, he will never harm another child.

CeCe Moore also led the IGG work which contributed to the exoneration of Christopher Tapp. This was the first time that IGG had been utilized to identify the true perpetrator in a case of wrongful conviction.

These cases paved the way, but since they were solved more than 800 cases have been resolved utilizing IGG. This tool is the most significant and powerful development in the resolution of violent crime since the discovery of DNA itself.

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While the use of DNA to identify perpetrators of violent crime and identify human remains is not new, IGG utilizes a more advanced type of DNA testing which has not traditionally been used for investigative purposes.

Traditional DNA testing involves analysis of STRs or short tandem repeats. You can think of this type of testing like a grainy photo on your 2006 flip phone. It is useful for capturing a picture, but not picking up the finer details. STR testing uses tens or dozens of markers along the genome, and can be used to compare a subject to their own sample or to a sample from their direct relatives such as their parent or child.

SNP testing, or single nucleotide polymorphism testing, is the type of testing used for the development of profile suitable for IGG. This type of DNA testing examines hundreds of thousands or millions of markers along the genome. Think of this like a high-definition photo on your smartphone in today's world - great for zooming in on the finer details. SNP testing can be used to identify not only the DNA contributor and their direct relatives, but also their 3rd, 4th, 5th and more distant cousins.

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Development of a SNP profile depends on advanced DNA testing from a qualified laboratory. Next, I'll provide an overview of the lab process that precedes IGG.

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IGG practitioners are typically not experts in forensic DNA - although there are exceptions - and thus, they rely on relationships with forensic DNA laboratories to guide the laboratory process for the successful development of a SNP profile.

The process begins with specimen collection, wherein the investigating agency and the laboratory select the appropriate specimen for testing. Commonly tested specimens include existing DNA extract, bone, teeth, hair - including rootless hair, blood, semen and more.

Next, extraction is performed to isolate the DNA of the individual the agency wishes to identify. If you've ever seen a child complete a science project where they extracted DNA from a strawberry, you've seen what DNA extract looks like!

After that, genotyping is the next step. This is where the sequence of the individual's DNA is analyzed to develop the genetic profile for the subject. This can be done through various methods including whole genome sequencing and array genotyping, and is offered at various costs based on the specific sample tested.

In most cases, bioinformatics is required to convert the genotype profile into a file suitable for upload to the genetic genealogy databases used in IGG. Sometimes, the bioinformatics step also helps to repair the DNA sequence if there are any "holes" in the DNA from degradation or low coverage of an area of the genome.

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After the laboratory process is complete, the work of the IGG practitioner begins. What happens next?

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The IGG practitioner works with a number of different outputs generated from the genotype profile and the databases used in IGG. Outputs from the databases used in IGG include a bioancestry report (also called the ethnicity estimate) and a genetic match list.

Depending on the type of genotyping performed during the laboratory process, the IGG practitioner may also receive an estimate of the subject's mitochondrial and y-DNA haplogroups.

Note: At this time you may wish to provide information about the databases utilized for IGG. Due to the ever-evolving nature of database availability for IGG, we have chosen to eliminate this language from the script.

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Each of those outputs is useful to the IGG researcher or team. The bioancestry report provides the IGG practitioner with a rough estimate of the subject's heritage. An example will be provided in the following slides.

The genetic match list is the primary focus of the IGG practitioner's work. The genetic relatives of the subject will be analyzed by the IGG practitioner to form a hypothesis of how the subject is related to them. This allows the IGG practitioner to reverse engineer the family tree of the subject.

The mitochondrial and Y-DNA haplogroup estimates for the subject allow the IGG practitioner to make an educated guess about the ancestry of the subject's direct paternal ancestors and direct maternal ancestors.

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This is an example of a bioancestry report for the same person from two different databases. This individual is believed to be half Irish, and half American. Her ethnicity estimate shows that she is fully European. Keep in mind that these estimates are just that - estimates! They provide helpful context but are not the primary focus for the IGG practitioner.

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These are two examples of genetic match lists for two subjects. The match list shows a list of relatives from the most closely related to the most distantly related. Relatedness is expressed in centimorgans - the higher the number of centimorgans shared between two individuals, the closer their relationship.

On the left, this match list demonstrates the closest match of 70 centimorgans. This would be in the range of a 3rd to 5th cousin match to the subject. If they are a third cousin, they would share 2nd-great-grandparents with the subject.

On the right, we see that the top match shares 738 centimorgans with the subject. This is in the range of a first cousin - perhaps this person would share grandparents with the subject.

Which case do you think would be easier to resolve? *(Pause for discussion)*

In both cases, the IGG research team would build family trees for the genetic matches to determine how they may be related to the subject. This allows the IGG practitioner to develop a hypothesis about who the subject is based on their genetic matches. This hypothesis is the *investigative lead* produced in IGG.

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After the genealogy work produces a potential candidate to be the DNA contributor of crime scene DNA or the unidentified decedent in an unidentified remains case, the IGG practitioner will share the candidate's name and key important information with the investigating agency. From here, the agency takes over and must further investigate the lead. In an unidentified human remains case, that may involve a proof-of-life search or contact with the person's family. In a violent crime case, it may involve looking into the criminal background of the potential perpetrator.

Next, the lead must be confirmed with a means of confirmatory testing. In unidentified human remains cases, this can be an STR DNA test from a family member reference sample, a fingerprint comparison, dental records comparison, or other means of confirmation. In criminal cases, confirmation usually involves DNA testing from a specimen obtained through a warrant or through surreptitious collection. It is only after the investigative lead is confirmed that a death certificate is issued for the formerly unidentified decedent, or that an arrest could be made in a violent crime case.

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This piece is important - IGG is a groundbreaking tool that can assist in cases of violent crime and unidentified remains cases, but it produces only an investigative lead which must be further investigated and confirmed with secondary means.

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Now that you've learned about how IGG works, you may be wondering how your agency can implement it and what the costs involved are.

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The cost of IGG work on a single case is extremely variable. The laboratory costs range by sample type and the needs of a particular case or specimen, ranging from $3,000-10,000 per sample. Next, the database uploads to generate a match list for the subject range from $0 to $2,400. This cost is variable because in some cases, only one database may be needed, but in other cases, all available IGG databases will need to be utilized for a case. Finally, there is the cost of the IGG research, which again is extremely variable. Pricing for IGG research may follow a flat fee structure or an hourly rate. Some IGG practitioners work in house as investigators, detectives or analysts at their agencies. Some IGG organizations utilize volunteers to provide research.

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This is not intended to be an exhaustive list of resources for IGG, but if funding is a challenge for your agency, there are some resources available that can provide financial and other types of support for IGG casework.

First, Ramapo College Investigative Genetic Genealogy Center provides pro bono IGG research as well as funding for laboratory costs. Ramapo IGG has helped resolve over a dozen cases through IGG including unidentified human remains, violent crimes and wrongful convictions, all of which were fully funded at no cost to the investigating agencies.

Second, Season of Justice is a nonprofit organization offering funding support for qualifying violent crime cases through an application process.

Third, the National Center for Missing and Exploited Children offers various resources, including funding support for some qualifying cases in which the victim is believed to be under 21.

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While IGG is a powerful tool, it is not a “slam dunk” that can solve every case. There are some barriers to resolving cases and it’s important for investigators to recognize that not every case can be solved with IGG.

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One potential barrier is ethnicity or heritage of the subject. The databases utilized for IGG contain DNA profiles primarily from a Western European population in United States and Canada. While there is some representation of other populations, cases involving subjects from minority populations may be more difficult to solve using IGG.

Additionally, those cases might be impacted by scarcity of genealogical records. One example would be if the subject is from a rural region of Latin America - there may be genealogical records available in churches or municipal resources close to where the individual is from, but they might not be accessible online by IGG practitioners in other countries.

An additional barrier is misattributed parentage. Families are complicated, and many families are impacted by adoptions or misattributed parentage events - cases in which the biological parents of an individual are not the documented parents. These can complicate the IGG search process, which relies on both the biological and documented connections between individuals.