Blairsville, PA Dentist
Dr. John Yelenic

Murder Victim

April 2006: Death in home by exsanguination

State Trooper Arrested

November 2007: Kevin Foley charged with crime
Fingernail DNA Evidence

93.3% victim + 6.7% DNA component

Three DNA Match Statistics

<table>
<thead>
<tr>
<th>Score</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 thousand</td>
<td>inclusion</td>
</tr>
<tr>
<td>23 million</td>
<td>subtraction</td>
</tr>
<tr>
<td>189 billion</td>
<td>addition</td>
</tr>
</tbody>
</table>

• Why are there different match results?
• How do mixture interpretation methods differ?
• What results should be presented in court?
Addition Method (TrueAllele)

Step 1: infer genotype

victim genotype
other genotype
10, 13 ?
genotype pattern

Step 2: match genotype
high probability retains LR information

TrueAllele Preserves Information

At the suspect's genotype, identification vs. coincidence?

after (evidence)
data
before (population)

Prob(suspect matches evidence) = 100%
Prob(suspect matches population) = 1.72%

Step 2: match genotype
high probability retains LR information

Inclusion Method (CPI)

Step 1: infer genotype

• apply threshold
• discard peak data
• make all the same

• 10 possible pairs
• equal likelihood
• diffuse probability
• lose match strength
CPI Loses Information
At the suspect's genotype, identification vs. coincidence?

\[
\text{Prob}(\text{suspect matches evidence}) = 4.42\% \\
\text{Prob}(\text{suspect matches population}) = 1.72\% \\
\]

Step 2: match genotype
lower probability loses LR information

Interpretation: Same Principle
DNA data
A. Infer genotype
1. Data
2. Model
3. Compare
4. Probability
B. Match genotype
Likelihood ratio

Different Methods

<table>
<thead>
<tr>
<th>Data Used</th>
<th>inclusion</th>
<th>subtraction</th>
<th>addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>victim profile</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>original data</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>
Frye: General Acceptance in the Relevant Community

• Quantitative STR Peak Information
• Genotype Probability Distributions
• Computer Interpretation of STR Data
• Statistical Modeling and Computation
• Likelihood Ratio Literature
• Mixture Interpretation Admissibility
• Computer Systems for Quantitative DNA Mixture Deconvolution
• TrueAllele Casework Publications

Validating Mixture Methods

Match Score = Information
• efficacy
• reproducibility


Ranking:
1 Addition
2 Subtraction
3 Inclusion

Validation Study
Expected Result

Addition vs. Inclusion

Threshold: all or none
Quantitative: shades of gray

Statistical Inference View

- "often robs the items of any probative value" - B. Weir
- "usually discards a lot of information compared to the correct likelihood ratio approach" - C. Brenner
- "does not use as much of the information included in the data as the LR approach but, conceptually, they are equivalent" - M. Krawczak
- "Recommendation 1: The likelihood ratio is the preferred approach to mixture interpretation." - DNA commission of the International Society of Forensic Genetics (2006)

Relevant Scientific Community

- The forensic scientists who largely focus on DNA inference and statistics.
- Develop, discuss, publish, validate & assess DNA interpretation methods.
- Implement methods in computer software.
- Provide a pallet of interpretation methods for the practitioner to choose from.
- Lay the scientific foundation for practitioners.
- Give expert backup in court testimony.
Mixtures with a known contributor
• genetic profile of the unknown can be inferred
• subtracting the contribution of the known donor
• peak height ratios can be used

Christine S. Tomsey, et al
Forensic DNA Laboratory
Croatian Medical Journal, 2001

Interpretation Differs
National Institute of Standards and Technology
Two Contributor Mixture Data, Known Victim

Other Methods are Similar

James Curran,
“A MCMC method for resolving two person mixtures.”
TrueAllele Users

Allegheny County Crime Lab (Forensic Identification)
Armed Forces DNA Identification Laboratory (Forensic Identification)
DeCode Genetics, Iceland (Genetic Discovery)
Forensic Science Service, UK (Forensic Identification)
Maryland State Police (Forensic Identification)
Marshall University, WV (Forensic Research)
Massachusetts State Police (Forensic Identification)
National Institutes of Health (Genetic Discovery)
New York City OCME (Mass Disaster Forensic Identification)
New York State Police (Forensic Identification)
Orchid Cellmark - Abingdon, UK (Forensic Identification)
Orchid Cellmark - Nashville, USA (Forensic Identification)
Puerto Rico Forensic Science Center (Forensic Identification)
SmithKline Beecham Pharmaceuticals, UK (Genetic Discovery)
University of Pittsburgh (Genetic Counseling, Genetic Discovery)

Other Mixture Systems

GeneMapper® ID-X (Applied Biosystems, California)
FSS I-3®-I-STREAM (Forensic Science Service, United Kingdom)
TrueAllele® Casework System (Cybergenetics, Pennsylvania)
Least Square Deconvolution (University of Tennessee)
MCMC-Pendulum (University of Auckland, New Zealand)

Cross Examination

• How can reliable DNA give different statistics?
• Why doesn't the computer use thresholds?
• Has this method ever been used before in court?
TrueAllele Admitted

Trial Testimony

- one principle: infer genotype, then match
- methods make different use of the data
- better data use gives more information
- MIX05: huge variation in interpretation
- validation study predicts match result

Inclusion DNA Match
Trial Cross Examination

- Why are there different statistics? how method uses data, ethnic population, …
- Shouldn't the same data give the same answer? microscope analogy for examining same slide
- Don't computers need thresholds? that is a human limitation, and is not relevant

Microscope Metaphor

“The less informative methods ignored some of the data, while the TrueAllele computation considered all of the available DNA data.”

“A scientist may look at the same slide using the naked eye, a magnifying glass, or a microscope. A computer that considers all the data is a more powerful DNA microscope.”

Jury convicts trooper of dentist slaying

An Indiana County Court jury this evening convicted state trooper Kevin Foley of first degree murder in the April 13, 2008, slaying death of Bloomfield dentist John Yelenic.

“John Yelenic provided the most eloquent and poignant evidence in this case,” said the prosecutor, senior deputy attorney general Anthony Krastek. “He managed to reach out and scratch his assailant,” capturing the murderer’s DNA under his fingernails.
Pennsylvania Precedent

TrueAllele in Pennsylvania

<table>
<thead>
<tr>
<th>Crime</th>
<th>Evidence</th>
<th>Defendant</th>
<th>Outcome</th>
<th>Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>murder</td>
<td>fingernail</td>
<td>Kevin Foley</td>
<td>guilty</td>
<td>life</td>
</tr>
<tr>
<td>rape</td>
<td>clothing</td>
<td>Ralph Skundrich</td>
<td>guilty</td>
<td>awaiting</td>
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<tr>
<td>murder</td>
<td>gun, hat</td>
<td>Leland Davis</td>
<td>guilty</td>
<td>23 years</td>
</tr>
<tr>
<td>rape</td>
<td>clothing</td>
<td>Akaninyene Akan</td>
<td>guilty</td>
<td>32 years</td>
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<tr>
<td>murder</td>
<td>shotgun shells</td>
<td>James Yeckel, Jr.</td>
<td>guilty plea</td>
<td>25 years</td>
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<td>murder</td>
<td>fingernail</td>
<td>Anthony Morgan</td>
<td>stipulation</td>
<td>life</td>
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<td>weapons</td>
<td>gun</td>
<td>Thomas Doswell</td>
<td>guilty plea</td>
<td>1 year</td>
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<tr>
<td>drugs</td>
<td>gun</td>
<td>Derek McFossick &amp; Steve Morgan</td>
<td>guilty pleas</td>
<td>2 1/2 years</td>
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<tr>
<td>murder</td>
<td>wood</td>
<td>Sherman Holes</td>
<td>guilty plea</td>
<td>10 years</td>
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