TrueAllele® Mixture Interpretation

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9th Annual DNA Technology Educational Seminar
Centre of Forensic Sciences
and the Promega Corporation
Toronto, Ontario
November, 2012

Cybergenetics

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Murder in McKeesport

October 25, 2008
Tamir Thomas

Biological evidence

DNA analysis

PowerPlex® 16 STR

Partial DNA profiles obtained for both the gun and the cap

CPI results

COUNTY OF ALLEGHENY
OFFICE OF THE MEDICAL EXAMINER

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DAN ONORATO
CHIEF EXECUTIVE

KARL E. WILLIAMS, M.D., M.P.H.
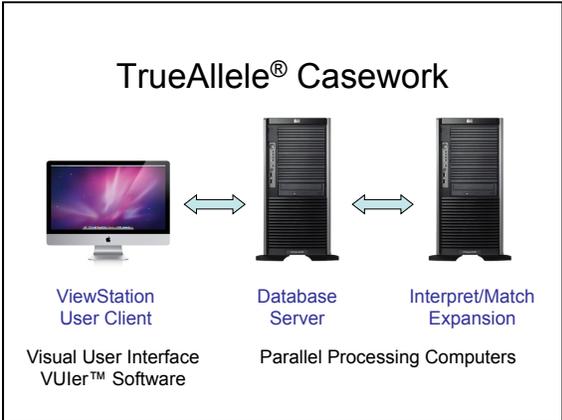MEDICAL EXAMINER

ROBERT M. HUSTON
LABORATORY DIRECTOR

CPI match to Leland Davis

Black	420	Black	5.7 quadrillion
Caucasian	500	Caucasian	9.3 quadrillion
Hispanic	470	Hispanic	1.8 quadrillion

Prosecutor question

What is the true match information of the evidence to the suspect?

TrueAllele® Casework

ViewStation
User Client

Database
Server

Interpret/Match
Expansion

Visual User Interface
VUIer™ Software

Parallel Processing Computers

TrueAllele operator

STR evidence data
.fsa genetic analyzer files

• Replicate computer runs for each item
• Three unknown mixture contributors
• Degraded DNA was considered

Evidence genotypes
probability distributions

Cybergenetics

Perlin MW. Explaining the likelihood ratio in DNA mixture interpretation.
Promega's Twenty First International Symposium on Human Identification, 2010; San Antonio, TX.

TrueAllele report

Genotype probability distributions

Evidence genotype   Suspect genotype

Likelihood ratio (LR)
DNA match statistic

Population genotype

Cybergenetics

TrueAllele DNA match

LR match to Leland Davis

Black	18.6 billion	Black	89 quadrillion
Caucasian	12.1 billion	Caucasian	420 quadrillion
Hispanic	3.37 billion	Hispanic	73.5 quadrillion

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Trial preparation

- case report
- direct examination
- PowerPoint slides
- background reading
- other questions

TrueAllele reports 2 & 3

2. Is Dominick Haynes in the DNA evidence?
Answer: No – million factor against.

3. Is anyone else in both DNA evidence items?
Answer: No – Leland Davis is the only one.

Cybergenetics

TrueAllele precedent

No pretrial admissibility hearing

Commonwealth of Pennsylvania v. Kevin James Foley

Superior Court, 2012

Computer Interpretation of Quantitative DNA Evidence

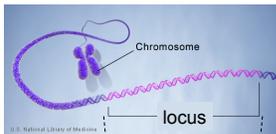**Commonwealth v Leland Davis**
August, 2012
Pittsburgh, Pennsylvania

Mark W Perlin, PhD, MD, PhD
Cybergenetics, Pittsburgh, PA

Cybergenetics

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DNA genotype

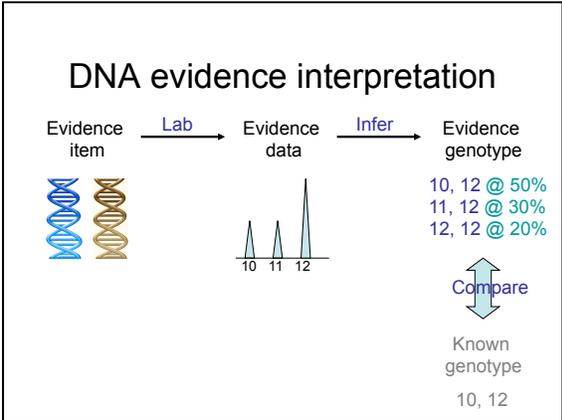Chromosome

locus

mother allele

ACGT repeated word

father allele
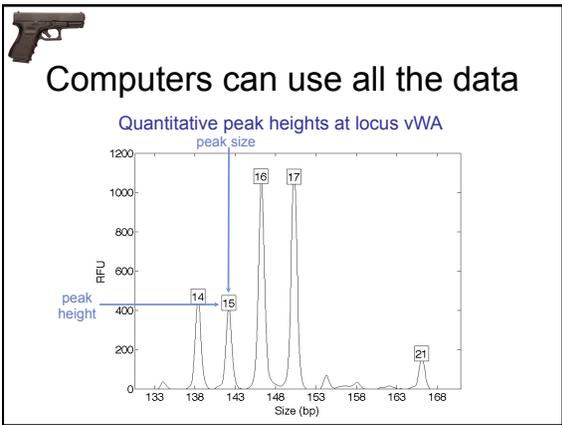
A genetic locus has two DNA sentences, one from each parent.
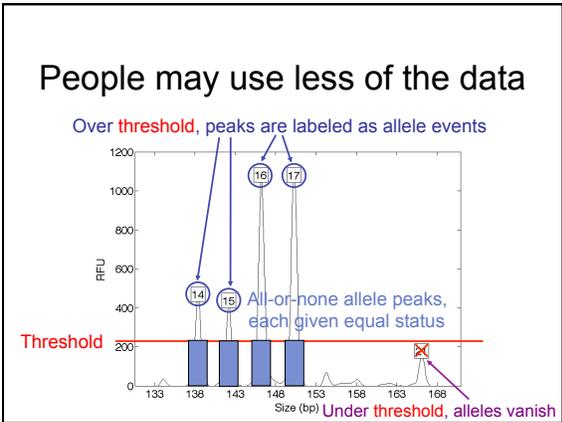
An allele is the number of repeated words.

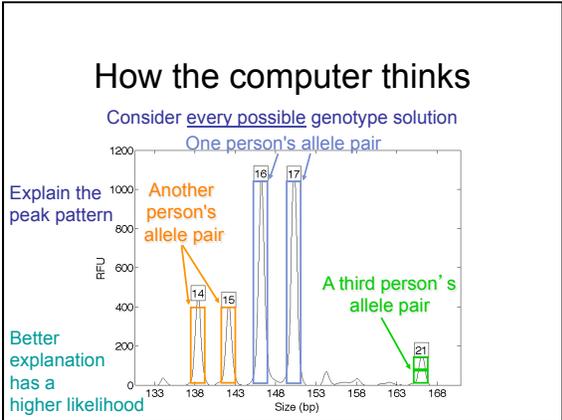A genotype at a locus is a pair of alleles.

8, 9

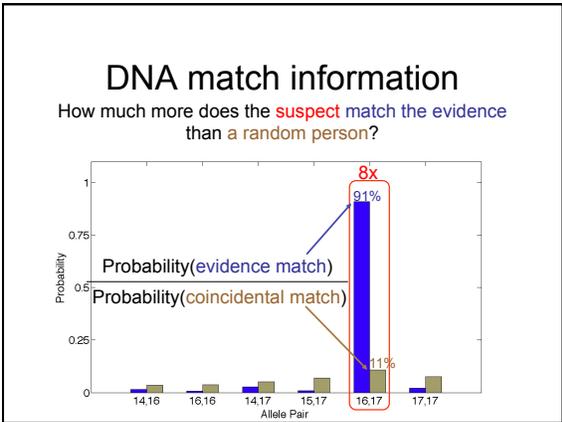Many alleles allow for many many allele pairs. A person's genotype is relatively unique.

DNA evidence interpretation

Evidence item → **Lab** → Evidence data → **Infer** → Evidence genotype

10, 12 @ 50%
11, 12 @ 30%
12, 12 @ 20%

10 11 12

Compare

Known genotype

10, 12

Computers can use all the data

Quantitative peak heights at locus vWA

peak size

peak height

RFU

16 17
14 15
21

Size (bp)
133 138 143 148 153 158 163 168

People may use less of the data

Over **threshold**, peaks are labeled as allele events

RFU

16 17
14 15

All-or-none allele peaks, each given equal status

Threshold 200

Size (bp)   Under threshold, alleles vanish

133 138 143 148 153 158 163 168

How the computer thinks

Consider every possible genotype solution
One person's allele pair
Explain the peak pattern
Another person's allele pair
A third person's allele pair
Better explanation has a higher likelihood

Evidence genotype

Objective genotype determined solely from the DNA data.
Never sees a suspect.

DNA match information

How much more does the suspect match the evidence than a random person?

8x

Probability(evidence match)
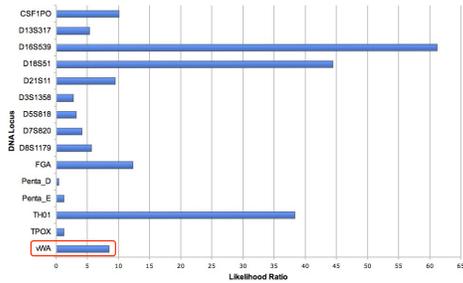Probability(coincidental match)

Match information at 15 loci

Is the suspect in the evidence?

A match between the **handgun** and Leland Davis is:

18.6 billion times more probable than
a coincidental match to an unrelated Black person

12.1 billion times more probable than
a coincidental match to an unrelated Caucasian person

3.37 billion times more probable than
a coincidental match to an unrelated Hispanic person

Is the suspect in the evidence?

A match between the **baseball cap** and Leland Davis is:

89 quadrillion times more probable than
a coincidental match to an unrelated Black person

420 quadrillion times more probable than
a coincidental match to an unrelated Caucasian person

73.5 quadrillion times more probable than
a coincidental match to an unrelated Hispanic person

Is anyone else in both items of evidence?

		1 9%	2 9%	3 81%
1	17%	-1.70	-1.67	-1.41
2	63%	-1.73	-1.52	9.35
3	20%	-1.19	-1.19	-0.26

There is no indication that any person, other than Leland Davis, contributed their DNA to both items of evidence.

Verdict

Leland Davis was convicted of third degree murder and weapons charges in the 2008 McKeesport slaying of Tamir Thomas.

TrueAllele in criminal trials

Over 100 case reports filed on DNA evidence

Court testimony:
• state
• federal
• military
• foreign

Crimes:
• armed robbery
• child abduction
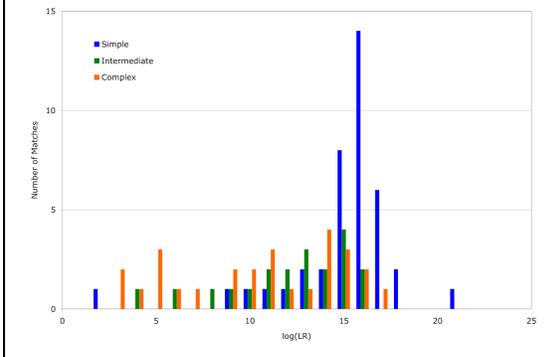• child molestation
• murder
• rape
• terrorism
• weapons

TrueAllele reliability

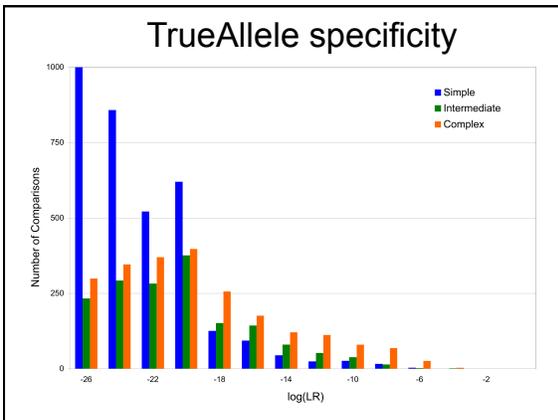Perlin MW, Sinelnikov A. An information gap in DNA evidence interpretation. *PLoS ONE*. 2009;4(12):e8327.

Perlin MW, Legler MM, Spencer CE, Smith JL, Allan WP, Belrose JL, Duceman BW. Validating TrueAllele® DNA mixture interpretation. *Journal of Forensic Sciences*. 2011;56(6):1430-47.

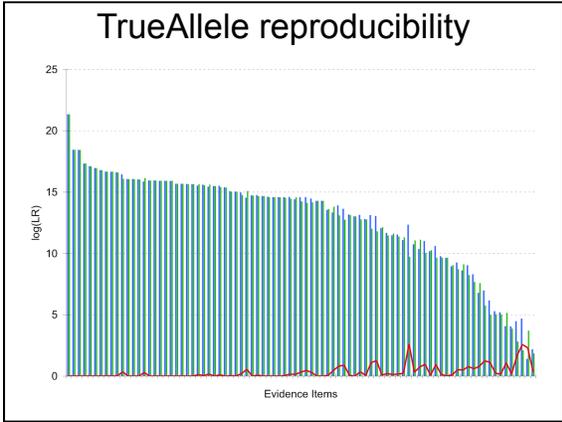Perlin MW, Belrose JL, Duceman BW. New York State TrueAllele® Casework validation study. *Journal of Forensic Sciences*. 2013;58(6):in press.
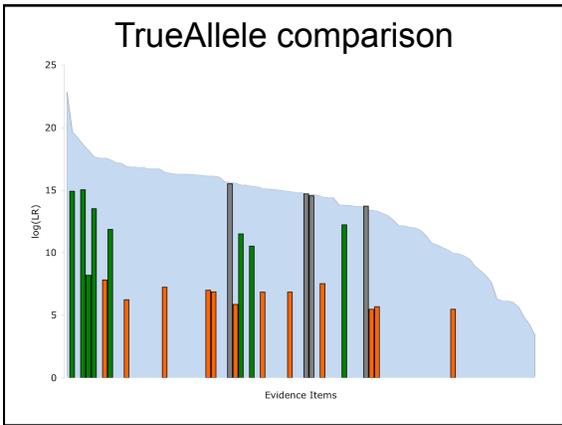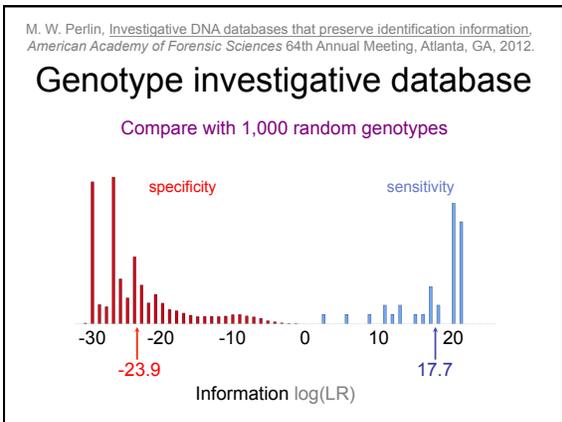
TrueAllele sensitivity

TrueAllele specificity

TrueAllele reproducibility

log(LR) vs Evidence Items

TrueAllele comparison

log(LR) vs Evidence Items

Genotype investigative database

Compare with 1,000 random genotypes

specificity   sensitivity

-30   -20   -10   0   10   20

-23.9   17.7

Information log(LR)

11

Kinship genotype

Genotype probability distribution

10, 10
10, 11
10, 12
10, 13

mother | biological father | child
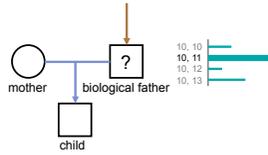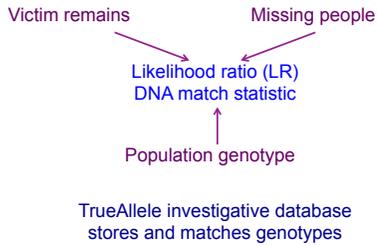

M. W. Perlin, Identifying human remains using TrueAllele® technology, in *Forensic Investigation and Management of Mass Disasters*, M. I. Okoye and C. H. Wecht, Eds., Tucson, AZ: Lawyers & Judges Publishing Co, 2007, pp. 31-38.

World Trade Center

Genotype probability distributions

Victim remains   Missing people

Likelihood ratio (LR)
DNA match statistic

Population genotype

TrueAllele investigative database
stores and matches genotypes

System: in the laboratory

Cybergenetics

Service: fast and easy

1. Send STR data
   mixed, low-level

2. Preliminary report
   LR match statistic

3. Final report
   ready for court

Cybergenetics

Learning more

- Cases
  challenging mixtures

- Webinars
  crime lab, CLE

- Workshops
  CAC, NEAFS

Cybergenetics

Learning a lot more

- Science & Software
  hands-on, one week

- Solving Cases
  operator practice

- Reporting Cases
  presenting results

Cybergenetics

Magazine reading

Perlin MW. Forensic science in the information age. *Forensic Magazine*. 2012;9(2):17-21.

Perlin MW, Galloway J. Computer DNA evidence interpretation in the Real IRA Massereene terrorist attack. *Evidence Technology Magazine*. 2012;10(3): 20-23.

Perlin MW. Easy reporting of hard DNA: computer comfort in the courtroom. *Forensic Magazine*. 2012;9(4):32-37.

Book chapters

Perlin MW, DNA identification science, in *Forensic Sciences*, Wecht CH, editor. Albany, NY: LexisNexis® Matthew Bender®; 2012; Chapter 37C.

Perlin MW, The Blairsville slaying and the dawn of DNA computing, in *Death Needs Answers: The Cold-Blooded Murder of Dr. John Yelenic*, Niapas A, New Kensington, PA: Grelin Press, 2012.

Human-computer partnership

Objective, reliable truth-seeking computer
• solves the DNA mixture problem
• handles low-copy and degraded DNA
• provides accurate DNA match statistics
• automates DNA evidence interpretation

Current TrueAllele applications
• eliminate DNA backlogs
• reduce forensic costs
• solve crimes
• find criminals
• convict the guilty
• free the innocent
• create a safer society

Much information on-line

http://www.cybgen.com/information
- Courses
- Newsletters
- Newsroom
- Presentations
- Publications

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