FORENSIC SCIENCE ERROR MANAGEMENT

INTERNATIONAL FORENSICS SYMPOSIUM

JULY 20-24, 2015 • WASHINGTON, DC

Forensic DNA: Gold Standard or Fool's Gold?

A critical perspective on the current practice of forensic DNA

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Introduction to Independent Forensics

Background of the speaker

Background to the talk

The underlying assumption that needs to be qualified.

Topics covered

What are the issues

Independent Forensics: commercial DNA laboratory – AABB, ISO/IEC17025, NY-DOH

Products for forensic biology (serology): **RSID**™ series of lateral flow tests
SPERM HY-LITER™ for sperm detection

Products for forensic DNA: **AmpliconRx**™, post-PCR clean & purification
OneTouch™, touch DNA collection and purification kit
iPLEX-STR™, 18+1 DNA-STR kit

DNA Expert Witness: case review, testimony

Financial Conflicts: none.

Assumption: Superiority of forensic DNA *v.* other forensic disciplines

(no symbol for DNA in the logo for this meeting . .)

Held by: Forensics, the Courts, law enforcement, Prosecutors, the Public, . . .

Conclusion: probably true, but not important.

Conclusion: other forensic fields should emulate or attempt to replicate the standards and practices used in Forensic DNA

Note: everything is relative

Warning: careful what you ask for

Trouble in forensic DNA

Funding / Support Gap + Wasted Research Effort

NIH, NSF, HHMI - who funds R&D in forensic DNA?

NIJ funded 'research' – flavor of the month, publications *v.* practicality

Technological stagnation

instrumentation – 100% monopoly = 100% lack of innovation

software – monopoly = outdated algorithms

double monopoly = doubly good for the company, bad for the process, bad for users

Training and Education Gap

lack of R&D experience in forensic DNA laboratories – training/background of analysts

no internal support for R&D - no protected positions within the laboratory

i.e., new methods and validations performed by summer interns

most forensic DNA laboratories run by law enforcement

institutionalized resistance to change

innumerate and scientifically challenged

Structural bias in forensic DNA

- laboratories run by and for law enforcement – a particular world view
- pre-determined conclusions – no separation of questioned and known samples
- protected environment: no incentive to change + no penalty for failure

Evaluating forensic DNA I: access to CODIS

- statutory access to DNA databases – legally mandated, but a practical impossibility
- analysis of DNA databases: a wealth of information locked away
  - frequencies (real, not imagined or miscounted)
  - error rates - various kinds, including laboratory analysis errors
  - real searching statistics using partial profiles, all against all, etc.,
  - . . . .

Evaluating forensic DNA II: laboratory statistics

- lack of basic accounting data – $$, # of samples, # of cases, types, outcomes, # profiles, etc.,
- no lab statistics = lack of benchmarks
- no lab statistics = lack of best practices
- no benchmarks = reliance on anecdotal evidence
- anecdotes ≠ science

Funding / Support Gap

NIH – total budget: ~$30.3 billion –
budget for forensics: $0

NSF – total budget: ~$7.72 billion –
budget for forensics: $0

HHMI – research budget ~$825 million (~$1M/investigator)
budget for forensics: $0

NIJ - Social, physical and forensic science research ~$1.8 M
budget for forensics: < $1 M

Funding for forensics

flavor of the month, *e.g.,* automation – little or no impact on throughput -
many instruments 'mothballed'
e.g., rapid DNA – high failure rate, only the military can afford it!

performance measures: citations and publications *vs.* practical outcomes

lack of transparency in peer review process and awards at NIJ

- not the most efficient use of the limited R&D funds

Technological stagnation

instrumentation – complete monopoly = complete lack of innovation
- same instrumentation & thus same problems for 20 years
- expensive – slow – limited dynamic range – wasteful – noisy – expensive to maintain

software – complete monopoly = outdated algorithms
- despite fantastic increases in computing power – same analysis and computational methods as the original MAC-based software
- time consuming – poorly representative of actual data – poor QA/QC measures

complete monopoly = good for the company's revenue and profits, bad for the field

methods – DNA [a very partial list]
- qPCR on reference standards – what were they thinking?
- 25 µL PCR reactions = waste of 95% of analyte = great for ABI profits
- one size fits all extractions = high failure rate on difficult samples
- . . .

Biology
- microscopy – based on materials science, not on biology (long list of issues here!)
- extractions in water – in this day and age?
- acid phosphatase? really? 50x less sensitive, high false positivity, etc., still almost universally used = guaranteed to miss semen stains

Training and Education Gap

lack of R&D experience in forensic DNA laboratories –
- analysts do not come from a research background
- 4 yrs + 5-6 yrs + 2x2 yrs *v.* 6 months (entry level academic scientists *v.* DNA analyst)

no internal support for R&D - production environment
- no protected positions within the laboratory for R&D
- production environment does not support innovation
- consequence: new methods and validation performed by summer interns
- *i.e.,* least trained and least experienced person evaluates/validates new methods and then leaves!

most forensic DNA laboratories run by law enforcement -
- numerically and scientifically challenged management –
  - no professional lab managers

most prosecutors and most judges are untrained in the basics of science and DNA
- junk data and biased conclusion are allowed to be presented in the court room

Structural bias in forensic DNA

laboratories run by and for law enforcement –
i.e., a particular world view permeates the entire process of forensic DNA

- pre-determined conclusions which can lead to -
  - ‘interesting’ choices as to what samples to actually process and test
    subtle but pernicious problem

  - introduction of bias in interpretation of mixtures
    well documented in the literature

  - reluctance to challenge investigators, prosecutors or ‘group think’
    so called ‘peer review’ of internal results

prosecutorial pressure for data, interpretations, & convictions
i.e., well worn path to fraud (every lab system has a scandal – and we know why)

protected environment: no incentive to change + no penalty for failure

Evaluating forensic DNA I: access to CODIS

statutory access to DNA databases – legally mandated, but a practical impossibility
law enforcement and prosecutors fight tooth and nail to limit access to DNA databases . . . this is unethical – (I can find no other way to describe this)

analysis of DNA databases: a wealth of information locked away
could calculate frequencies (real, not imagined or miscounted)

could calculate error rates of DNA profiling
deeper analysis could reveal even more about errors in forensic DNA

could calculate real searching statistics
instead of relying on the inflated statistical approach now used

all against all for 6 loci, 7, loci, etc., how many loci (and which loci) do we actually need for identity?

how probative is a 6 locus profile? a 7 locus profile? etc.,

plus a whole lot more . . .

Evaluating forensic DNA II: laboratory statistics *(or lack thereof)*

lack of basic accounting data –

the money: what does a lab spend on kits, salaries, maintenance, disposables (tips, gloves, etc.,), equipment, etc.,

the results: how many searchable profiles did they develop? how many cases did they process? what kind of cases? how many samples? how many questioned samples, how many reference samples?

failures: how many samples from each case type fail to provide a searchable DNA profile?

success: how many samples from each case type do provide a searcheable profile?

how many samples give mixtures? from what kind of cases?

how much does a searchable DNA profile cost for each sample/case type?

how many cases of each case type does an analyst process?

what is the success rate of the lab *v.* the success rate of a given analyst?

what is the relative success rate and sample throughput for this lab?

no lab statistics = lack of benchmarks

no lab statistics = lack of best practices

no benchmarks = reliance on anecdotal evidence

anecdotes ≠ science

Structural problems: bias, 'the thin blue line', prosecutorial influence, protected environment

Solution: separate forensic DNA laboratories from law enforcement

Response: *Good luck with that!*

Training problems: lack of scientific background, experience

Solution: graduate programs, protected R&D positions

Response: *Seems reasonable – who is going to start the process? who is going to fund it?*

Technical and procedural problems: outdated and legacy methods,

Solution: better training, laboratory metrics, best practices approaches

Response: *Seems reasonable – funding agencies should demand metrics for all work*

“Every great cause begins as a movement,

becomes a business,

and eventually degenerates into a racket.”

Eric Hoffer (1902-1983)

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