



# Forensic Science Improvement in the United States

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## Wrongful convictions and claims of false or misleading forensic evidence

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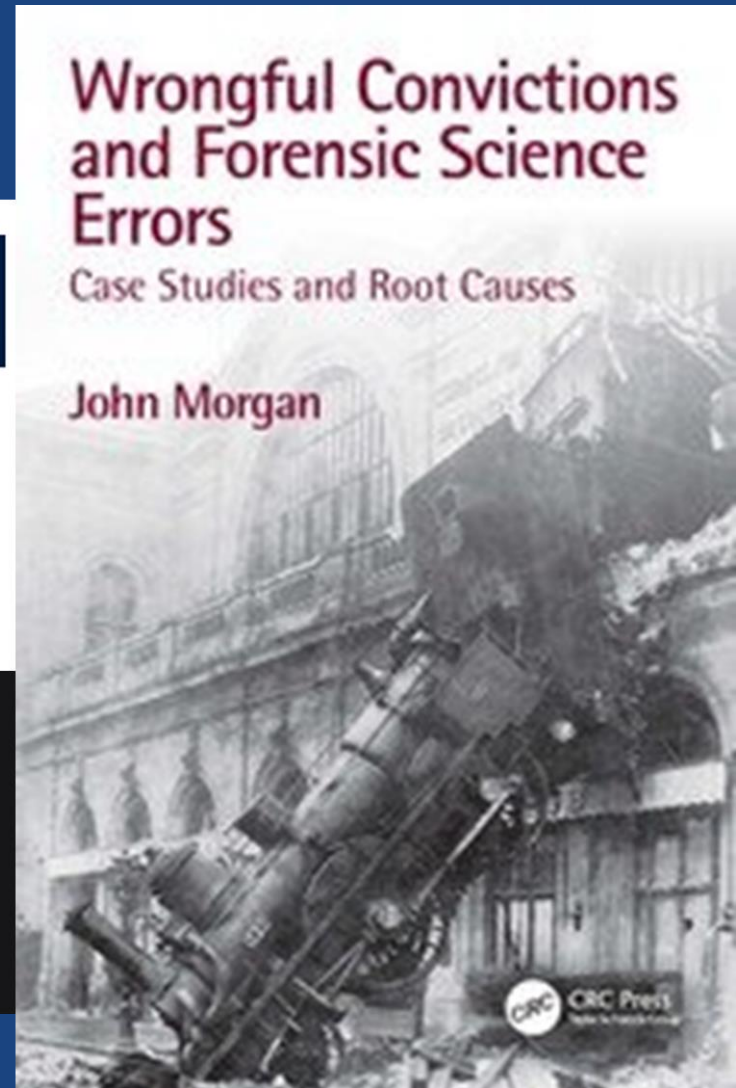
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# Wrongful Convictions and Forensic Science Errors

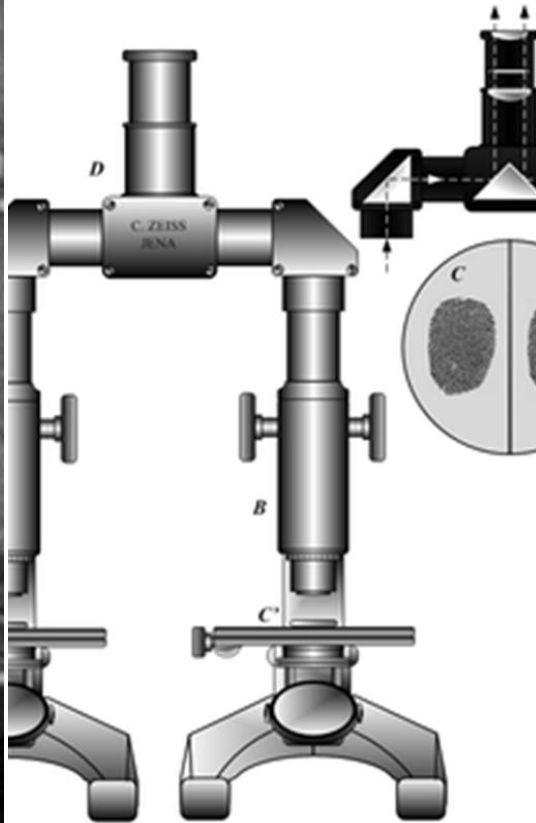
Case Studies and Root Causes

John Morgan





# Calvin Goddard



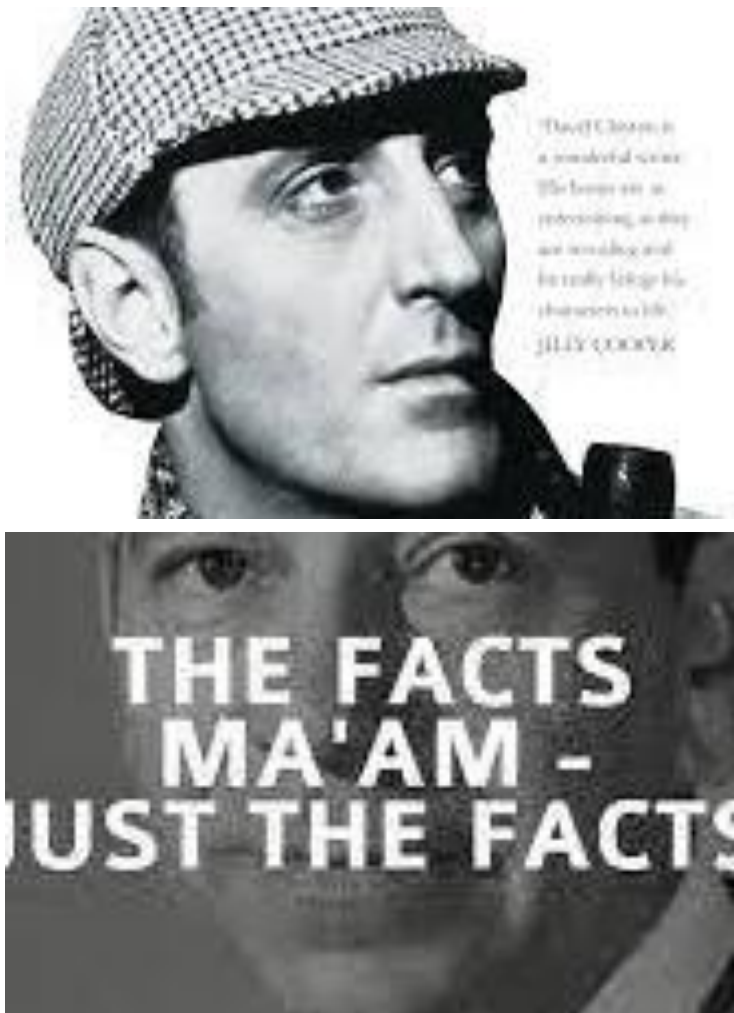
Founded modern ballistics, including comparison microscope and standards for interpretation.

(Gravelle, Waite, Fisher)

Helped the FBI set up the FBI Crime Laboratory.

Inspired by Stielow-Green wrongful conviction.

# Philosophy of crime detection



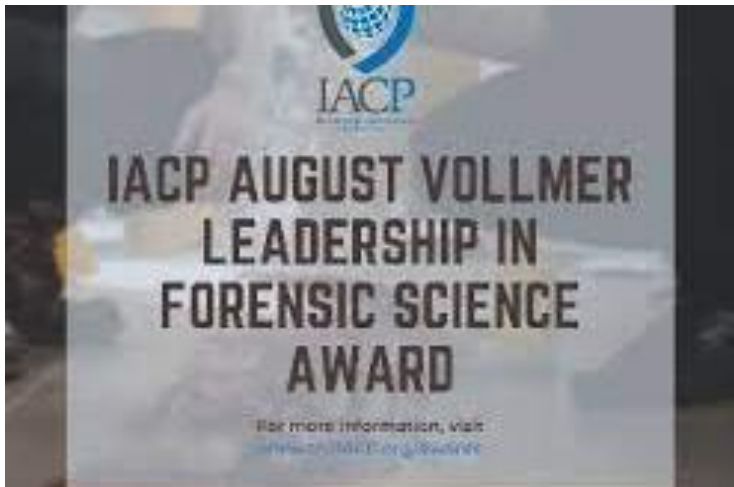
Scientific positivism: All true knowledge is scientific.

Forensic science can establish facts and solve crime.

Professional-era policing emphasized rapid response and solving crime over community interaction.

Police helped to establish crime laboratories to establish facts to support convictions in support of the police mission.

# Implications




Crime laboratories proliferated under law enforcement control.

- Money and resources
- Political support
- Leadership
- Bias

We're seeing the positive and negative results of this history.

# DNA exonerations change everything.



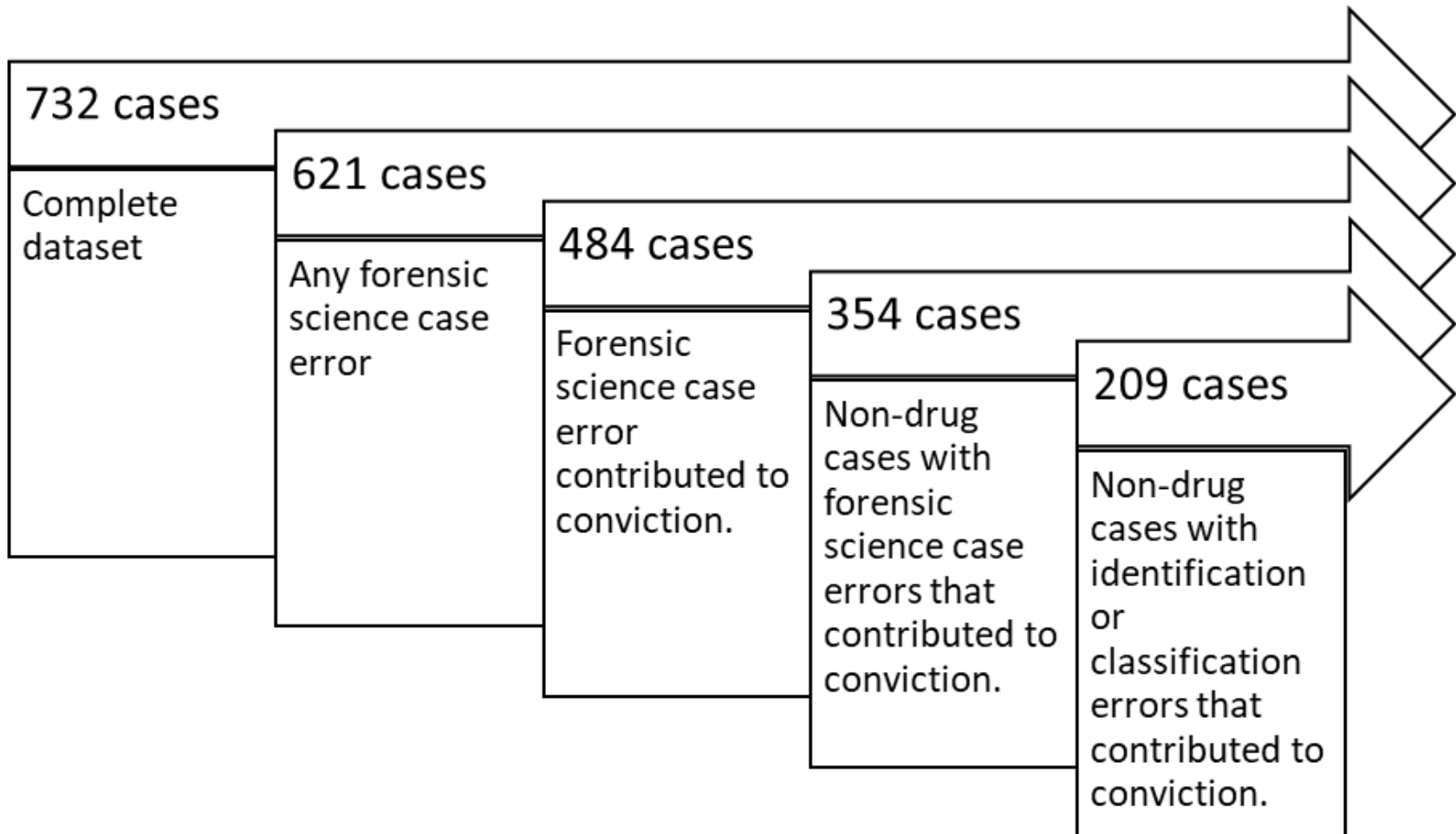
Demonstrated that hair, serology, and other methods had much less probative value than believed.

1989: First DNA exoneration (Gary Dotson) and more than 500 defendants since then.

Over 3000 documented wrongful convictions (National Registry of Exonerations)

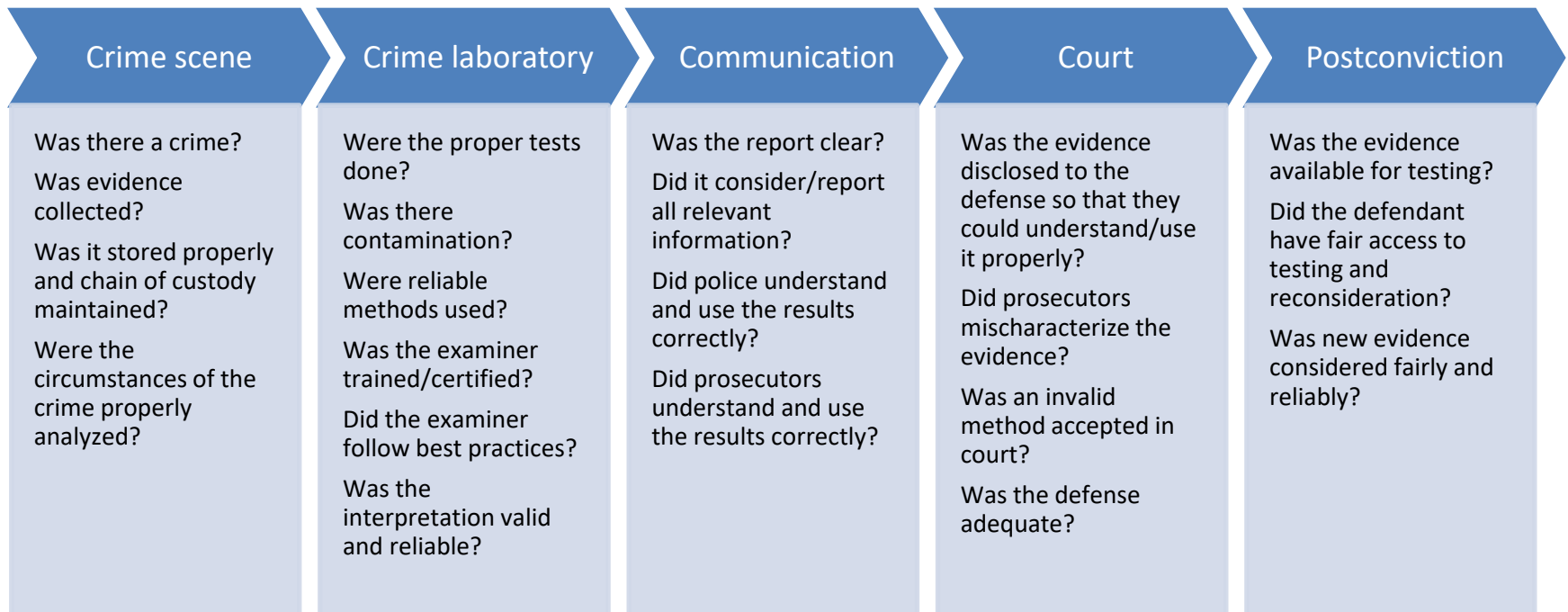
PCR/STR methods did not come into wide use until the 2000's, though less discriminating methods were available in the 1990's.

# Overview





# System errors found in wrongful convictions



# Some key ideas

Wrongful convictions are most closely aligned with poorly communicated forensic results, failure to follow best practices, and system errors in the use of forensic results.

Practice standards and quality assurance mitigate the risk of forensic errors in wrongful convictions.

- Certified examiners working in public labs may be contributing to fewer wrongful convictions over the last 20 years.
- Many examiners practice outside the governance mechanisms associated with public forensic science organizations.

# The role of science and technology

Scientific and technological improvements have provided more reliable and probative forensic results to prevent wrongful convictions.

- The majority of wrongful convictions associated with false or misleading forensic evidence may have been prevented with improvements in science or technology.
- Researchers should take great care to validate new methods and specify the limitations on their probative value. Methods should be independently replicated prior to introduction into court.
- Novel techniques may not be recognized and subject to judicial review. Courts may not recognize the difference between a trained forensic examiner adhering to science-based standards and an expert presenting unvalidated scientific testimony.

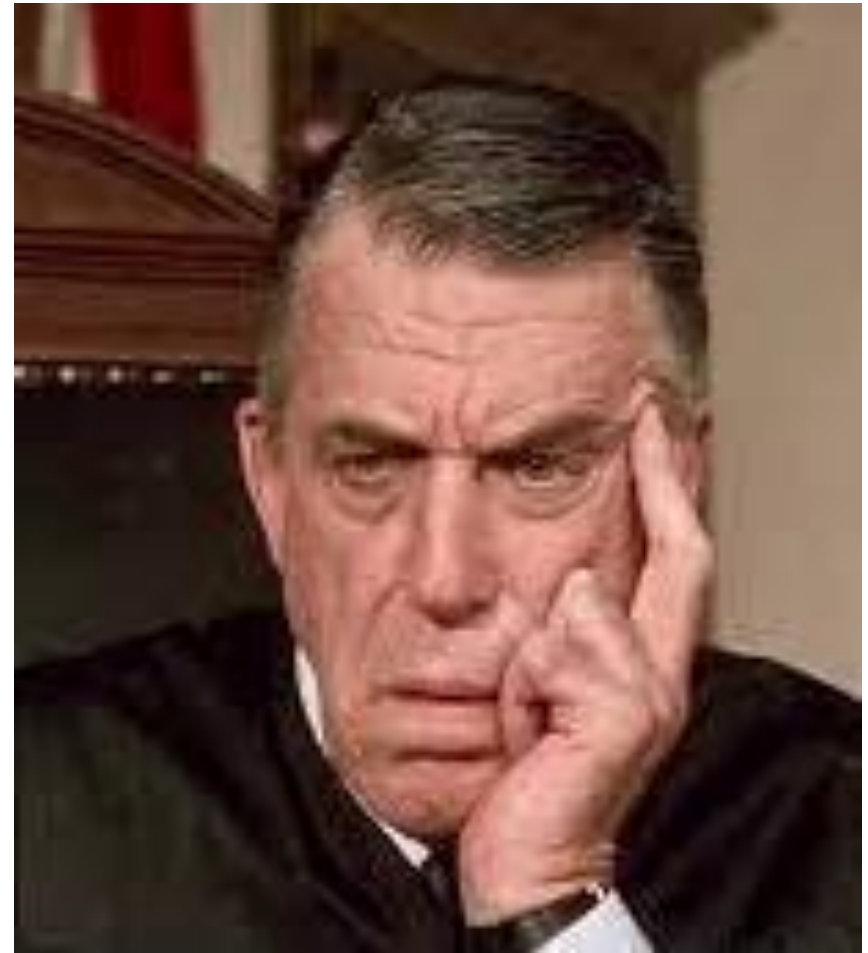
# The court system is poorly equipped to review scientific evidence.

Judges and lawyers lack formal training in science but are expected to understand complex questions concerning forensic science.

Lawyers may misrepresent evidence or perform poorly on direct/cross examination.

Inadequate defense is closely associated with a majority of wrongful convictions with forensic evidence case errors.

- 584 examinations were associated with inadequate defense (out of 835 examinations with case errors)
- No independent review or examination that could have impacted the probative value of forensic evidence: 317 instances
- Exculpatory evidence was known but ignored: 81 instances



# Forensic science improvement

## Key NIJ publications

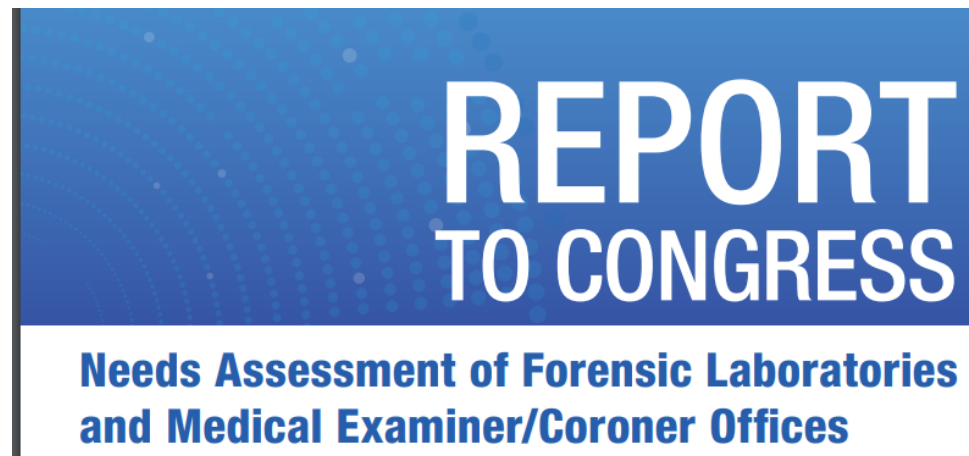
1999

2006

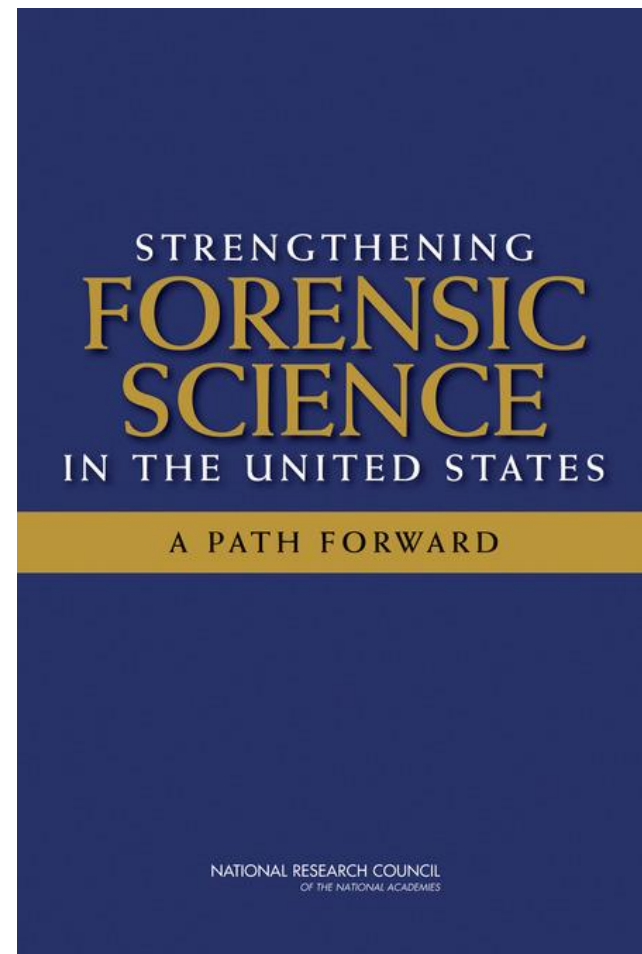
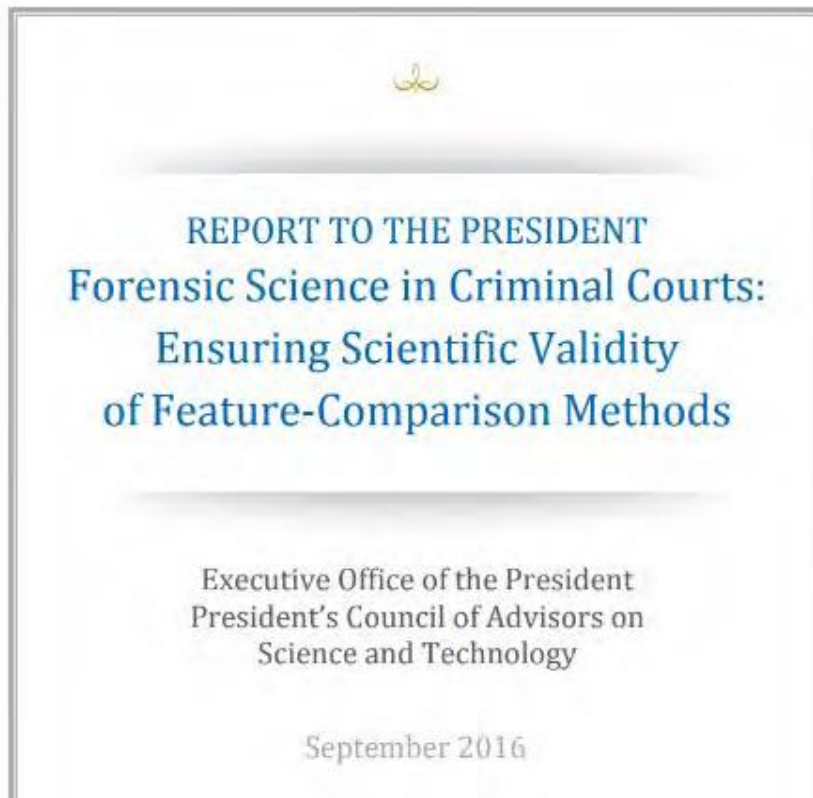
2019



**Status and Needs of Forensic Science Service  
Providers: A Report to Congress**



# Notable external reviews



# Notable initiatives



NATIONAL COMMISSION ON FORENSIC SCIENCE



# What do they want?

## National Research Council 2009

1. National Institute of Forensic Science
2. Standardized Terminology and Reporting
3. More and Better Research
4. Best Practices and Standards
5. National Code of Ethics
6. Improve Education and Training
7. Support Medicolegal Death Investigation
8. National AFIS Standards
9. Homeland Security Forensic Progress



# What do they want?

## PCAST 2016

1. Assessment of foundational reliability
2. DNA mixture analysis
3. OSAC improvement
4. Forensic science R&D strategy
5. FBI research improvement
6. DOJ feature-comparison reporting
7. DOJ testimony guidelines
8. Admissibility improvements

# What do they want?

## NIJ 2006 report

1. Capacity building
2. Continuing education
3. Professional and accreditation standards
4. Collaboration among federal, state, and local providers
5. Research and development

## NIJ 2019 report

1. Better collaboration among forensic scientists and users of forensic analyses
2. Medicolegal resource gaps (shortage of certified FP's)

**HOW'S IT GOING?**

**NOW**

Yesterday

# Capacity building

Staffing, training, technology, and funding

- Many wrongful convictions are associated with funding and capacity shortfalls. The “role bias” of crime labs within LE agencies may be mitigated by the availability of resources within that environment.

Forensic science professionals tend to emphasize capacity improvements much more than external researchers and observers.

- NRC and PCAST reports did not address it.
- Interventions related to cognitive bias—such as blinded reviews—may exacerbate resource constraints.

# Capacity building

2002: 2.7 million service requests

- Backlog of 500K service requests (BJS)
- DNA reference samples: 205,000

2014: 3.6 million service requests

- Backlog of 570K service requests (BJS)
- DNA reference samples: 908,000

WVU FORESIGHT program estimated that there was a \$640M annual deficit in public lab funding in 2017. Annual budget of labs was \$1.7B in 2014 (BJS).

- Labs expended \$250M to deal with opioid crisis in 2015.
- Federal investments (DNA, Coverdell) are less than \$200M/year.

# Bottom line

Capacity has improved.

Resources have not kept pace with demand.

The implementation of improvement initiatives should take into account resource constraints.

- How do we prioritize?
- How can we use improvement to achieve efficiencies?

# Governance

Governance gaps allow unreliable evidence to be introduced into criminal proceedings.

- Key priority of the NRC 2009 report. The National Institute for Forensic Sciences has not been seriously considered.
- Primary reason for the establishment of the National Commission on Forensic Science: “...strengthening the validity and reliability of the forensic sciences...”

Federal governance mechanisms are inherently weak in the US system.

- Some work: Voluntary OSAC standards, NDIS requirements.
- Some not so much: NCFS, grant funding requirements

Accreditation and quality assurance mechanisms have been successful.

- 88% of public labs are accredited

State-level mechanisms may work better, but we are just learning how these might adapt to the unique environment in each state.

- The NAFSB may help!

# Standards

Standards development was one of the few items that were consistently listed as a priority by NIJ, NRC, and PCAST.

- The development and implementation of standards has had a profound impact on fire investigation and firearms comparison in the wake of wrongful convictions.

OSAC now has 152 proposed or published standards covering 22 disciplines and 1 interdisciplinary category.

- Standards Developing Organizations include NFPA, ASTM, ISO, and ASB (associated with AAFS).



# Standards implementation

## NIST OSAC survey report of June 2022

- 128 providers had partially or fully implemented at least one ASB standard.
- Most common implementations were ISO 17025 and ASTM E2917-19a (training) and ASTM seized drug standards. No ASB standard had been implemented by more than 38% of respondents.

44% of respondents: standards implementation is an important priority, but resource challenges are a barrier to implementation.

- Lack of personnel, instrumentation, facilities, validation, and training

# Testimony standards

## National Center on Forensics

A Program of the National Institute of Justice

### Post-PCAST Court Decisions Assessing the Admissibility of Forensic Science Evidence

This database gathers federal and state court decisions issued after the release of a 2016 report by the President's Council of Advisors on Science and Technology titled [Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods](#) (the "PCAST Report").

The PCAST Report, among other things, defined and established guidelines for what its authors termed "foundational validity" and applied those guidelines to certain forensic science disciplines: DNA, latent fingerprints, firearms/toolmarks, footwear, bitemarks, and hair microscopy. The authors opined that only the following forensic science disciplines met their standard for "foundational validity": (1) DNA samples from one individual, (2) a mixture of DNA from no more than two individuals, and (3) latent fingerprints. The PCAST report judged the remaining forensic science disciplines to lack

Overview

News and Announcements

Project Partners

Educational Resources

Publications and Reports

**Post-PCAST Court Decisions Assessing the Admissibility of Forensic Science Evidence**

OSAC and DOJ have made significant progress in the development of testimony standards.

DOJ Uniform Language of Testimony and Reports (ULTR) cover 17 disciplines.

- DOJ has also implemented a testimony review process.
- Courts have generally admitted any examiner who conforms to ULTR standards in testimony.

Admissibility v. weight-of-evidence continues to be a debate for legal consideration of forensic evidence.

# Admissibility

PCAST called for changes to FRE 702 because issues of accuracy, foundational validity, and validity as applied may be unclear to judges.

- December: Minor amendment and committee note will take effect.

Amendment: Proponent must demonstrate that testimony is “more likely than not” reliable. The rule shifts assessment from how expert applied a method to an assessment of their “opinion.”

“The amendment is especially pertinent to the testimony of **forensic experts** in both criminal and civil cases. Forensic experts should avoid assertions of absolute or 100% certainty—or to a reasonable degree of scientific certainty—if the methodology is subjective and thus potentially subject to error. In deciding whether to admit forensic expert testimony, the judge should (where possible) receive an estimate of the **known or potential rate of error** of the methodology employed, based (where appropriate) on studies that reflect how often the method produces accurate results. Expert opinion testimony regarding the weight of feature comparison evidence (i.e., evidence that a set of features corresponds between two examined items) must be limited to those inferences that can reasonably be drawn from a **reliable application of the principles and methods**. This amendment does not, however, bar testimony that comports with substantive law requiring opinions to a particular degree of certainty.”

# Evidence discovery

FRE 16—evidence discovery and inspection—was revised in 2022.

- A much more important issue in wrongful convictions than scientific reliability.
- Disclosures must be a complete statement of the substance and basis for any expert opinions and the expert's qualifications.
- Experts must sign their own disclosures.
- Many legal practitioners may lack the scientific background required to understand/use the material. This problem echoes PCAST's concern.

# Bottom line

There has been significant improvement in standards and testimony guidelines.

- Resources issues have limited implementation.

Governance has changed in limited ways.

- Accreditation, some increased independence, some increase in state-level oversight.

Admissibility has not changed considerably.

- Courts remain highly variable in their ability to discern the limits of scientific reliability.

# Pattern evidence

PCAST report was highly critical of pattern evidence and found that only latent print analysis had a basis for scientific reliability. But said the error rate was 1 in 160 or 1 in 306 and higher than would be “expected by many jurors.”

- PCAST’s interpretations have been criticized.

Since 2016, there have been numerous “black box” studies across the disciplines that have established error rates for fingerprints, palmprints, firearms, etc.

- Certified pattern evidence examiners are unlikely to make identification errors. This is supported by wrongful conviction data. Inconclusives, suitability determinations, and underutilization remain a concern.

# Cognitive bias

PCAST and NRC both cited subjectivity of pattern evidence disciplines. The FRE 702 rule also specifies this issue.

- There is very limited data about the impact of bias and the extent to which changes have been enacted by labs, systems, or states.

Research indicates that contextual bias may be an issue in any discipline. Many policy and practice changes have been suggested, but labs face difficulty to implement responsive changes within resource constraints.

- Many subjective interpretation disciplines use context as an inherent part of their work (fire, pathology, medicine).

Forensic intelligence approaches (rapid DNA, genetic genealogy, ballistic imaging, etc.) may produce more reliable investigations but also make contextual information management more difficult.

# Statistical interpretation

NRC and PCAST supported expansion of statistical interpretation of error rates. ENFSI has adopted guidelines that require the use of statistical methods in most circumstances.

- Statistical interpretation frameworks have been incorrectly justified as a way to eliminate error, cognitive bias, or subjective interpretation. Misleading statistics are a common element of wrongful convictions, especially in relation to hair comparison and serology.
- Uptake of statistical interpretation has been slow in the US—partly due to training gaps and partly due to the limitations of statistical tools.



# Probabilistic genotyping—the big exception

PG used or under validation in over 80% of US DNA laboratories.

- Responsive to PCAST concerns about DNA mixture interpretation. These concerns aligned with wrongful conviction cases (e.g., Kerry Robinson in GA).
- PCAST and others have criticized the validation of PG systems, although these issues have been largely addressed by research and standards (e.g., SWGDAM).
- Miscommunication of results, incorrect prosecutor/defense hypotheses, and interlaboratory variability remain concerns.

# Trying to help fact-finders make sense of statistics

SWGDM's Ad Hoc Working Group on Genotyping Results Reported as Likelihood Ratios recommended that LR's be complemented by verbal qualifiers.

The DNA typing results for Item 1 are 23 billion times more likely if they originated from

- *“SMITH and an unknown, unrelated individual than if they originated from two unknown, unrelated individuals. This analysis provides very strong support for the proposition that SMITH is a contributor to the DNA obtained from Item 1.”*

This language follows the ENFSI guidelines and Evett's theoretical framework but lacks an empirical basis.

**Table 1. Scale of verbal qualifiers for reporting likelihood ratios**

<b>LR for <math>H_p</math> Support and <math>1/LR</math> for <math>H_d</math> Support</b>	<b>Verbal Qualifier</b>
1	Uninformative
2 – 99	Limited Support
100 – 9,999	Moderate Support
10,000 – 999,999	Strong Support
$\geq 1,000,000$	Very Strong Support

# Medicolegal death investigation

The 2009 NRC and 2019 NIJ “needs” reports highlighted continuing gaps in death investigation.

- Less than 400 full-time, board-certified forensic pathologists. 30 to 40 new each year.
- Many conduct over 350 autopsies/year, well in excess of NAME guidelines.
- Forensic pathology issues continue to be associated with wrongful convictions at a similar rate over many decades.

Recommendations: more funding, improved federal collaboration, standards development, universal accreditation, and the use of board-certified FP’s for all autopsies.

- CDC and NIJ have established a Medicolegal Death Investigation Interagency Working Group.

# MDI working group priorities

Developing technologies and other solutions to facilitate information and data sharing between MDI offices, toxicology laboratories and federal, state, and local entities.

Reducing the shortage of forensic pathologists.

Coordinating MDI research priorities.

Strengthening MDI investigations, including death scene investigations and autopsies.

Supporting postmortem toxicology screening and analysis, particularly for novel synthetic drugs.

## STRENGTHENING THE MEDICOLEGAL- DEATH-INVESTIGATION SYSTEM: IMPROVING DATA SYSTEMS

Executive Office of the President

National Science and Technology Council



September 2016

# Scientific research

NRC 2009 called for additional funding for research related to forensic science and highlighted the need for research related to “uncertainties and bias.”

- NIJ research funding has averaged \$20M/year since 2009.
- NIJ 2019 assessment: “Continuous development of a national forensic science research infrastructure is hindered by a lack of dedicated federal grant funding needed to advance the speed, accuracy, and scope of forensic analysis of all types of evidence.”
- Cognitive science research has been done but tends to exhibit poor empirical methodology.
- New investments: NIST CSAFE, NSF CARFS, FBI black box work

PCAST called for “black box” research to establish foundational validity and validity-as-applied of the disciplines, especially for pattern evidence. Significant progress has been made in this regard.

# Education and training

Wrongful convictions are closely associated with untrained examiners who failed to follow the standards of their field. Issue was highlighted by NIJ and NRC reports.

- PCAST: Training is not enough. Proficiency testing and certification are inadequate or lack rigor. More funding needed to train judges and assist the academic community.

FEPAC formed in 2004 and accredits 51 colleges and universities—but only two west of Texas.

- Labs specify the need for degrees but not necessarily from FEPAC-accredited institutions. Some forensic leaders feel graduates are not adequately prepared for forensic practice by undergraduate programs.

Training budgets are 0.5% of lab operating budgets. Training gaps are exacerbated by S&T changes. Coverdell and other funds have increased but remain small compared to the need, especially with the casework demands competing with training time.

# Code of ethics

NRC 2009 called for national code of ethics.

- ASCLD has had code of ethics since 2005
- ASCLD has established leadership training over the last decade. ASCLD has prioritized organizational improvement initiatives.
- DOJ has largely adopted NCFS recommendations.



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# NRC 2009 priorities: how's it going?

Recommendation	Completely subjective assessment
National Institute of Forensic Science	Not implemented
Standardized Terminology and Reporting	Significant. NIST OSAC and DOJ ULTR
More and Better Research	Limited. Funding levels stagnant
Best Practices and Standards	Limited. OSAC work is substantial but implementation has lagged due to resource constraints.
National code of ethics	Significant
Improved education and training	Limited, insufficient data
Support medicolegal death investigation	Limited
National AFIS standards	Limited
Homeland security forensic progress	Unknown, no data available

# PCAST priorities: how's it going?

Recommendation	Completely subjective assessment
Assessment of foundational reliability	Significant (black box studies)
DNA mixture analysis	Significant. Probabilistic genotyping
OSAC improvement	Significant
Forensic science R&D strategy	Limited. Funding levels stagnant
FBI research improvement	Limited.
DOJ feature-comparison reporting	Significant. ULTR
DOJ testimony guidelines	Significant. Testimony review proces
Admissibility improvements	None

# NIJ report priorities: how's it going?

Recommendation	Completely subjective assessment
Capacity-building	Limited. Demand/backlogs are higher.
Continuing education	Limited. Coverdell helps, but insufficient
Professional and accreditation standards	Significant
Collaboration among federal, state, and local providers	Limited
Research and development	Limited. Funding levels stagnant
Better collaboration among forensic scientists and users of forensic analyses	Limited, some progress related to sexual assault kit backlogs
Medicolegal resource gaps (shortage of certified FP's)	None

**Thank you!**  
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