

SEXUAL ASSAULT CASES: EXPLORING THE IMPORTANCE OF NON-DNA FORENSIC EVIDENCE

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Investigating and prosecuting sexual assault crimes is much more complicated than simply performing DNA testing.



After an evening of hanging out with friends, a 20-year-old woman decided to get a ride home with her ex-boyfriend. They had broken up several months before but had remained friendly with each other. During the drive, the young man started talking about how they should get back together because he missed the relationship they once had. However, she was not interested and wanted to remain friends.

Only blocks from her home, the man stopped the car and suddenly turned violent. Grabbing her neck, he began to force himself on her. As he ripped off her clothes, she managed to grab a small pocket knife from her purse, but he took the knife from her and broke it. He then dragged her by the legs out of the car and raped her in a nearby wooded area. Afterwards, he stole her credit cards and drove away. The woman managed to walk to her home and called the police to report the rape. She was brought to the hospital, where she was interviewed, photographed, and examined for several hours. Evidence was collected for a sexual assault kit (SAK).

In cases in which probative DNA evidence is not readily available or offers little or no meaning, an accumulation of non-DNA forensic evidence can be what ultimately leads to a successful conviction.

To many, this would seem like a clear-cut case of sexual assault. However, a case is not determined by what one believes, but rather by what the investigation shows and what can be proved.

When the police spoke with the young man, he described a very different series of events. He claimed that he and his ex-girlfriend had a fun evening at the party and that she came on to him and wanted to get back together. He admitted to taking some drugs that evening and thought he blacked out briefly. When he woke up, he claimed that his ex-girlfriend was on top of him and they had consensual rough sex. He said their clothes were everywhere, and he must have accidentally taken her credit cards when he gathered his things. He denied ever handling a knife.

So what really happened that evening? In a case like this of “he said, she said,” investigators look to the forensic evidence to help them piece together what may have actually happened. The investigation and exploration of the totality of the evidence collected are critical to unravelling the allegations and discerning whether charges can be filed.

DNA Is Not Always Probative or Present

DNA analysis has had an unprecedented impact on the criminal justice system. It has propelled investigations forward and made charging alleged perpetrators easier. Science can now provide focus or direction to an investigation, help develop a case theory, and clear suspects or those wrongfully convicted with more certainty. As a result, the criminal

justice community has become highly reliant on DNA analysis.

Many believe DNA analysis is the death knell for most criminal defendants, and juries and lawyers alike *expect* to see DNA evidence presented during a trial.¹ It has been reported that 72 percent of jurors anticipate seeing DNA in a sexual assault trial² and that juries are 33 times more likely to convict when presented with DNA evidence.³ This raises serious concerns, as the need to provide probative DNA evidence in sexual assault cases has become increasingly more important if a prosecutor hopes to secure a conviction.

But what happens in a “he said, she said” case like the one described above, where the alleged suspect is not a stranger and, in fact, admitted to having sexual intercourse? In a random sampling of 602 reported rapes, 36.2 percent were among intimates or family members and 42.7 percent were friends or acquaintances.⁴ In such cases where the suspect and victim are acquainted, consent is pivotal to determining whether a crime was committed, and the presence of the suspect’s DNA may not necessarily be informative.⁵

Or what about cases in which no DNA is found? Recently, a great deal of attention has been placed on testing SAKs, especially those collected years ago and never submitted to a forensic laboratory. Although testing SAKs for DNA is important, the reality is that DNA is sometimes not found or is not eligible for entry into the Combined DNA Index System (CODIS),⁶ which is composed of databases maintained by the Federal Bureau of Investigation that allow DNA profiles to be compared to one another. For example, to be uploaded into CODIS, DNA profiles must meet certain quality standards, and sometimes the DNA is old, degraded, not in sufficient quantity, or otherwise unviable. Additionally, the sample may not be directly probative (such as in cases in which the alleged perpetrator admitted having sexual contact).⁷ Based on NIJ’s SAK-related projects (see exhibit 1), DNA profiles that were of sufficient quality for CODIS upload were obtained in only 38 percent of more than 7,000 SAKs submitted for DNA testing.⁸ Also,

Exhibit 1: Data From NIJ SAK Programs

Study	Number of SAKs Tested	Number of CODIS Entries	% of Profiles Eligible for CODIS Entry	CODIS Hits	CODIS Hits/ CODIS Entries (%)	CODIS Hits/Total Number of SAKs (%)
Los Angeles ¹	1,948	699	36%	347	50%	18%
Detroit ²	1,595	785	49%	455	58%	29%
New Orleans ³	1,008	256	25%	139	54%	14%
Houston ⁴	491	213	43%	104	49%	21%
FBI (as of 1/5/2017) ⁵	1,584	808	51%	306	38%	19%
Marshall (as of 10/5/2016) ⁶	588	149	25%	39	26%	7%
Total	7,214	2,910		1,390		
Average			38%		46%	18%

Notes

1. Joseph Peterson et al., "Sexual Assault Kit Backlog Study," Final report to the National Institute of Justice, grant number 2006-DN-BX-0094, June 2012, NCJ 238500, <https://www.ncjrs.gov/pdffiles1/nij/grants/238500.pdf>.
2. Rebecca Campbell et al., "The Detroit Sexual Assault Kit (SAK) Action Research Project (ARP)," Final report to the National Institute of Justice, grant number 2011-DN-BX-0001, December 2015, NCJ 248680, <https://www.ncjrs.gov/pdffiles1/nij/grants/248680.pdf>.
3. Mark Nelson, *Analysis of Untested Sexual Assault Kits in New Orleans*, 2012, Washington, DC: U.S. Department of Justice, National Institute of Justice, <https://www.ncjrs.gov/pdffiles1/nij/242312.pdf>; FBI-funded interagency agreement with NIJ 2013MUR6019.
4. William Wells, Bradley Campbell, and Cortney Franklin, "Unsubmitted Sexual Assault Kits in Houston, TX: Case Characteristics, Forensic Testing Results, and the Investigation of CODIS Hits," Final report to the National Institute of Justice, grant number 2011-DN-BX-0002, April, 2016, NCJ 249812, <https://www.ncjrs.gov/pdffiles1/nij/grants/249812.pdf>.
5. For more information on the NIJ-FBI Sexual Assault Kit Partnership, go to NIJ.ojp.gov, keyword: nj-fbi.
6. For more information, go to http://www.hpdww.com/initiatives_sexual-assault-kit-testing.php.

performance metrics collected from NIJ's Solving Cold Cases with DNA program showed that about 48 percent of the cases with tested biological evidence yielded any DNA profile.⁹ NIJ's results are consistent with other national findings. For example, a recent South Dakota SAK project that tested 504 kits yielded only 254 DNA profiles,¹⁰ and half of the

3,542 kits tested in a Colorado project yielded DNA profiles.¹¹

As new and emerging technologies advance across the criminal justice system and provide necessary links for locating and apprehending assailants, criminals continue to learn about forensic science

Non-DNA forensic evidence can be used to identify a suspect, associate a suspect with a victim, associate a suspect with a crime scene, and corroborate other evidence.

techniques and have started to “get smart.” Many sex offenders, for example, now use gloves, masks, and condoms, and some even have a victim shower before they leave a scene — all in the hope of thwarting law enforcement’s ability to collect potential DNA evidence. Take, for example, the case of Colorado serial rapist Marc O’Leary, who committed several sexual assaults in multiple jurisdictions. He ordered women to shower and brush their teeth, and he took the bedding and clothing with him. However, he executed his crimes with the same *modus operandi*, leaving behind shoe prints, glove pattern evidence, and other non-DNA evidence that was used to connect him to the crime scenes.¹²

The Value of Non-DNA Evidence

In cases in which probative DNA evidence is not readily available or offers little or no meaning to the allegations being made, an accumulation of non-DNA forensic evidence can be what ultimately leads to a successful conviction.

A wealth of other forensic evidence may be invaluable in sexual assault investigations; some examples are trace evidence (e.g., hairs, fibers, glass, paint, or soil), toxicology, cell phone and digital forensics, and impression and pattern evidence (e.g., fingerprints, shoe prints, tire marks, and handwriting). One study showed that in addition to bodily fluids, fingerprints and hairs are the most common types of physical evidence collected and examined in sexual assault casework.¹³ The Bureau of Justice Statistics also reported that from 2005 through 2010, sexual assault offenders were armed with a gun, knife, or other weapon in 11 percent of rape or sexual assault

victimizations.¹⁴ All of these types of non-DNA forensic evidence can be used to identify a suspect, associate a suspect with a victim, associate a suspect with a crime scene, and corroborate other evidence.

Based on the evidence identified and collected during the sexual assault investigation in our case example, the knife was tested and contained prints of both the victim and the suspect, even though the suspect denied handling the knife. The young woman had no alcohol in her system, and the medical exam showed she had cuts, bruises, and tears to her body and genitals — 33 documented injuries. Her clothing was torn and her pants zipper was broken. Toxicology results revealed that the suspect tested positive for methylenedioxymethamphetamine (MDMA, commonly known as Ecstasy), a drug that is known to produce feelings of increased energy, pleasure, and distorted sensory and time perception. The investigation also revealed that the suspect sent the victim text messages in the days after the assault, even though he denied having any contact with her.

Therefore, when DNA is not available or not probative, other forensic evidence can help establish the facts. The most important take-away is that a case should be developed using the totality of the evidence rather than relying solely on DNA, which allows one to recreate an entire series of events; corroborate or refute testimony from the victim, suspect, or other witnesses; and ultimately include or exclude a potential suspect. Based on the accumulated evidence described in this case scenario, criminal charges would likely result,¹⁵ as there is evidence showing injury and violence, corroboration of the victim’s account of the attack, and evidence that would disprove aspects of the suspect’s version of events.

Prosecutors also rely on scientific evidence to establish and prove their cases during prosecution. Research has shown that “analysis of forensic evidence was associated with [increased] case referrals to prosecutors, [and] charges filed.”¹⁶ Evidence from a medical forensic exam can be key in the prosecution of a sexual assault case. A study conducted in 1999 found a relationship where the victims’ injuries were seen as one of the most

Drug-Facilitated Sexual Assaults

Drug-facilitated sexual assaults (DFSA) are increasing nationwide, especially among college-age women.¹ Alcohol and drugs are common contributors to sexual assault, especially assaults committed by acquaintances, because they can cause diminished capacity and make a person vulnerable to their surroundings. Depending on the drug, effects can be felt as quickly as 20 minutes after ingestion and can cause amnesia for up to 8 hours. Whether a “date-rape” drug such as alprazolam (Xanax) or gamma-hydroxybutyric acid (GHB) is unknowingly ingested or a mainstream party drug such as alcohol, methylenedioxymethamphetamine (Ecstasy), or marijuana is used voluntarily, the identification of these substances through toxicological testing may offer a jury compelling evidence indicating a victim’s inability to have consented to the advances of an alleged assailant.²

Ensuring that toxicological testing is completed in a timely manner³ is paramount due to the rapid metabolic process and excretion rates of many drugs.⁴ NIJ is currently supporting research to explore new ways of extending the testing window to allow drugs to be detected days or even weeks after ingestion.⁵ This novel research is looking at complexes formed between proteins in the blood and the drug, which remain in the blood for weeks after ingestion. This could offer evidence of a victim’s incapacitation in cases where reporting of the assault is delayed.

Toxicological testing is complicated by the emergence over the past decade of “designer” drugs, which may not be detectable using a lab’s usual methods.⁶ NIJ-supported research has also confirmed that many of these drugs break down very rapidly in blood or urine, even in samples that have already been collected and refrigerated or frozen, as they would be in a suspected DFSA case.⁷ Drugs also are broken down into metabolites by the body, and little is known about the metabolites of these new drugs. Often, these metabolites are present at higher levels than the original drug, so it is critical to be able to identify them if present in the body of a DFSA victim. NIJ is committed to supporting research to identify these metabolites, determine which new drugs are being abused, and develop new methods for identifying these emerging drugs.⁸

Notes

1. Steven Lawyer et al., “Forcible, Drug-Facilitated, and Incapacitated Rape and Sexual Assault Among Undergraduate Women,” *Journal of American College Health* 58 no. 5 (October 2010): 453–460, <http://www.tandfonline.com/doi/abs/10.1080/07448480903540515>. Recent news reports describe incidents on college campuses such as the

continued on the next page

significant predictors in the decision to prosecute in nonstranger cases.¹⁷ The presence of injuries seemed to influence a prosecutor’s decision-making, as the documented appearance of violence makes it more difficult to assert consent.

The presence of forensic evidence also strengthens the likelihood of conviction at trial and has been

associated with harsher sentences.¹⁸ Prosecutors are better able to recreate events and illustrate a theory to a jury by connecting testimonial evidence and forensic evidence. More specific to sexual assault cases, research has indicated that cases with physical evidence were more likely to lead to arrest, be referred to the prosecutor, be charged, and result in conviction than cases without evidence.¹⁹ Sometimes

Drug-Facilitated Sexual Assists (continued)

University of Missouri (UM) and Northwestern University where fraternities were using date-rape drugs at parties and for initiations. At UM, the Delta Upsilon fraternity initiation process allegedly required new members to drug women in order to incapacitate them and engage in sexual activity. The fraternity is even alleged to have supplied the drugs. These examples are not unique; a 2015 study from the University of Pennsylvania notes that 6 percent of the students were sexually assaulted while they were incapacitated. Claire Landsbaum, "University of Missouri Fraternity Allegedly Forced New Members to Give Women Date-Rape Drugs," *The Cut*, October 14, 2016, <https://www.thecut.com/2016/10/misouri-fraternity-allegedly-gave-out-date-rape-drugs.html>; Joe Sterling, "Sex Assault, Date-Rape Drug Allegations Rattle Northwestern," *CNN Wire*, February 7, 2017, <http://www.cnn.com/2017/02/07/us/northwestern-date-rape-drug-reports/index.html>; and David Cantor et al., *Report on the AAU Campus Climate Survey on Sexual Assault and Sexual Misconduct* (New York: Association of American Universities, 2015), https://www.aau.edu/sites/default/files/%40%20Files/Climate%20Survey/AAU_Campus_Climate_Survey_12_14_15.pdf.

2. State laws define consent differently, but some factors to consider are age, disability, intoxication, and unconsciousness. "Legal Role of Consent," *Rape, Abuse & Incest National Network*, <https://www.rainn.org/articles/legal-role-consent>.
3. A Sexual Assault Evidence Collection Program through the Massachusetts Executive Office of Public Safety and Security supplies a toxicology kit to test for the presence of substances as part of their SAK; however, toxicology testing in Massachusetts is conducted only within 96 hours of the assault. Theodore P. Cross et al., "Forensic Evidence and Criminal Justice Outcomes in a Statewide Sample of Sexual Assault Cases," Final report to the National Institute of Justice, grant number 2011-WG-BX-0005, September 2014, NCJ 248254, <https://www.ncjrs.gov/pdffiles1/nij/grants/248254.pdf>.
4. Some drugs are no longer in the blood after 4-6 hours; others can remain in the urine up to 48 hours because of the way the body metabolizes the substance. "Drug Facilitated Sexual Assault," *West Virginia Foundation for Rape Improvement Services*, <http://www.fris.org/SexualViolence/DrugFacilitated.html>.
5. Richard A. Gilliland, Carolina Moller, and Anthony P. DeCaprio, "Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) -Based Analysis of *In Vitro* Covalent Modifications of Glutathione (GSH) and Peptide Thiols by Drugs of Abuse," proceedings of the 69th Annual Scientific Meeting of the American Academy of Forensic Sciences, New Orleans, LA, February 2017, <https://www.aafs.org/wp-content/uploads/2017Proceedings.pdf>.
6. Anthony P. DeCaprio, W. Lee Hearn, and Madeleine J. Swortwood, "Comprehensive Forensic Toxicological Analysis of Designer Drugs," Final report to the National Institute of Justice, grant number 2011-DN-BX-K559, December 2013, NCJ 244233, <https://www.ncjrs.gov/App/Publications/abstract.aspx?ID=266314>.
7. Lindsay Glicksberg, Kelsie Bryand, and Sarah Kerrigan, "Identification and Quantification of Synthetic Cathinones in Blood and Urine Using Liquid Chromatography-Quadrupole/Time of Flight (LC-Q/TOF) Mass Spectrometry," *Journal of Chromatography B* 1035 (2016): 91-103; and Megan Grabenauer, Katherine N. Moore, and Brian F. Thomas, "Characterization of Designer Drugs: Chemical Stability, Exposure, and Metabolite Identification," Final report to the National Institute of Justice, grant number 2012-R2-CX-K001, April 2016, NCJ 249855, <http://www.ncjrs.gov/App/publications/abstract.aspx?ID=272015>.
8. Amanda L.A. Mohr, Melissa Friscia, and Barry K. Logan, "Identification and Prevalence Determination of Novel Recreational Drugs and Discovery of Their Metabolites in Blood, Urine and Oral Fluid," Final report to the National Institute of Justice, grant number 2013-DN-BX-K018, October 2016, NCJ 250338, <http://www.ncjrs.gov/App/publications/abstract.aspx?ID=272498>; Alex J. Krotulski, Amanda L.A. Mohr, Melissa Friscia, and Barry K. Logan, "Application of SWAT™ Acquisition for Broad Based Forensic Toxicology Drug Screening of Oral Fluid Using Liquid Chromatography Quadrupole Time-of-Flight Mass Spectrometry (LC-QTOF)," poster presentation to the Society of Forensic Toxicologists, October 2016, http://www.soft-tox.org/files/meeting_abstracts/SOFT_2016_meeting_abstracts.pdf; and Sarah Kerrigan, "Designer Amphetamines in Forensic Toxicology Casework," Final report to the National Institute of Justice, grant number 2008-DN-BX-K126, March 2013, NCJ 241439, <https://www.ncjrs.gov/pdffiles1/nij/grants/241439.pdf>.

the availability or admission of forensic evidence, merely to show its existence, can be essential as well. Regardless of the context or support the evidence may offer to a case, juries continue to expect personally identifying forensic evidence; for example, Ric Ridgway, chief prosecutor for the 5th Judicial Circuit in Central Florida, received feedback from jurors after an acquittal asserting, "Well, there wasn't any DNA or fingerprints."²⁰

The Need for Research and Innovative Non-DNA Forensic Methods

Countless types of forensic evidence are used to investigate and prosecute thousands of crimes annually. According to the Bureau of Justice Statistics, in 2014 the nation's 409 crime labs received an estimated 3.8 million requests for forensic services. Only 9 percent of these requests were for forensic biology casework such as from a crime scene (which includes DNA testing), and 24 percent were for DNA analysis of reference samples collected from convicted offenders and arrestees that were then added to the national database.²¹ This means 67 percent of the total requests were solely for non-DNA forensic analysis.

Exhibit 2 illustrates the types of evidence analysis requested from publicly funded laboratories between 2009 and 2014. Clearly there is a demand for non-DNA forensic evidence. Toxicology testing, or the identification of drugs or other chemicals in the human body, was the third most requested of all forensic evidence, after forensic offender/arrestee DNA sample testing. Controlled substance analysis of drugs or chemicals regulated by the government, such as cocaine, heroin, marijuana, or certain prescription drugs, was first.

Toxicological analysis has become critical in the prosecution of drug-facilitated sexual assault cases as another way to nullify an assertion of consent. To further advance science and ensure that evidence can be identified and used appropriately, NIJ supports and funds a diverse portfolio of forensic science research to develop highly discriminating, accurate,

reliable, cost-effective, and rapid methods for the identification, analysis, and interpretation of physical evidence for criminal justice purposes. (See sidebar, "Drug-Facilitated Sexual Assaults.")

Fingerprint evidence can be instrumental when trying to place a person at a crime scene, such as from the knife used during the assault in the opening case scenario. As seen in exhibit 2, requests for fingerprint analysis have only increased. Other than DNA, fingerprints are one of the most common types of evidence that can link a perpetrator to an assault. NIJ has a rich research and development portfolio focused on new technologies related to the development of latent prints, as well as studies related to the accuracy and reliability of fingerprint examinations.²² (See sidebar, "What You Can't See Might Solve the Case.")

In certain cases of sexual assault, chemical examination of condom lubricants may also prove surprisingly valuable, as many assailants are serial perpetrators and routinely use condoms to avoid leaving DNA evidence. NIJ recently funded a project at the University of Central Florida to improve the characterization and classification of condom lubricants recovered in sexual assault cases and build databases of lubricant mass spectra and infrared spectra that will be available for use in casework.²³ This type of analysis can help determine if the perpetrator used a condom and, in some cases, forensic scientists can compare the lubricant recovered from the victim with condoms seized from the suspect.

Additionally, analyzing the various materials used during an assault can provide important information; for example, physically matching a piece of tape collected from a bound victim with evidence recovered from a suspect. Recognizing that duct tape is commonly used in abductions, homicides, and the construction of explosive devices, NIJ provided funding for researchers at the University of California, Davis to perform a statistical evaluation on matching the torn and cut ends of duct tape. They examined 1,800 torn tape specimens and 400 cut tape specimens and concluded that the mean accuracy

Exhibit 2: Requests for Services Received and Completed by Publicly Funded Forensic Crime Labs, by Type of Request, 2009 and 2014

Type of Request	Received				Completed			
	2009		2014		2009		2014	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All requests	4,020,000	100%	3,783,000	100%	3,830,000	100%	3,646,000	100%
Controlled substances	1,358,000	34	1,265,000	33	1,261,000	33	1,197,000	33
Crime scene	188,000	5	171,000	5	188,000	5	170,000	5
Digital evidence	33,000	1	25,000	1	33,000	1	24,000	1
Firearms/toolmarks	147,000	4	154,000	4	132,000	3	142,000	4
Forensic biology casework	260,000	6	333,000	9	239,000	6	296,000	8
Forensic biology from convicted offender/arrestee samples	1,053,000	26	908,000	24	1,027,000	27	904,000	25
Impressions	11,000	--	7,000	--	11,000	--	7,000	--
Latent prints	270,000	7	295,000	8	274,000	7	301,000	8
Questioned documents	13,000	--	9,000	--	12,000	--	9,000	--
Toxicology	629,000	16	566,000	15	606,000	16	554,000	15
Trace evidence	58,000	1	49,000	1	47,000	1	41,000	1

Note: Totals exclude requests outsourced to other labs. The number of requests completed in 2009 and 2014 exceeded the number of requests received during that year for certain disciplines because the completed requests included some requests received prior to that year. Numbers are rounded to the nearest thousand. Detail does not sum to total due to rounding.

--Less than 0.5 percent.

Source: Bureau of Justice Statistics, Census of Publicly Funded Forensic Crime Laboratories, 2009 and 2014.

What You Can't See Might Solve the Case

Latent fingerprints hold the potential to associate an individual perpetrator with high probability to a crime scene. In 1991, a 78-year-old widow, Lucille Johnson, was attacked and severely beaten in her home. Johnson died at the scene due to multiple blunt force injuries, and several personal possessions were missing. Through an NIJ Solving Cold Cases with DNA award,¹ the jurisdiction of Unified Police of Greater Salt Lake was able to reexamine the case records and evidence associated with Johnson's homicide.

As a result, a CODIS match identified John Sansing as the contributor to a DNA sample recovered from evidence associated with the homicide. However, in addition to the DNA evidence, the cold case detectives noted that investigators recovered Lego building blocks from the scene. Johnson's family insisted that she was a meticulous housekeeper and would not have left the toys out unless one of her grandchildren had visited.

The suspect was currently incarcerated for the brutal death of a social worker who was bringing supplies to the suspect's family. Particularly disturbing is that he sexually assaulted and killed the social worker in the presence of his young children. Johnson's family stated that she would not have let a stranger into her house unless perhaps the stranger had a child, such as Sansing's then 5-year-old son. Using this information, detectives compared and matched the fingerprints found on the Lego blocks to the now-adult son of the suspect. The fingerprints on the Legos and the DNA CODIS match led to the arrest of John Sansing for the murder of Lucille Johnson. Sansing pled guilty to the Utah homicide; he is still incarcerated in Arizona and sentenced to death for the social worker's homicide.²

Notes

1. National Institute of Justice, "Solving Cold Cases with DNA" award to the Unified Police of Greater Salt Lake, grant number 2012-DN-BX-K029, 2012.
2. Colleen Curry, "Lego Fingerprints Helped Solve Cold Case Murder," *ABC News* (August 29, 2014), <http://abcnews.go.com/US/lego-fingerprints-helped-solve-cold-case-murder-authorities/story?id=25178331>.

for correctly matching specimens ranged from 98.58 to 100 percent for torn tape and from 98.15 to 99.83 percent for cut tape.²⁴ NIJ also awarded Florida International University a grant to evaluate and validate the scientific reliability of chemical methods for profiling tapes. Using a collection set of more than 250 tapes (duct and electrical), researchers are applying rigorous analytical methods to examine the variations within and between rolls of tape to understand the relation to tape manufacturing and distribution.²⁵

Finally, body fluid identification of stains (such as differentiation of semen, saliva, vaginal fluid, and menstrual blood) can be critical in identifying probative evidence and corroborating the events of an assault. Serological methods used for body fluid identification can provide more meaningful information about the nature of the crime. Even in the absence of definitive DNA results, confirmation for the presence of body fluids — semen or saliva, for example — in a victim or on a particular piece of evidence may prove significant in building a case or corroborating

Body Fluid Identification

Methods used to examine sexual assault evidence — such as the use of an alternate light source (e.g., ultraviolet light) to visually detect semen stains, histological microscopic examination to observe spermatozoa, chemical methods based on the detection of seminal fluid acid phosphatase, and immunological methods based on the detection of p30 (or prostate-specific antigen) — have been described in scientific literature for more than three decades. Other common body fluids for which presumptive identification methods are routinely employed include blood and saliva. Such methods are typically based on the detection of hemoglobin (blood) through a phenolphthalein (Kastle-Meyer) test and the detection of saliva through an α -amylase test. Regardless of whether serological tests are performed as a screening step prior to DNA testing or to provide additional substantive case information after DNA testing, they are instrumental tools for forensic investigators.

Technology companies continue to develop new kits and tools to make body fluid identification more discriminatory, faster, and less labor intensive. More recent commercial advances boast the ability for multiplex testing to identify multiple body fluids simultaneously in a relatively short amount of time.

Meanwhile, NIJ continues to fund innovative research to address the need for new tools to better identify body fluids while minimizing the consumption of evidence. With NIJ funding, spectroscopic methods used in other analytical chemistry applications are being applied to forensic science to develop new methods. Attenuated total reflection (ATR) Fourier transform infrared (FT-IR) spectroscopy has the potential for nondestructive blood stain analysis in laboratory and crime scene settings.¹ Raman spectroscopy coupled with chemometrics has been shown to be able to discriminate between peripheral blood, menstrual blood, saliva, semen, sweat, and vaginal fluid, without consuming any sample.² Advances are also being made in surface-enhanced Raman spectroscopy for the identification of dried blood, semen, vaginal fluid, saliva, and urine.³ NIJ funds are also being used to develop multiplex methods to identify multiple body fluids (e.g., human saliva, urine, seminal fluid, vaginal fluid, peripheral blood, and menstrual blood) using mass spectrometry.⁴ As forensic laboratory interest in massively parallel sequencing technologies increases, NIJ's investments into research projects that support sequence analysis-based methods to identify body fluids are becoming more relevant to potential practice.

events. This evidence may provide a prosecutor with the source attribution information needed to connect specific forensic evidence with testimonial accounts. For example, if a victim asserts that an assailant bit her neck and ejaculated on her jeans, the body fluid identification process would allow one to assert that the fluid collected from the victim's neck was saliva and biological material on the victim's clothing was, in fact, semen and not from casual contact.²⁶ Body fluid evidence can also be significant in instances where a suspect states that the presence of blood was a result of consensual sex with a partner in menses. In these cases, identification of the stain as venous

blood might refute this claim and instead support that a violent act had occurred.

As with all science, body fluid identification can be advanced. For example, the power to more accurately differentiate one body fluid from another may be increased, meaning that presumptive or preliminary identifications can be moved toward more confirmatory conclusions. Also, the time and effort required to complete testing could be decreased and sample consumption and destruction could be minimized. Currently, all commonly used testing methods involve exhausting a portion of the evidence

Body Fluid Identification (continued)

Scientific methods used to identify body fluids, as currently performed or as they may be in the future, are important factors that can influence the crime scene investigation, inform the forensic laboratory processing, and affect court outcomes. Regardless of the perceived adequacy of existing methods, it is critical to continue to advance the field, building on new scientific findings and technologies that continue to evolve rapidly. As the field moves forward, it is critical to also continue to generate publicly available scientific knowledge that rigorously tests new methods, validates that the methods can do what they purport, and ultimately supports the foundation for the new tools and technologies that are adopted into practice.

Notes

1. Ewelina Mistek and Igor K. Lednev, "Identification of Species' Blood by Attenuated Total Reflection (ATR) Fourier Transform Infrared (FT-IR) Spectroscopy," *Analytical and Bioanalytical Chemistry* 407 no. 24 (September 2015): 7435-7442.
2. Claire K. Muro, Kyle C. Doty, Luciana de Souza Fernandes, and Igor K. Lednev, "Forensic Body Fluid Identification and Differentiation by Raman Spectroscopy," *Forensic Chemistry* 1 (August 2016): 31-38; Kyle C. Doty, Claire K. Muro, Justin Bueno, Lenka Halamkova, and Igor K. Lednev, "What Can Raman Spectroscopy Do for Criminalistics?" *Journal of Raman Spectroscopy* 47 no. 1 (January 2016): 39-50; and Gregory McLaughlin and Igor K. Lednev, "In Situ Identification of Semen Stains on Common Substrates via Raman Spectroscopy," *Journal of Forensic Sciences* 60 no. 3 (May 2015): 595-604.
3. Jennifer Fore et al., "Recent Progress in the Development of a Surface-Enhanced Raman Spectroscopy (SERS) Platform for Rapid Identification of Trace Amounts of Human Body Fluids," proceedings of the 68th Annual Scientific Meeting of the American Academy of Forensic Sciences, B184, 2016; and Kathryn Anne Zegarelli et al., "Surface-Enhanced Raman Spectroscopy (SERS) for the Forensic Analysis of Vaginal Fluid," proceedings of the 68th Annual Scientific Meeting of the American Academy of Forensic Sciences, E39, 2016.
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sample to test for each body fluid presumed to be present. NIJ continues to support and fund innovative research to address the need for new tools to better identify body fluids while minimizing the consumption of evidence. (See sidebar, "Body Fluid Identification.")

Empowering Criminal Justice Stakeholders and Victims Through Forensic Science

Forensic evidence as collected and analyzed is unbiased, as the science does not judge. Science is about revealing facts. For example, finding a

fingerprint at the scene of a crime does not imply guilt or innocence; it is offered only to identify that a person was at a particular location or touched a particular item at some point, not whether he or she committed a crime. Any inferences drawn depend on the criminal justice practitioner using the information. Solving sexual assault crimes — bringing rapists to justice and supporting victims — is much more complicated than simply testing SAKs.

All aspects of criminal justice practice — from the initial investigation through adjudication — can benefit from DNA and non-DNA forensic evidence. However, processing and analyzing forensic evidence

in a timely and efficient manner are critical. Delays in testing make the use of forensic evidence impractical during the investigative phase; therefore, many law enforcement officers do not realize the full potential of all forensic evidence as a tool for developing new leads in investigations.²⁷ For example, NIJ's *National Best Practices for Sexual Assault Kits: A Multidisciplinary Approach* emphasizes the importance of the identification, collection, and preservation of all evidence, not just DNA, from victims and crime scenes. The forensic science community has a responsibility to provide investigators with the answers they need, when they need them. As technology and testing methods advance, new tools may become available, throughput will increase, and the benefits of forensic analysis on various types of evidence may be better realized earlier in investigations.

Within this complex process, the forensic evidence itself affects many of the decision points, including but not limited to decisions to arrest, referral for and filing of charges, plea arrangements, and court outcomes. The justice system has come to rely a great deal on various types of evidence to help link a suspect to a crime scene and to the victim, but often in sexual assault cases, forensic evidence is also used to corroborate or refute statements of fact. That is, the findings from forensic testing are also used to substantiate a victim's or suspect's account. In rape cases where a DNA profile from a suspect is recovered, the findings may affirm the victim's testimony and even empower the victim, because their story is now corroborated.²⁸

It is critical to provide increased training for law enforcement, prosecutors, and judges on the application and scientific validity of forensic evidence. In addition, increasing the capacity of our nation's laboratories to process *all* forensic evidence and advancing policies and best practices for the collection and processing of evidence are crucial to the timely and accurate testing and delivery of results to the law enforcement and judicial communities. Furthermore, the criminal justice system needs sound research that not only advances current forensic practice but also substantiates the existing validity

of forensic evidence analyses, so all involved can be assured that the evidence being proffered against someone is sound. Evidence has a voice; we must ensure that science continues to be just and unbiased and that those who are listening are trained and accountable.

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For More Information

Read NIJ's "National Best Practices for Sexual Assault Kits: A Multidisciplinary Approach" at NIJ.ojp.gov, keyword: safer.

Read about the NIJ-FBI sexual assault kit partnership at NIJ.ojp.gov, keyword: nj-fbi.

To learn more about rape and sexual assault, go to NIJ.ojp.gov, keyword: rape.

Read about sexual assault on campus at NIJ.ojp.gov, keyword: campus assault.

Read four brochures to help address issues with unsubmitted sexual assault kits in your jurisdiction at NIJ.ojp.gov, keyword: llkits.

Notes

1. "Many attorneys, judges, and journalists have claimed that watching television programs like CSI has caused jurors to wrongfully acquit guilty defendants when no scientific evidence has been presented. The mass media quickly picked up on these complaints. This so-called effect was promptly dubbed the 'CSI effect,' laying much of the blame on the popular television series and its progeny." Donald E. Shelton, "The 'CSI Effect': Does It Really Exist?" *NIJ Journal* 259 (March 2008): 1-7, NCJ 221500, <https://www.ncjrs.gov/journals/259/pages/csi-effect.aspx>.
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4. Joseph Peterson et al., "Sexual Assault Kit Backlog Study," Final report to the National Institute of Justice, grant number 2006-DN-BX-0094, June 2012, NCJ 238500, <https://www.ncjrs.gov/pdffiles1/nij/grants/238500.pdf>.
5. This should not preclude investigators from obtaining a DNA sample from the suspect to upload into the FBI's Combined DNA Index System (CODIS) database, which may help to establish whether the suspect has a history of "acquaintance rapes" or has committed other unsolved crimes.
6. As of January 2017, CODIS requires 20 core loci for DNA data to be included in the DNA database. Federal Bureau of Investigation, "Frequently Asked Questions on CODIS and NDIS," February 17, 2017, <https://www.fbi.gov/services/laboratory/biometric-analysis/codis/codis-and-ndis-fact-sheet>. Basic criteria for a CODIS entry are as follows: documentation that a crime was committed, a documented request to collect consensual partners/elimination samples, the evidence produced a DNA profile that was foreign to the victim, and the DNA profile meets the FBI's data quality requirements.
7. An assailant's DNA profile may be probative in a sexual assault case where consent is at issue, if the DNA profile links the perpetrator to other similar crimes.
8. Studies represent unique projects with unique circumstances and should not be compared against one another; the results are an illustration of consistency that less than 50 percent of SAKs produce CODIS-eligible profiles.
9. Cases reviewed within NIJ's Cold Case program are not limited to sexual assaults.
10. Seth Augenstein, "South Dakota Clears Rape Kit Backlog – 16 Percent CODIS Hits," *Forensic Magazine* (January 23, 2017).
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13. Joseph L. Peterson, Steven Mihajlovic, and Michael Gilliland, *Forensic Evidence and the Police: The Effects of Scientific Evidence on Criminal Investigations*, Washington, DC: U.S. Government Printing Office, 1984; cited in Donald Johnson et al., "Use of Forensic Science in Investigating Crimes of Sexual Violence: Contrasting Its Theoretical Potential With Empirical Realities," *Violence Against Women* 18 no. 2 (2012): 193-222, <http://journals.sagepub.com/doi/pdf/10.1177/1077801212440157>.
14. Michael Planty et al., *Female Victims of Sexual Violence, 1994-2010*, Special Report, Washington, DC: U.S. Department of Justice, Bureau of Justice Statistics, March 2013, NCJ 240655, <https://www.bjs.gov/content/pub/pdf/fvsv9410.pdf>.
15. Specific charges would be dependent on state laws.
16. Tasha A. Menaker, Bradley A. Campbell, and William Wells, "The Use of Forensic Evidence in Sexual Assault Investigations: Perceptions of Sex Crimes Investigators," *Violence Against Women* 23 no. 4 (2017): 399-425.
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22. "Awards Related to Forensics and Research and Development," National Institute of Justice, <https://www.ncjrs.gov/funding/awards/pages/awards-list.aspx?tags=and%3aForensics%2cResearch%20and%20Development>.

23. Ibid.
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 25. "Characterization and Comparison of Tape Evidence Using Elemental Profiling Methods and Chemometric Analyses," National Institute of Justice, <https://external.ojp.usdoj.gov/selector/awardDetail?awardNumber=2015-DN-BX-K050&fiscalYear=2015&applicationNumber=2015-90943-FL-DN&programOffice=NIJ&po=NIJ>.
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