Evidence Collection in Child Abuse Cases

A Primer for Investigators and Prosecutors

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Overview

This guide will inform investigators and prosecutors about major advances in evidence collection and processing as they relate to child homicide, child sexual abuse (CSA), and other forms of child abuse and neglect (CAN). Current best practices and advances in the field will be discussed, alongside critiques and concerns regarding the future landscape of forensic evidence collection in child maltreatment cases.

Disclaimer: This document describes general best practices for collecting various types of evidence. Please check specific jurisdictional and laboratory policies for any deviations or discrepancies related to evidence collection or timing of collection.[1]

Zero Abuse Project

Zero Abuse Project works to eliminate child abuse in all of its forms. A 501(c)(3) organization, Zero Abuse Project is committed to transforming institutions to more effectively prevent, recognize, and respond to child sexual abuse. Efforts focus on cross-disciplinary education and training, advocacy for systemic legal change, guidance for survivor support, and leadership on emerging technologies. Zero Abuse Project also addresses the intersection of child maltreatment and child sexual abuse.

About the Author

Tyler Counsil, EdD, is Director of Zero Abuse Project's Center for Child Advocacy Studies (CAST), where he oversees undergraduate and graduate programming, develops and delivers evidence-based training, and mentors faculty through curriculum mapping, course design, cross-discipline training, and administrative advocacy. Dr. Counsil also provides training and technical assistance through Zero Abuse's Trauma-informed Prosecutor Project, and serves on SAMHSA's Project FORECAST simulation committee for the University of Missouri-St. Louis. He has collaborated on several peer-reviewed publications, and he most recently co-authored a chapter in the *Handbook of Interpersonal Violence and Abuse Across the Lifespan*. A 10-year veteran of forensic laboratory work, Dr. Counsil has served as Criminal Justice and Forensic Science Chair at Oakland City University and the Indiana Institute of Technology, and has developed Academy of Criminal Justice Sciences and Forensic Science Education Programs Accreditation Commission-compliant programs. Dr. Counsil presently serves as a first responder in the state of Indiana, acting as certified medicolegal death investigator for Daviess County, where he works with local frontline agencies to thoroughly investigate cause and manner of death and is the Sudden Unexpected Infant Death Investigation (SUIDI) training liaison for the Indiana Department of Health.

[1] Sexual Assault Forensic Examiner Technical Assistance. 2021. B8. Evidence Collection. Retrieved from https://www.safeta.org/page/KIDSSectionB8.

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Introduction

DNA in Demand

In the realm of investigation and prosecution, the presence and application of relevant evidence is tantamount to resolving a case. Forensic science has broadened evidentiary scope significantly, particularly since the breakthrough establishment of forensic DNA profiling—first proposed as a feasible method for establishing identity in 1984 and subsequently used in a court of law in 1987.[2] Based on the latest crime-laboratory data, the demand for evidence processing in forensic biology casework increased approximately 28% in a mere five years, along with a near 10% uptick in latent print examination requests.[3] Applications involving forensic science are rapidly increasing in criminal investigation.

The surge in demand for evidence processed in a crime lab using validated scientific principles is not without cause. A 2010 study on the role and impact of forensic evidence on case resolution gives us key insight into why: Joseph Peterson and associates found that, out of the 81 cases examined, 67 resulted in a conviction. Of those convictions, 87.3% had some kind of physical evidence collected, and nearly half (44.8%) involved evidence that was processed forensically.[4] Thus, pursuing forensic evidence in the absence of other persuasive physical evidence greatly increases the chances of conviction. This trend in conviction rates has held since the early 1980s, when the clearance rate for criminal cases was three times higher for cases with forensically processed evidence than those without forensic evidence—despite them being a fraction (20-30%) of the total caseload.[5]

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[2] The Royal Society. No Date. Forensic DNA Analysis: A Primer for Courts. Retrieved August 4, 2020 from https://royalsociety.org/-/media/about-us/programmes/science-and-law/royal-society-forensic-dna-analysis-primer-for-courts.pdf.

[3] Durose, M.R., Burch, A.M. (*BJS Statisticians*), Walsh, K. & Tiry, E. (*Urban Institute*). 2014. Publicly Funded Forensic Crime Laboratories: Resources and Services, 2014. Retrieved August 4, 2020 from https://www.bjs.gov/content/pub/pdf/pffclrs14.pdf.

[4] Peterson, J., Sommers, I., Baskin, D., & Johnson, D. 2010. The Role and Impact of Forensic Evidence in the Criminal Justice Process. Retrieved August 4, 2020 from https://www.ncjrs.gov/pdffiles1/nij/grants/231977.pdf.

[5] Peterson, J.L., Mihajlovic, S., & Gilliland, M. 1984. Forensic Evidence and the Police: The Effects of Scientific Evidence on Criminal Investigations. U.S. Department of Justice. Retrieved August 4, 2020 from https://play.google.com/store/books/details?id=r3KjNmsIl08C&rdid=book-r3KjNmsIl08C&rdot=1; Peterson, J.L., Hickman, M.J., Strom, K.J., & Johnson, D.J. 2012. Effect of Forensic Evidence on Criminal Justice Case Processing. *J Forensic Sci* (51:1), S78-S90. https://doi.org/10.1111/1556-4029.12020.

A higher conviction rate for cases with physical evidence analyzed through scientific methodology has two roots: (1) rigorous, scientific methods have the potential to reconstruct detailed, accurate events and supply incriminating information in lieu of other sources of evidence; and (2) quite simply, triers of fact and investigative professionals alike have grown to emphasize (perhaps overly so) the ability of forensic science to provide definitive results pointing to specific offenders.[6] In fact, the "CSI Effect" has been well-documented as a barrier to success for prosecutors, who fear that jurors may be less likely to convict without scientifically analyzed evidence.[7] The concern with this phenomenon is valid. A 2008 study of 1,000 jurors found that almost half (46%) of the triers of fact expected some form of scientific evidence in court, with 22% of study participants expecting DNA evidence and 36% expecting latent prints in *each* criminal case.[8] Child maltreatment and child homicide cases are not exempted from these expectations. In a study of 733 child abduction murder cases, the odds of solvability (i.e., probable cause for an arrest) were increased by a factor of 1.4 if evidence items were collected from a crime scene.[9]

In keeping with these findings, a study by Cross et al. (2022) found that 75% of cases involving sexual assault where DNA retrieved from crime scene evidence matched the alleged suspect resulted in either a bench trial or guilty plea.[10] The study went on to demonstrate that the presence of DNA can exclusively push a case toward prosecution, and also indicated that DNA discovery isn't limited to the initial evidence collection—DNA can be found throughout an investigation as new information leads to detecting biological evidence that may otherwise have been overlooked. With respect to biological evidence in sexual assault investigations, Cross succinctly explains: "this evidence does really matter."[11]

In light of these studies, evidence tethered to scientific interpretation could greatly benefit child maltreatment cases. More should be done to educate prosecutors and other investigative personnel about the need to consistently explore, collect, and process high-quality physical evidence that may result in DNA profiles in order to improve case resolution.

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[6] Durose, M.R., 2014. *Publicly Funded Forensic Crime Laboratories*. https://www.bjs.gov/content/pub/pdf/pffclrs14.pdf.
[7] Legal Information Institute. No Date. CSI Effect (Definition). *Cornell Law School*. Retrieved August 4, 2020 from https://www.law.cornell.edu/wex/csi_effect.
[8] Shelton, D.E. 2008. The 'CSI Effect': Does it Really Exist? *National Institute of Justice*. Retrieved August 4, 2020 from https://nij.ojp.gov/topics/articles/csi-effect-does-it-really-exist.
[9] Brown, K.M., & Keppel, R.D. 2011. Child Abduction Murder: The Impact of Forensic Evidence on Solvability. *Journal of Forensic Sciences* (57:2), 353-363. https://doi.org/10.1111/j.1556-4029.2011.01970.x.
[10] Cross TP, Siller L, Vlajnic M, Alderden M. The Relationship of DNA Evidence to Prosecution Outcomes in Sexual Assault Cases. Violence Against Women. February 2022. doi:10.1177/10778012221077124.
[11] Forrest, S. 2022. Study Examines the Impact of DNA Evidence in Sexual Assault Prosecutions. Illinois News Bureau. Retrieved from https://news.illinois.edu/view/6367/1871771146.

Challenges and Consequences

Corroborating Evidence Considerations

As established, forensic evidence is important for case outcomes. However, the drive for forensic evidence has also led to two critical challenges. First, overindulgence in "smoking gun" evidence that can yield forensic results has led to multidisciplinary teams (MDTs) effectively ignoring the utility and bearing of corroborating evidence. Too often, for example, investigators focus solely on stereotypical physical evidence and locations.[12] They may over-emphasize traditional forensic evidence—seminal material, blood, hair, or touch DNA—or improperly and, thus, futilely target those items outside the logical scope of a given case. Investigators and professionals who follow their own presumptions based on prior cases without exploring the victim statement for clues may miss prime evidence—clothing hidden in a laundry basket or biological fluids pulled from an item used to inflict harm that might otherwise be overlooked in a cursory review of the crime scene.

A bias toward biological evidence may also interfere with investigators pursuing other, non-traditional types of corroborating evidence. For example, a child may disclose details regarding the physical location of maltreatment (e.g., wall color, carpet descriptions, bedsheets). These features could not only be photographed to corroborate the disclosure narrative, but they may also contain biological evidence that is not traditionally considered in a case—for instance, the perpetrator's skin cells ("touch DNA") on a teddy bear the child said they were holding during the assault. Combined with victim testimony and reconstructive photos and imagery, this corroborative biological evidence can help powerfully transport jurors and reconstruct the crime scene. As a result, corroborative evidence can be as, if not more, empowering to the triers of fact as stereotypical biological evidence and should not be abandoned.

Neglecting proper collection of corroborating evidence can have disastrous consequences to child maltreatment cases. A study from the *Journal of Investigative Psychology and Offender Profiling* (2010) examining the merits of traditional forensic evidence found that child sexual abuse allegations are more frequently believed when corroborating proof is present, compared to evaluating a case based on testimony alone.[13] In fact, while forensic, biologically focused evidence is important in case

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[12] Vieth, V.I. 1999. When a Child Stands Alone: The Search for Corroborating Evidence. American Prosecutors Research Institute (12:6), 1-4.
[13] Herman, S. 2010. The Role of Corroborating Evidence in Child Sexual Abuse Evaluations. *Journal of Investigative Psychology and Offender Profiling* (7), 189-212.

resolution (remembering that solvability odds increased 1.4 times), such biological evidence may not always result from criminal activity, and, therefore, should not be considered a guarantee for resolving a case on its own. The same study found that, compared to cases with no physical evidence, the odds of resolving a case with evidence *outside* of typical stains or touch DNA were still approximately 4.9 times higher.[14]

Thus, it is apparent that *all* evidence types and evidence context must be considered in the scope of a multidisciplinary child maltreatment investigation. MDTs should engage in training on both direct and corroborating evidence collection as well as crime scene photography. Improving the breadth and quality of evidence collection will support allegations of child abuse or neglect beyond traditional evidence considerations.[15]

Sensitivity Complications

The second challenge in solving child abuse and neglect (CAN) or child homicide cases centers around the demand for increased sensitivity of the chemistries and techniques used to analyze forensic evidence, which has grown as much as the demand for forensic analysis itself. More sensitive tools require less evidence to produce meaningful results. However, these increasingly fine techniques have also yielded new concerns regarding contamination and carryover of trace materials: as target DNA is detected or amplified, so too are any incidental DNA profiles. An examination into forensic DNA methods commonly used in today's forensic casework helps illustrate how sensitive chemistries have become in forensic science laboratories across the world.

Typical chemistries used to generate DNA profiles for use in court only require one nanogram (1 ng) of DNA to develop a robust, discernible electropherogram profile. These profiles help investigators determine which suspects to include in or exclude from an investigation. The average epithelial (skin) cell contains five picograms (5 pg) of DNA.[16] With one nanogram of DNA being equivalent to 1,000 picograms (1,000 pg), in theory one only needs two hundred skin cells to generate a DNA profile with modern forensic DNA kits. Put another way, the period at the end of this sentence could fit roughly

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[14] Shelton, D.E. 2008. The "CSI Effect." https://nij.ojp.gov/topics/articles/csi-effect-does-it-really-exist.
[15] Jolene's Law Task Force. 2016. Final Report. Retrieved from https://sdlegislature.gov/docs/referencematerials/requiredreports/RR1401112016.pdf.
[16] Darnell, J., Lodish, H., & Baltimore, D. 1986. Molecular Cell Biology. *Scientific American Books*, 1187.

25,000 ng of DNA. A single nanogram is an exceedingly small quantity of DNA needed for laboratory analysis.[17]

Table 1 below highlights the concern with forensic technique sensitivity in the context of DNA analysis.[18] Based on years of research pertaining to DNA quantities correlated to substrate type and contact, one can discern that only a few moments of contact are necessary to deposit an abundance of DNA for profile development. In the context of crime scene processing, this could be a major concern, as extraneous personnel or improper techniques could lead to contamination that compromises the integrity of the evidence. Complex mixtures of both suspect, victim, and contaminating individuals could render evidence unusable or open it to criticism during cross-examination regarding collection techniques and crime scene processing protocol. Non-DNA contamination is also a concern, as environmental contaminants, such as humic acids or polysaccharides from soil or plant material, could inhibit DNA profile generation. Laboratory analysts should check for potential contaminants and attempt to remove them prior to DNA processing.[19]

Likewise, with the low levels of DNA required for sample processing, transference is a major concern. Several studies have outlined how DNA can be carried over between evidentiary items. DNA outside of a crime scene and unrelated to the case can also be deposited into a scene, thereby muddling the investigation.[20]

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[17] Rogers, S.O. (2012). Integrated Molecular Evolution (1st ed.). CRC Press. https://doi.org/10.1201/b16537
[18] Ryan, S. 2016. Touch DNA. What Is It? Where Is It? How Much Can Be Found? And, How Can It Impact My Case? *Ryan Forensics*. Retrieved from http://ryanforensicdna.com/touchdna/.
[19] Bessetti, J. 2007. An Introduction to PCR Inhibitors. *Promega*. Retrieved from https://promega.media/-media/files/resources/profiles-in-dna/1001/an-introduction-to-pcr-inhibitors.pdf?la=en.
[20] Goray, M. & Van Oorschot, R.A.H. 2013. DNA Transfer During Social Interactions. *Forensic Science International: Genetics Supplemental Series* (4:1), E101-E102. https://doi.org/10.1016/j.fsigss.2013.10.052; Fonnelop, A.E., Johannessen, H., Egeland, T., & Gill, P. 2016. Contamination During Criminal Investigation: Detecting Police Contamination and Secondary DNA Transfer from Evidence Bags. *Forensic Science International: Genetics* (23), 121-129. https://doi: 10.1016/j.fsigen.2016.04.003.

Table 1. Amount of DNA on Different Surfaces by Type of Contact[21]			
DNA Amount	**Mean**	**Substrate and Method of Contact**	**Research**
0 – 5.2ng	0.52ng	Glass held for 60 sec.	Daly et al., 2011
0 – 14.8ng	1.23ng	Fabric held for 60 sec.	Daly et al., 2011
0 – 169ng	5.85ng	Wood held for 60 sec.	Daly et al., 2011
0.16 – 6.4ng		Swab of hands	Bright & Petricevic, 2003
0 – 0.4ng		Fingers pressed on various substrates for 30 sec.	Alessandrini et al., 2009
0 – 50.8ng	1.7ng	Various volume crime evidence items	Raymond et al., 2009
	4.3ng	Wallets held for 60 sec.	Raymond et al., 2009
3.1 – 33ng	11.7ng	Wallets held for various times	Raymond et al., 2009
	17.8ng	Plastic knife held for 15 min.	van Oorschot & Jones, 1997
6.8ng		Mug held for 15 min.	van Oorschot & Jones, 1997
34ng		Glass held for 15 min.	van Oorschot & Jones, 1997
	51ng	Vinyl gloves worn for 20-90 min.	van Oorschot & Jones, 1997
	11.68ng	Cotton rubbed with palm, finger, and side of hand for 15 sec.	Goray et al., 2010
	0.396ng	Plastic rubbed with palm, finger, and side of hand for 15 sec.	Goray et al. 2010

Keeping Pace: Educational Challenges to Investigations

These emerging concerns regarding evidence context and advances in forensic sensitivity make it all the more important that frontline, child-serving professionals be sufficiently instructed on the breadth

[21] *Reprinted with permission.* Ryan, S. Touch DNA. http://ryanforensicdna.com/touchdna/. Compiled from: Daly D.J., et al. The Transfer of Touch DNA from Hands to Glass, Fabric, and Wood. *Forensic Sci. Int. Genet.* 6 (2012), 41-46; Bright, J. and Petricevic S.F. Recovery of Trace DNA and Its Application to DNA Profiling of Shoe Insoles. *Forensic Sci. Int.* 145 (2004) 7-12; Allesandrini et al. Fingerprints as Evidence for a Genetic Profile: Morphological Study on Fingerprints and Analysis of Exogenous and Individual Factors Affecting DNA Typing. *J. Forensic Sci.* 48 (3) (2003); Raymond, J.J. et al. Trace Evidence Characteristics of DNA: A Preliminary Investigation of the Persistence of DNA at Crime Scenes. *Forensic Sci. Int. Gen.* 4 (2009) 26-33; Raymond J.J. et al. Trace DNA Success Rates Relating to Volume Crime Offences. *Forensic Sci. Int.: Gen. Suppl. Ser.* (2009) 136-137; Raymond J.J. et al. Trace DNA and Street Robbery: A Criminalistic Approach to DNA Evidence. *Forensic Sci. Int.: Gen. Suppl. Ser. 2* (2009) 544-546; van Oorschot, R.A.H. and Jones, M.K. DNA Fingerprints from Fingerprints. *Nature*. Vol 387 (1997) 767; Goray, M. et al. Investigation of Secondary DNA Transfer of Skin Cells under Controlled Test Conditions. *Legal Medicine* 12 (2010) 117-120; Goray, M. et al. DNA Transfer within Forensic Exhibit Packaging: Potential for DNA Loss and Relocation, *Forensic Sci. Int. Gen.* (2011), doi 10.1016j.fsigen.2011.03.013.

of best practices in evidence collection and forensic processing. It is documented, however, that lawyers and judges are under-educated in the realm of forensic science and evidence collection.[22] Similarly, "...the science of criminal investigations is changing rapidly, and many law enforcement agencies are not prepared for the changes that are taking place."[23] Only by optimizing evidence quality can we ensure that cases are adjudicated with the best information possible. In short, today's MDTs must either keep informed on evidence collection, novel forensic processes, and integration of direct and corroborating evidence in their child maltreatment cases, or face myriad issues ranging from missed evidence considerations to admissibility challenges, to misinterpretation of both forensic results and best practices in collection—in turn, generating negative outcomes for children and non-offending caregivers.

It is for these reasons that this document exists: to act as a handbook of sorts for child protection professionals on concepts pertaining to traditional and novel child maltreatment-related evidence, collection best practices, considerations for innovative corroborating evidence, and suggestions for optimizing case outcomes based on maltreatment type. It is particularly for those investigating and prosecuting child abuse and neglect—to ultimately improve results for the children served by their dedicated efforts.

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[22] Sanger, R.M. 2019. Forensics: Educating the Lawyers. *J of the Legal Profession* (43:2), 221-250. http://dx.doi.org/10.2139/ssrn.3303376
[23] Wexler, C. 2018. The Changing Nature of Crime and Criminal Investigations. Police Executive Research Forum. Retrieved from https://perf.memberclicks.net/assets/ChangingNatureofCrime.pdf.

Before We Begin

Given the power of biological evidence in the context of child maltreatment investigations, an expansive review of evidence typologies and best practices for collection is warranted.

This document is designed to help the reader determine if all evidence is being considered and then collected properly to improve lab processing and interpretation of the results in a court of law. It is not intended as an exhaustive list of every evidence type that may manifest in a case, nor is it meant to supplant local, state, or regional laboratory physical evidence bulletins or collection best practices. Please defer to local laboratory guidelines when collecting evidence in the field. (If evidence present at the crime scene is not accepted at your established lab, consider reaching out to other laboratories for potential processing. See "Sexual Assault Kit Processing" or "Atypical Biological Evidence" for examples.)

Types of DNA Evidence

DNA samples may be found on a variety of surfaces—e.g., bedsheets, clothing, handles, or objects. They typically come from two sources: **body fluids (serological evidence)** or **skin cells ("touch" or "contact" DNA)**. In the context of child maltreatment cases, typical body fluids associated with victimization are blood, semen, and saliva; these fluids may have probative value when investigating child abuse allegations. Touch DNA collection is also important in supporting claims associated with child abuse and neglect incidents. Together, these DNA sources are considered "traditional evidence" when collected from major stains or stereotypical locations such as underwear.

Table 2 below outlines typical evidentiary items, common locations where biological evidence may be found, and potential sources of DNA. Table 3 outlines additional items that may be considered within the forensic scope of a child maltreatment investigation but that are not necessarily related to biological evidence interpretation.

The items listed may be direct constructs used in the commission of a child-related crime, or they may be evidentiary items that corroborate the child's testimony. Corroborative items include those related to a location or event where maltreatment occurred that, upon forensic analysis, could strengthen the information gleaned from a disclosure or forensic interview.

Note that the items listed are not all-inclusive but instead provide MDTs with a general frame of reference for identifying items of forensic pertinence. For other biological evidence considerations (e.g., urine, feces, hair), please consult with your forensic laboratory to determine evidence context and, if probative, best practices for collection and transport.

Table 2. Potential Locations of Biological Evidence in Child Maltreatment Cases

Evidentiary Item	Possible Location of Biological Evidence	DNA Source
Implement or weaponized implement (e.g., curling iron, knife, sex toy)	Handle, penetrating or damage-inducing face/side of implement	• Skin cells (touch/contact; vaginal, rectal, oral) • Body fluids (blood, sweat, semen, saliva, or mix)
Contact surfaces (e.g., door handles, countertops, tables, sinks/bathtubs, toilets)	Internal/external contact surfaces	• Skin cells (touch/contact) • Deposited body fluids (single or mix), including sweat
Facial or bathroom tissue	Surface area	• Body fluids (single or mix), including mucous
Garments, undergarments, bedding (dirty laundry, recently worn, or clean)	Internal/external contact surfaces	• Skin cells • Body fluids (single or mix), including mucous
Used condom	Internal/external contact surfaces	• Skin cells (touch; vaginal, rectal, oral) • Body fluids (blood, semen)
Toys, play items (e.g., gifts from assailant)	External surfaces	• Skin cells (touch)—corroborating evidence
Candy, food, oral implements (e.g., bottles, cigarettes, suckers, toothpicks)	External surfaces	• Skin cells (touch/contact) • Body fluids (saliva)
Contusions, abrasions, bite/licked areas	Contact areas	• Skin cells (touch/contact) • Body fluids (saliva, semen, other)—as narrative dictates
Bindings (e.g., tape, rope)	Surface area	• Skin cells (touch/contact) • Body fluids (sweat, other)—as narrative dictates
Glasses, masks, hats, bandannas, gloves	Internal/external contact surfaces	• Skin cells (touch/contact) • Hair • Body fluids (sweat)
Refuse/discarded items	Contact surfaces, internal/external surfaces	• Skin cells • Body fluids

Insects (e.g., maggots, beetles, flies)	Internal contents, location and morphological estimates	• Stomach contents: victim DNA, post-mortem interval estimates, location approximation (e.g., crime scene details)

Table 3. Potential Sources of Additional Evidence with Forensic Relevance in Child Maltreatment Cases

Source	Products Generated	Potential Evidence
Medical examination (e.g., dental exam for tooth damage, decay; blood panel; BMI analysis)	Medical evaluations, sexual assault kit items	• Skin cells, body fluids for DNA analysis • Professional reports/test results to substantiate physical injury, neglect
Electronic devices (e.g., phones, tablets, computers, smart devices, cameras)	Images, videos, audio products; digital footprint items (e.g., IP, website activity)	• Perpetrator and victim images, location information (corroboration), source information
Trace materials (e.g., paint chips, glass fragments, dust, leaves/seeds/dirt)	Transferred items between victim, assailant, environment	• Environmental corroboration: locale, item use/contact • Biological details if body fluids, skin (contact) information is pertinent
Documents (electronic or physical)	Journal, electronic accounts/documents (e.g., word processing documents, blogs), ciphers, receipts	• Substantiating narratives, details regarding additional evidence items, crime scenes, victims, assailants

Personal Protective Equipment Considerations

Personal protective equipment, or PPE, is necessary for a wide range of professionals who work with infectious, hazardous, sterile, or otherwise sensitive materials. In forensic contexts, PPE both prevents contamination of the biological evidence and mitigates any exposure to the evidence collector that might negatively affect their health and safety. PPE for the biological evidence collector includes:

- Disposable gloves and footwear coverings
- Non-reusable coveralls
- Masks (e.g., respirators or surgical masks),
- Protective eye equipment (e.g., goggles), and
- Laboratory coats when applicable.

The following guidelines are pertinent to PPE use when collecting evidence of a biological nature:[24]

- PPE should be worn anytime there is risk of exposure to a body fluid. Assume *any* encounter with a body fluid is a potential infectious exposure event, and never assume a given evidentiary item is safe for non-PPE use.
- Only use PPE that is clean and shows no signs of wear and tear. If any item appears to be soiled or compromised, replace it promptly before commencing evidence collection.
- Make sure to have replacement PPE. If PPE becomes contaminated, replace it with clean PPE items.
- Replace applicable PPE between handling evidence items as necessary. For example, replace gloves between touching evidentiary items to avoid potential evidence transfer and subsequent contamination.
- Label all materials in accordance with your chain of custody procedures, and seal all items appropriately to avoid future contamination or exposure to others. Make sure all biological items are labeled with biohazard signage to ensure others are aware of the contents and the potential risk to their health.

[24] National Institute of Standards and Technology. 2013. The Biological Evidence Preservation Handbook: Best Practices for Evidence Handlers. Technical Working Group on Biological Evidence Preservation. Retrieved from https://nvlpubs.nist.gov/nistpubs/ir/2013/nist.ir.7928.pdf.

Traditional Evidence Best Practices

This section discusses the major types of evidence that may be useful in child maltreatment investigations and outlines best practices for collecting these items of interest.

Collection Methods by Type of Evidence

Serological Collection

In the context of child maltreatment cases, typical body fluids associated with victimization include blood, semen, and saliva. As such, these body fluids may have probative value when investigating child abuse allegations.

Depending on the timeframe of the alleged crime, body fluids may be found in either a wet or dry state.

Collection Caveats:

Working with Body Fluids

Before delving into serological evidence collection best practices, it is important to note three pertinent elements:

1. **Only a qualified, trained professional should be deployed** for serological evidence collection to avoid contamination, destruction, and possible infection from the evidentiary material.*
2. Laboratories differ in what they may and may not test.** As such, **please consult with your forensic laboratory** beforehand to determine what evidence they can process and the serological procedures available for casework.
3. Be aware that definitions of biological evidence differ from state to state. Because not all physical evidence with potential DNA may be feasible for collection and laboratory processing, MDTs should incorporate team members with insight into what **evidence types may have probative value**.

*FBI. 2019. Handbook of Forensic Sciences. www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view.
**NIST. 2013. The Biological Evidence Preservation Handbook: Best Practices for Evidence Handlers. Technical Working Group on Biological Evidence Preservation. https://nvlpubs.nist.gov/nistpubs/ir/2013/nist.ir.7928.pdf.

Collection of Wet Evidence

Wet body fluids on surfaces that cannot otherwise be transported to the lab may be collected by rolling a sterile, clean cotton swab through the liquid:[25]

- Apply a gentle rolling technique to cover the entirety of the swab.
- Use one swab per stain.
  - An exception is if, based on case knowledge or professional understanding of stain deposition, the evidence indicates that several satellite stains are associated with either one body fluid-letting event or the primary stain of origin.
  - If several stains are believed to be identical fluid, a single swab may be used.
- Allow swabs to air dry in a location away from the crime scene and other personnel to avoid unwarranted evidence transfer or contamination.
  - Do not use any heating source to expedite the drying process (e.g., hair dryer), as this can damage any DNA and potentially introduce more contaminants through aerosolization.
- Once dry, the swabs may be packaged in a paper evidence envelope or swab box and labeled accordingly.
- Seal all open edges and label packaging accordingly to maintain chain of custody and evidence categorizing procedures.
  - Do not attempt to package wet swabs in paper containers or in plastic, as doing so may result in putrefaction of the evidence and thus diminished results, or may render the laboratory unable to process the items due to severe DNA degradation or bacterial or fungal overload.

If the stains are on a garment or other easily transportable item (e.g., blanket, towel, cigarette butt, implement), then the item may be taken to a location outside of the crime scene and allowed to air dry before storing it in a paper evidence container. It is important to note that the circumstances of a crime scene may not allow for wet evidence to be fully dried before packaging. In those instances,

[25] Fonnelop, A.E., et al. Contamination During Criminal Investigation. 121-29.

place the item in a non-porous, waterproof container and place under refrigeration (~35-46°F) until it can be transported to the lab for appropriate air drying.[26]

Collection of Dry Evidence

If an item is too large to be reasonably transported to a laboratory, and the stain is dry, a cutting or scraping of the item may be acquired and transported to the laboratory for examination.

- Make sure all cutting implements are sterile prior to use.
- Metal implements may be flame-sterilized away from the evidence collection area.
    - Alternatively, non-perishable implements may be dipped into 10% bleach and then submerged into 70% alcohol before being dried with a sterile disposable wipe (e.g., Kimwipe). The bleach allows for any potential DNA to be denatured (i.e., degraded), and the alcohol is used to sequester the DNA and pull it from the implement in the second submersion, thus mitigating contamination of evidentiary DNA from item-to-item.
- Alternatively, disposable, single use implements may also be deployed for any cutting or scraping needs.
- Ensure all cuttings or scrapings are air-dried as appropriate and packaged in non-plastic, airtight containers.
- Note that a separate sample should be extracted from an unstained section of the item. This unstained control sample can be used to detect any contaminants or other adulterants, if necessary, that may impact the viability of downstream DNA extraction, quantification, amplification, and genetic analysis.

If dried stains cannot be cut or otherwise transported, a clean, sterile cotton swab may be moistened with sterile water and rolled across the entirety of the stain. Sterile water (distilled or, ideally, nuclease-free or DNA-free water) is necessary to avoid contaminating the body fluids with chemicals or bacteria, and in some instances, DNA may be present in the local water source. As with wet swabbed stains, the swab must be air-dried prior to packaging it in a paper evidence envelope or swab box.

[26] Goray, M. & Van Oorschot, R.A.H. DNA Transfer During Social Interactions. E101-E102.

Hair Collection

It should be noted that hair is another form of biological evidence that may be considered during collection. That said, a strand of hair on its own provides few details: a microscopic hair examination can be used to indicate if an article is a hair or fiber, and if hair, if it is of human or animal origin.[27] Hair samples can only be processed for DNA if a follicular (skin) tag is present or if a root is available and has sufficient DNA for profiling. Therefore, when collecting suspected hair evidence, use clean forceps and avoid damaging the root or any follicular tag.[28] If the hair is wet, air dry it prior to packaging. Suspect hair evidence may be packaged in a paper envelope or bindle with sealed corners.

Touch DNA Processing

Touch DNA is any DNA found within sloughed or shed epithelial (skin) cells that ultimately deposits onto surfaces via human contact.[29] Examples of touch DNA sources are nearly limitless but include: a glass pane where a hand has touched, a wooden surface that a person sat on with bare legs, a wall where someone's face was pressed, the side of a rope or other cordage used for binding, or a hand making contact with an article of clothing (e.g., folding laundry, grasping a shirt).

Touch DNA can be a useful source of corroborating evidence, supporting and enhancing the details of a child's testimony. For instance, a child's touch DNA may be retrieved from the adhesive on a piece of duct tape used to muffle their cries; skin cells trapped on the adhesive from their mouth and lips could provide enough DNA to develop a profile. Likewise, the exterior surface of the tape could provide touch DNA from the perpetrator, who used their bare hand to force the binding to the child's mouth.

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[27] Organization of Scientific Area Committees for Forensic Science. 2019. Standard Practice for Training in the Forensic Examination of Hair by Microscopy. https://www.nist.gov/system/files/documents/2020/03/17/Standard%20Practice%20for%20Training%20in%20the%20Forensic%20Examination%20of%20Hair%20by%20Microscopy_for_website_april_20193_1_COVERPAGE.pdf.
[28] Fonnelop, A.E. 2016. Contamination During Criminal Investigation. *Forensic Science International: Genetics*. https://doi: 10.1016/j.fsigen.2016.04.003.
[29] Daly, D.J., Murphy, C., & McDermott, S.D. 2012. The Transfer of Touch DNA from Hands to Glass, Fabric, and Wood. Forensic Science International: Genetics (6), 121-129. https://doi:10.1016/j.fsigen.2010.12.016.

Large items unable to be transported to the laboratory should be swabbed in a similar fashion to dry body fluid stains:[30]

- A sterile swab dampened with sterile (distilled or nuclease-free) water should be used to collect across the entire surface of the suspected touch DNA source.
- Air dry the swabs and place in a paper container or cardboard swab box.

Otherwise, items that can be packaged for DNA processing at the forensic laboratory should be collected using cutting methods similar to those outlined for body fluid evidence (e.g., cuttings with unstained control sample) or packaged in their entirety in a paper container. Make sure to secure the item as necessary to avoid incidental sloughing of the potentially diluted or minuscule evidence onto the surface of the packaging.

Regarding how to select items for transport to a crime laboratory, items that are believed to have been significantly contacted should be submitted, such as a garment or an implement that was touched for a considerable time. Please note that in these instances "considerable time" for deposition of skin cells sufficient to yield enough DNA for optimal profile development may differ depending on many factors, including:

- "Shedder" status of the individuals in question (e.g., level of personal skin-cell sloughing)[31]
- Medical conditions (e.g., exfoliating dermatitis, seborrheic dermatitis)[32]
- Composition of contacting surface,[33] and
- Handling time and intensity.[34]

In fact, several studies have looked at the relationship between the length of contact and the quantity of DNA associated with the deposited skin cells. While several studies indicate that "considerable time" ranges from 30 seconds to a minute or more,[35] other research has determined

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[30] Fonnelop, A.E. 2016. Contamination During Criminal Investigation. *Forensic Science International: Genetics*. https://doi: 10.1016/j.fsigen.2016.04.003.
[31] Kanokwongnuwut, P., Martin, B., Kirkbride, K.P., & Lincare, A. 2018. Shedding Light on Shedders. *Forensic Science International: Genetics* (36), P20-25. https://doi.org/10.1016/j.fsigen.2018.06.004.
[32] Healthline. 2021. Exfoliating Dermatitis. Retrieved from https://www.healthline.com/health/exfoliative-dermatitis; Mayo Clinic. Seborrheic Dermatitis. Retrieved from https://www.mayoclinic.org/diseases-conditions/seborrheic-dermatitis/symptoms-causes/syc-20352710.
[33] Alketbi, Salem. (2018). The Affecting Factors of Touch DNA. *J of Forensic Research*. 09. 10.4172/2157-7145.1000424.
[34] Sessa, F., Salerno, M., Bertozzi, G. *et al.* Touch DNA: impact of handling time on touch deposit and evaluation of different recovery techniques: An experimental study. *Sci Rep* 9, 9542 (2019). https://doi.org/10.1038/s41598-019-46051-9.
[35] Ryan, S. 2018. Touch DNA. http://ryanforensicdna.com/touchdna/.

that as little as two seconds is sufficient to acquire ample touch DNA for a forensic profile.[36] Thus, mere seconds of contact can lead to several nanograms of DNA deposited on a given substrate, and many popular forensic DNA amplification chemistries (such as the Promega PowerPlex Fusion 6c kit) only require minute amounts of DNA (1-2 ng).[37]

DNA Persistence and Transference

To date, DNA is arguably one of the most empowering tools in the forensic arsenal of a child maltreatment investigator. DNA is highly discriminating, providing outstanding results regarding contributors to stains and corroborating contact described by victims, suspects, and other eyewitnesses. However, there are two additional features of DNA that—in combination with forensic analysis capabilities—bolster its utility in criminal investigations: persistence and transferability.

DNA Persistence

Research has shown that DNA deposition through stain (body fluid) or contact (touch DNA) is quite persistent on items regardless of environmental exposure or timeframe between crime and collection. A study by Helmus et al. determined that submerged items still maintained DNA quantities that could generate robust profiles, regardless of source—both for garments rinsed under a tap for upwards of 10 minutes as well as items that were submerged underwater for a week.[38] Another study examining the impact of persistence on items looked at how one garment worn by multiple individuals could maintain the DNA of all wearers. The study found that the external surface of the clothing item maintained the DNA profiles of the wearers in 67% of samples, and the internal surface of the item demonstrated persistence in 80%.[39]

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[36] Kanokwongnuwut, P. 2018. Shedding Light on Shedders. *Forensic Science International: Genetics* (36), P20-25. https://doi.org/10.1016/j.fsigen.2018.06.004.
[37] Promega. 2018. PowerPlex® Fusion 6C System for Use on the Applied Biosystems® Genetic Analyzer. Retrieved from https://www.promega.com/~/media/files/resources/protocols/technical%20manuals/101/powerplex%20fusion%206c%20system%20protocol.pdf.
[38] Helmus J, Zorell S, Bajanowski T, Poetsch M. Persistence of DNA on clothes after exposure to water for different time periods-a study on bathtub, pond, and river. Int J Legal Med. 2018 Jan;132(1):99-106. doi: 10.1007/s00414-017-1695-2. Epub 2017 Sep 30. PMID: 28963636.
[39] Poetsch M, Pfeifer M, Konrad H, Bajanowski T, Helmus J. Impact of several wearers on the persistence of DNA on clothes-a study with experimental scenarios. *Int J Legal Med*. 2018 Jan;132(1):117-123. doi: 10.1007/s00414-017-1742-z. Epub 2017 Nov 18. PMID: 291511.

Seminal stains in particular are quite robust, persisting across various fabric types and environmental exposures. Specifically, linen, khaddar, silk, chiffon, and polyester items were inundated with seminal material and placed in various water environments (e.g., tap, river, canal, and swimming pool water).[40] After two weeks, all tested fabrics still retained detectable levels of seminal material. A separate study by Brayley-Morris et al. examined seminal DNA persistence with respect to simulated child sex trafficking evidence and found that viable DNA profiles could be retrieved from stains on clothing (in this case, school uniforms) stored in a wardrobe over an eight-month period.[41] After that time window, the samples were further stressed by washing them in either 86°F or 140°F water using biological and non-biological detergents. The researchers found that multiple washes after the extended storage period did not significantly diminish the DNA retrieved from the stains, with single-wash samples generating anywhere from 6,000-18,000 ng of DNA—well above the 1-2 ng threshold of most forensic amplification chemistries.

In conclusion, current research indicates that both biological stains and touch DNA samples may remain on evidentiary items well after an instance of abuse has occurred and despite potential attempts to adulterate or otherwise hide the criminal act.

DNA Transference

In addition to demonstrating its persistence, the Brayley-Morris et al. study also shows how easily DNA can be transferred from one source to another. The study authors noted that DNA on unstained socks was actually "…attributable to the donor of the semen on the stained clothing within the same wash, demonstrating the transfer of semen-derived DNA among items of clothing in the washing machine."[42] Because modern-day crime labs use highly sensitive DNA amplification methods to develop forensic profiles, incidentally transferred DNA may also be swept up in this dragnet and amplified to robust levels—despite ultimately having little to no importance to the crime. Other studies have likewise observed how easily DNA may be transferred between items, which could skew investigative efforts that hinge solely on forensic DNA results.

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[40] Nabi AG, Mateen RM, Khalid A, Tariq A, Parveen R. Persistence of Semen on Five Different Fabric Types in Various Water Environments. *Forensic Sci Int.* 2021 Oct;327:110944. doi: 10.1016/j.forsciint.2021.110944. Epub 2021 Aug 13. PMID: 34419677.
[41] Brayley-Morris H, Sorrell A, Revoir AP, Meakin GE, Court DS, Morgan RM. Persistence of DNA from Laundered Semen Stains: Implications for Child Sex Trafficking Cases. *Forensic Sci Int Genet.* 2015 Nov;19:165-171. doi: 10.1016/j.fsigen.2015.07.016. Epub 2015 Jul 19. PMID: 26232275.
[42] Ibid.

Like the aforementioned laundering transfer, Noël et al. (2016) found that body fluid-soiled sheets, when washed with other garments, can transfer body fluids onto those items and in fact yield full DNA profiles—even in cases where no child sexual abuse occurred.[43] In particular, the study looked at the transfer of spermatozoa and vaginal secretions from bedsheets to unstained underwear. It also examined, in control families where no sexual assault had occurred, whether "background" DNA from family-member garments migrated to children's underwear when washed together. Indeed, the body fluid secretions were transferred to such an extent that, in both cases, full DNA profiles could be yielded from the underwear.

Yet another experiment looked at DNA transference across 180 samples of plastic bags and fabrics and whether a "carrier" could transfer the DNA of a non-contact "donor." Carriers, carrying the donor DNA, handled the samples variously gloved or ungloved. The researchers found that 26% of samples had carrier DNA present, and 12% possessed the complete donor DNA profile. Glove use in the study proved irrelevant, as donor touch DNA was found regardless.[44]

Based on these findings regarding DNA transference, child maltreatment investigators must carefully evaluate the context of each case to build a successful prosecution. For years, DNA contamination due to transference has been a major concern of many justice system agencies. In 2001, the Office for Victims of Crime (OVC) of the U.S. Department of Justice, recognizing the gravity of the situation—in which MDTs contaminate their own investigative evidence—provided the following caution to victim service providers: "…DNA evidence can become contaminated when DNA from another source gets mixed with DNA relevant to the case. This can happen if someone sneezes or coughs over the evidence, or if the person collecting the evidence touches his/her mouth, nose, hair, or any other part of his/her body, and then touches the area that may contain the DNA to be tested."[45] Globally, the EUROFORGEN-NoE consortium has prioritized the understanding and incorporation of transference into a guide for criminal justice professionals, where it specifically highlights the notion of DNA being deposited by non-criminal entities and emphasizes that DNA should be used in context with all other sources of evidence in a given case.[46] In the United States, the National Institute of Standards and Technology (NIST) has likewise addressed the challenges transference can pose to a

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[43] Noël S, Lagacé K, Rogic A, Granger D, Bourgoin S, Jolicoeur C, Séguin D. DNA transfer during laundering may yield complete genetic profiles. *Forensic Sci Int Genet.* 2016 Jul;23:240-247. doi: 10.1016/j.fsigen.2016.05.004. Epub 2016 May 10. PMID: 27236542.
[44] Helmus J, Bajanowski T, Poetsch M. DNA transfer-a Never Ending Story. A Study on Scenarios Involving a Second Person as Carrier. *Int J Legal Med.* 2016 Jan;130(1):121-5. doi: 10.1007/s00414-015-1284-1. Epub 2015 Oct 27. PMID: 26507273.
[45] Office for Victims of Crime. 2001. Understanding DNA Evidence: A Guide for Victim Service Providers. Retrieved from https://ovc.ojp.gov/sites/g/files/xyckuh226/files/publications/bulletins/dna_4_2001/dna5_4_01.html.
[46] EUROFORGEN-NoE. 2017. Making Sense of Forensic Genetics: What can DNA Tell You About a Crime? Retrieved from https://senseaboutscience.org/wp-content/uploads/2017/01/making-sense-of-forensic-genetics.pdf.

given case, particularly with respect to mixture deconvolution (e.g., DNA profile separation from individual contributors), and has called for a contextual understanding of source attribution.[47]

Because DNA persistence and transference are ever-present in criminal investigations and arguably pose an even greater challenge in intrafamilial child maltreatment investigations—based on the research presented above—many agencies have recommended the inclusion of forensic laboratory personnel into multidisciplinary team (MDT) investigations. In its Sexual Assault Response Team (SART) toolkit, the National Criminal Justice Reference Service (NCJRS) recommended that core MDT personnel comprise both traditional members (e.g., prosecutors, law enforcement, medical examiners, child advocacy center personnel) and forensic laboratory professionals.[48] OVC has echoed these sentiments, proposing that forensic scientists be a core part of any SART team given their ability to not only process evidence for meaningful information pertinent to an investigation but also to provide feedback and correspondence to those who will see the case through to prosecution, ensuring that the relevance of laboratory results and contextual trappings will be communicated to triers of fact.[49]

While the demands across criminal justice agencies for forensic scientist-incorporation into MDT investigations are abundant, the reality is that forensic scientists currently participate in a small percentage of MDTs. A survey of 150 SART teams found that 0.7% of SART leadership is made of laboratory personnel and 19.8% of active SART members were forensic scientists.[50] Given the increasing sensitivity of modern-day forensic DNA analysis and the challenges posed by DNA persistence and transference to an investigation, it is imperative that more MDTs embrace the inclusion of forensic scientists into the ranks of these factfinding teams. Without a greater understanding of forensic evidence, and specifically DNA evidence, in the larger scheme of crime reconstruction, facts may become muddled or skewed, leading to suboptimal outcomes for children seeking justice through the justice system and at risk for revictimization.

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[47] Press, R. 2019. DNA Mixtures: A Forensic Science Explainer. National Institute of Standards and Technology. Retrieved from https://www.nist.gov/feature-stories/dna-mixtures-forensic-science-explainer.
[48] National Criminal Justice Reference Service. No Date. Learn About SARTs. Retrieved from https://www.ncjrs.gov/ovc_archives/sartkit/about/about-sart-print.html.
[49] Office for Victims of Crime. No Date. Develop a SART. Retrieved from https://www.ncjrs.gov/ovc_archives/sartkit/develop/team-forensic.html.
[50] Greeson, M.R. 2010. Sexual Assault Response Team (SART) Functioning and Effectiveness. National Sexual Violence Resource Center. Retrieved from https://www.nsvrc.org/sites/default/files/publication_researchbrief_sexual-assault-response-team-functioning-effectiveness.pdf.

Novel DNA Collection Techniques

With the rapid growth and evolution of forensic DNA *analysis*, improved techniques and novel methods for DNA *collection* are likewise on the rise. The following section highlights recent research advances in DNA evidence collection that could help optimize results for child maltreatment casework.

Comparing Common Collection Techniques

Recent studies have shown that collection methods do indeed impact the ultimate recovery of DNA from a given item. In a 2014 study, fingernail samples with blood deposited underneath (to simulate scratching during an assault) were tested under different scenarios to determine which method yielded the most useable DNA. Methods included: clipping and soaking the samples, double-swabbing with a wet foam swab, dry swabbing, or traditional scraping with a wooden applicator.[51] Soaking yielded the most DNA recovery, followed by wet then dry swabbing, and lastly, scraping. Interestingly, both soaking and swabbing nails yielded nail contributor as well as blood contributor (exogenous) DNA. Scraped samples, in contrast, provided a greater quantity of exogenous DNA but at the expense of some DNA chemistry markers, rendering those samples with incomplete or partial profiles. As such, this study gives considerable weight to soaking fingernail clippings or swabbing the nails rather than scraping. Of the three methods, swabbing fingernails is also the more trauma-informed practice when it comes to physically processing evidence from living victims, for instance, during a sexual assault examination.

A 2019 publication also explored collection methods, this time examining the impact of dry swabbing, adhesive tape lifting, and cuttings on DNA recovery from evidence.[52] The researchers statistically analyzed the recovery of DNA profiles from the "wearer" on the sample items (e.g., the DNA deposited by the primary person wearing the items). They used one-way Analysis of Variance (ANOVA) and found that adhesive tape lifting was the best method for sampling DNA and retrieving the full DNA profile for the items under examination. When examining DNA profile recovery for the "handlers" in the study (e.g., those who contacted the item after the wearer, such as an alleged perpetrator), they noted that adhesive lifting and cuttings of evidentiary items provided better

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[51] Hebda, L.M., Doran, A.E. and Foran, D.R. (2014), Collecting and Analyzing DNA Evidence from Fingernails: A Comparative Study, *J Forensic Sci,* 59: 1343-1350. https://doi.org/10.1111/1556-4029.12465.
[52] Sessa, F., Salerno, M., Bertozzi, G. et al. Touch DNA: Impact of Handling Time on Touch Deposit and Evaluation of Different Recovery Techniques. *Sci Rep* 9, 9542 (2019). https://doi.org/10.1038/s41598-019-46051-9.

recovery than dry swabbing but that, overall, no statistically significant difference was found among the collection methods. These results are logical given that cuttings allow the whole, undiluted stain to be transferred to the lab for processing, and adhesive lifting would also allow for greater contact and thus retrieval of DNA from a stain or contact area. Dry swabs, with no moisture to aid in sample contact and richer stain absorption, would naturally lead to diminished results such as those observed. Based on this information, agencies charged with collecting evidence should continue to rely on swabbing (wet preferred), cuttings, and scrapings when possible for optimal DNA recovery from touch items or body fluid-stained evidence.

Swab Materials

When it comes to swabbing samples, the swab material itself can also affect DNA recovery and body fluid collection. A 2016 study looked at differences between foam, microfiber, and flocked swabs as well as adhesive lifters to determine relative efficacy at collecting blood and touch DNA (fingerprints) from glass, cotton, copy paper, and drywall.[53] For both DNA sources, the study determined that adhesive lifters and flocked swabs outperformed the traditional cotton swab on drywall, and more touch DNA was collected from cotton as well. No statistically significant differences were observed for copy paper or glass based upon collection strategy.

Additionally, a study by Bruijns, Tiggelaar, and Gardeniers (2018) explored differing capacities for absorption and DNA extraction of swabs made of nylon, foam, rayon, polyester, and cotton.[54] While most swabs performed well in the realm of absorption (most absorbed over 100 microliters [μL]), rates did vary based on: swab material (volume, porosity, fiber structure); surface area; and packing density (e.g., how tightly the material or fiber was bound to the stick). Figure 1 shows the absorption capacity of various swabs identified by their base material. Swab with larger surfaces, like #11 (polyester), absorbed the most. Better absorption was also observed with swabs that were packed more densely (such as rayon swab #3 versus #4) as well as those whose fiber structures were less dense (rayon swab #4 versus #5).

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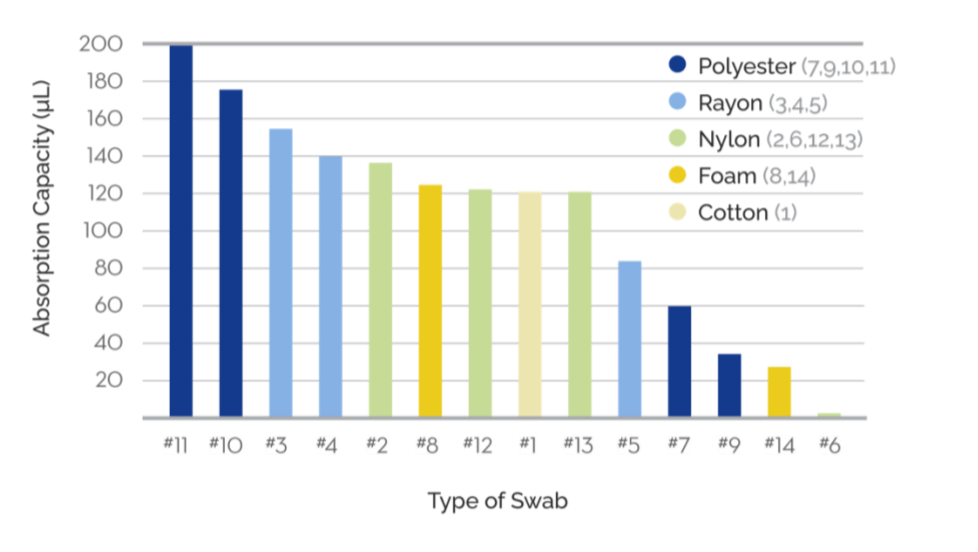
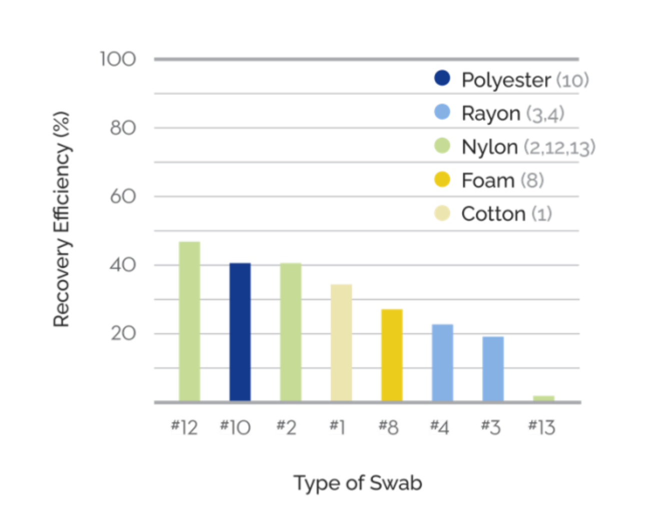
[53] Plaza, D.T., Mealy, J.L., Lane, J.N., Parsons, M.N., Bathrick, A.S. and Slack, D.P. (2016), Nondestructive Biological Evidence Collection with Alternative Swabs and Adhesive Lifters. *J Forensic Sci,* 61: 485-488. https://doi.org/10.1111/1556-4029.12980
[54] Bruijns BB, Tiggelaar RM, Gardeniers H. The Extraction and Recovery Efficiency of Pure DNA for Different Types of Swabs. *J Forensic Sci*. 2018 Sep;63(5):1492-1499. doi: 10.1111/1556-4029.13837. Epub 2018 Jun 11. PMID: 29890011.

Figure 1. Swab Recovery Capacity.[55]



Despite all swabs providing adequate absorption, swab material clearly affected the recovery of DNA—the transfer from sample surface to extraction solution for DNA processing. As depicted in Figure 2, nylon showed the most efficient recovery. For DNA extraction (Figure 3), nylon, foam, and polyester provided the highest DNA quantities. The researchers noted that the poor performance of the second nylon swab (swab #13) was likely the result of extraction solution issues.

Figure 2. Swab Recovery Efficiency.[56]



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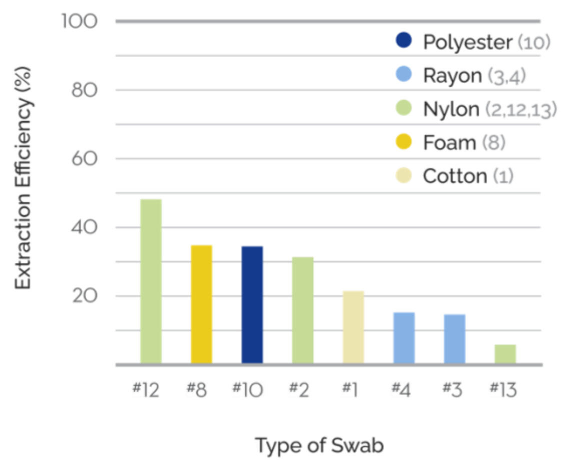
[55] Ibid.
[56] Ibid.

It is important to highlight that none of the swabs were able to achieve a recovery or extraction efficiency over 50%. This percentage is not atypical in terms of such efficiency metrics: many DNA-based extraction procedures use a limited amount of swab material with limited extraction volumes to avoid overly concentrated samples. Furthermore, the swab's tightly packed material may inherently trap DNA, thus preventing it from being fully released for higher extraction efficiencies.

Figure 3. Swab Extraction Efficiency.[57]



New Technologies

Additional DNA-collection methods beyond traditional swabbing and lifting processes are currently being deployed in the field and should be considered for child maltreatment cases. The **M-Vac system**, which uses wet vacuum technology, is one such example. Much like household upholstery cleaners, it dispenses sterile collection buffer on the surface of an item while a pressurized vacuum nozzle creates a turbulent environment, dislodging body fluids or skin cells that might otherwise be left behind.[58] Several validation studies have been successfully conducted on the system, and one Federal Bureau of Investigation study recommended that the M-Vac be used for difficult-to-process substrates, such as porous material (e.g., cardboard, wood, fabric), while traditional swabbing remain in place for non-porous surfaces and readily apparent stains.[59]

Detection of stains is often done using visible light and the naked eye, but modern crime scene investigators and forensic laboratory analysts have also begun to employ **Alternative Light Sources** (ALS). These sources of light at different wavelengths can improve the detection of near-invisible stains that would otherwise blend in with their background. Many body fluids naturally produce

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[57] Ibid.
[58] M-Vac Systems, Inc. No Date. How Does the M-Vac Work? Retrieved from https://www.m-vac.com/why-mvac/how-it-works.
[59] M-Vac Systems. No Date. Validations. Retrieved from: https://www.m-vac.com/why-mvac/validation-trials; McLamb, J.M., Adams, L.D. and Kavlick, M.F. (2020), Comparison of the M-Vac® Wet-Vacuum-Based Collection Method to a Wet-Swabbing Method for DNA Recovery on Diluted Bloodstained Substrates. *J Forensic Sci,* 65: 1828-1834. https://doi.org/10.1111/1556-4029.14508

fluorescent compounds or can interface with chemicals that induce fluorescence (e.g., Bluestar, Luminol). But some body fluids will fluoresce under different wavelengths of light. Some of these wavelengths even vary based on the time and concentration of stain deposition and the substrate involved.[60] Many devices are capable of emitting these variable wavelengths. If an MDT is considering the adoption of ALS devices and protocols for body fluid stain detection, the National Institutes of Justice ALS landscape study provides a robust look at the wavelengths and filters necessary for adequate body fluid and biological evidence detection (e.g., bitemarks, bones, hair).[61] Yet ALS evidence detection and collection continues to develop: recent studies have found meaningful results when using ALS to detect contusions (bruises) and atypical body fluids, such as human tears, to corroborate claims of abuse.[62] In fact, contusion detection for victims of color may be enhanced by employing ALS, where traditional imaging and photography may prove insufficient in detecting markings on the body. As such, MDTs seeking to improve their evidence collection of body fluids or to better document supporting evidence (detecting contusions that corroborate claims of physical abuse or contact that leads to bruising) should consider ALS and develop policy around this innovative evidence detection technology.

Swabs themselves are on the cusp of evidentiary evolution, as well. New advances in swab technology have resulted in the development of **dissolvable swab material**. Luna Innovations has created cellulose acetate material that completely dissolves in solution, maximizing cellular release for optimal DNA extraction—beyond the 50% or less extracted from traditional swabs.[63] A recent study found that the dissolvable swabs yield more DNA than traditional cotton swabs but less than flocked swabs. Researchers posited this gap was likely due to the swab's prototype nature and the substrate interfering with the magnetic bead DNA extraction system.[64] While more studies of this new swab substrate are needed, preliminary results are promising and show that traditional cotton-

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[60] Sijen, T.; Harbison, S. On the Identification of Body Fluids and Tissues: A Crucial Link in the Investigation and Solution of Crime. *Genes* 2021, 12, 1728. https://doi.org/ 10.3390/genes12111728; Miranda GE, Prado FB, Delwing F, Daruge E. Jr. Analysis of the Fluorescence of Body Fluids on Different Surfaces and Times. *Sci Justice*. 2014 Dec;54(6):427-31. doi: 10.1016/j.scijus.2014.10.002. Epub 2014 Nov 3. PMID: 25498929; Wawryk J, Odell M. Fluorescent Identification of Biological and Other Stains on Skin by the Use of Alternative Light Sources. *J Clin Forensic Med*. 2005 Dec;12(6):296-301. doi: 10.1016/j.jcfm.2005.03.005. Epub 2005 May 31. PMID: 15925535; Kearse, K.P. (2020), Ultraviolet 365 as an Alternative Light Source for Detection of Blood Serum. *J Forensic Sci,* 65: 1716-1721. https://doi.org/10.1111/1556-4029.14439.
[61] National Institute of Justice. 2018. Landmark Study of Alternative Light Sources. Forensic Technology Center of Excellence. Retrieved from https://www.crime-scene-investigator.net/PDF/landscape-study-of-alternate-light-sources.pdf.
[62] Scafide, K. N., Sheridan, D. J., Downing, N. R., & Hayat, M. J. (2020). Detection of Inflicted Bruises by Alternate Light: Results of a Randomized Controlled Trial. *J of Forensic Sciences*, *65*(4), 1191–1198. https://doi.org/10.1111/1556-4029.14294; Aparna, R. & Shanti Iyer, R. 2021. Detection and Visualization of Human Tears Using Alternate Light Sources for Forensic Purposes, *Science & Justice:* Volume 61, Issue 6, Pages 771-778, ISSN 1355-0306, https://doi.org/10.1016/j.scijus.2021.10.001.
[63] Luna Innovations. 2017. Luna's Dissolvable Swabs Can Revolutionize Crime Scene Investigations. Retrieved from https://lunainc.com/blog/lunas-dissolvable-swabs-can-revolutionize-crime-scene-investigations.
[64] Wise, N. M., Wagner, S. J., Worst, T. J., Sprague, J. E., & Oechsle, C. M. (2021). Comparison of Swab Types for Collection and Analysis of Microorganisms. *Microbiology Open,* 10(6), e1244. https://doi.org/10.1002/mbo3.1244

based swabs should be reconsidered in lieu of alternative materials that yield better DNA quantities for profile development.

As noted earlier, traditional swabbing is the preferred collection method based on its efficacy in prior studies and its more trauma-informed nature. Under some circumstances, however, other methods (e.g., scraping, cutting) may be beneficial. Swabbing spent shell casings from firearm discharges in criminal cases has historically proven challenging with regards to DNA collection, producing limited results for lab analysts. However, the San Diego Police Department Crime Laboratory has found an alternate way to collect this evidence.[65] By developing a new method that entails **soaking the shell casings** (both fired and unfired), lab analysts were able to produce successful DNA profiles for 26.1% of casework samples and for approximately 34% of samples analyzed in the study overall.[66] Thus, investigators with shell casings relevant to child homicides or child maltreatment-related incidents with firearm discharge should consider exploring the "soaking" method rather than the traditionally unsuccessful swabbing methods.

In summation, studies demonstrate that swab material and surface area are important factors when considering whether and which swabs to use in biological evidence collection for body fluid-based or touch DNA purposes. Traditional cotton swabbing as a "catch-all" method should only be considered when alternative swab substrates or other collection methods are impossible given the type of evidence. Instead, investigators are encouraged to explore and adopt research-backed alternatives, including novel measures for collecting touch DNA or body fluid evidence. With child maltreatment evidence varying by case and crime scene, MDTs should make every effort to optimize their evidence collection, guided by a commitment to rigorous science, reliable outcomes, and just due process.

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[65] Givens, A. 2019. A New Method of DNA Testing Could Solve More Shootings. Retrieved from https://www.wired.com/story/a-new-method-of-dna-testing-could-solve-more-shootings/.
[66] Montpetit S, O'Donnell P. An Optimized Procedure for Obtaining DNA from Fired and Unfired Ammunition. *Forensic Sci Int Genet*. 2015 Jul;17:70-74. doi: 10.1016/j.fsigen.2015.03.012. Epub 2015 Mar 25. PMID: 25828369.

Sexual Assault Kit Best Practices

Sexual Assault Kit Processing

According to the latest statistics from the Rape, Abuse and Incest National Network (RAINN), child protection professionals find evidence substantiating claims of child sexual abuse every nine minutes.[67] Child sexual abuse was the third most common type of child maltreatment listed in the latest Children's Bureau annual report, amounting to 9.3% of all child victims suffering from abuse or neglect.[68] It should come as no surprise, then, that a sexual assault kit—a toolkit for collecting evidence to substantiate allegations of sexual abuse—is a common resource for MDT professionals. Accordingly, this section outlines best practices with respect to sexual assault kit (SAK) collection.

It must be emphasized that SAK collection should be carried out **only by healthcare professionals trained in sexual assault forensic examination** and not untrained non-healthcare personnel, such as law enforcement, first responders, or other MDT members.[69] As such, this role is typically filled either by Sexual Assault Nurse Examiners (SANEs), who are trained on proper collection and processing procedures and have the clinical skills necessary for executing the forensic examination, or by Sexual Assault Forensic Examiners (SAFEs), also healthcare workers with advanced training on the examination process.[70]

Given the nature of the crime, sexual assault examinations and evidence collections must always be conducted with trauma-informed care. In that vein, examiners working with child victims must use a child-centered approach that accounts for the youth's linguistic and developmental status as well as their social and cultural values. The exam and subsequent evidence collection should be victim-focused, prioritizing victim choice and compassionate care. It is important to recognize that the trauma already experienced by the child may be compounded by an intensive forensic medical

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[67] Rape, Abuse and Incest National Network. 2022. Children and Teens: Statistics. Retrieved from https://www.rainn.org/statistics/children-and-teens.
[68] Children's Bureau. 2019. Child Maltreatment: 2019. Retrieved from https://www.acf.hhs.gov/sites/default/files/documents/cb/cm2019.pdf.
[69] National Institute of Justice. 2017. National Best Practices for Sexual Assault Kits: A Multidisciplinary Approach. Retrieved from https://www.ojp.gov/pdffiles1/nij/250384.pdf.
[70] Rape, Abuse and Incest National Network. 2022. What is a Sexual Assault Forensic Exam? Retrieved from https://www.rainn.org/articles/rape-kit.

examination.[71] As such and when applicable, it is imperative to empower victims during this examination. The following are examples of trauma-informed, child-centric measures that mitigate revictimization and return control to the victim:[72]

- Upon request, allow a same-status (e.g., gender, LGBTQIA+ status, ethnicity) examiner to conduct the evidence collection.
- Allow advocates or support persons to be present during the examination (e.g., in the same room, with privacy coverings or barriers in place, but not directly in the vicinity of the processing event). Conditional terms may be required prior to entry:
  - Stipulate that the individual's presence be non-obtrusive
  - Limit the number of support people allowed
  - Gain explicit consent from the victim
  - Ensure the person is not the alleged offender/caregiver
  - Ensure all parties are aware of their legal rights, responsibilities, and the processes involved.
- Provide access to essential items (e.g., alternative clothes if the victim's garments are processed—agencies may even consider hosting donation drives so a wide variety of garments and sizes are available).
- Provide comfort accommodations and recovery needs (e.g., provide children with a stuffed animal, allow for bathing, fulfill sanitary or hygiene requests such as for tampons, deodorant, or toothbrush/toothpaste).
- Explain the process and next steps in developmentally appropriate and familiar language (e.g., use clear, age-appropriate explanations in the child's primary language).
- Address safety concerns for the patient (e.g., remove non-essential personnel, remove non-essential kit items that are not relevant for processing, give the patient choice on refusing certain examinations or collections).

[71] Sexual Assault Forensic Examiner Technical Assistance. 2021. Principles of Care. International Association of Forensic Nurses. Retrieved from https://www.safeta.org/page/KIDSSectionA1.
[72] Office on Violence Against Women. 2013. A National Protocol for Sexual Assault Medical Forensic Examinations Adults/Adolescents. U.S. Department of Justice. Retrieved from https://www.ojp.gov/pdffiles1/ovw/241903.pdf; Sexual Assault Forensic Examiner Technical Assistance. 2021. National Protocol for Sexual Abuse Medical Forensic Examinations—Pediatric: Introduction. International Association of Forensic Nurses. Retrieved from https://www.safeta.org/page/KIDSIntro.

Not every community will have access to adequate sexual assault forensic examination personnel, equipment, or resources. If your local community lacks the necessary resources to provide a child victim of sexual abuse with a sexual assault forensic examination or if you are unfamiliar with your available options, please contact the National Sexual Assault Telephone Hotline at 800-656-HOPE (4673).[73] This hotline can identify sexual assault service providers in your region, allowing MDT members to hone in on the closest, most relevant agencies able to assist with collecting this type of evidence.

SAK contents may vary by state or jurisdiction. Typically, the SAK comprises sterile swabs, test tubes, and envelopes for collecting samples.[74] State-specific information can be found through a mobile app ("National Best Practices for Sexual Assault Kits") created by the Forensic Technology Center of Excellence (FTCoE) and the National Institute of Justice (NIJ) with developer RTI International. The app uses device location services to pull state laws associated with sexual assault, and provides real-time access to documentation on MDT approaches, investigative recommendations for SAK processing, and post-testing considerations.[75] Some SAKs may include their own documentation to assist with collection and chain of custody considerations. Note that not every potential evidentiary item indicated or accounted for in a SAK should necessarily be collected. Case details, as suggested by other sources of evidence (e.g., forensic interviews, eyewitness testimony, direct or circumstantial evidence), should dictate which samples to collect, bearing in mind that the victim may decline some procedures. In sum, case circumstances and victim consent ultimately determine what items will or will not be collected using a SAK.

Typical items that may be accounted for and processed using a SAK are noted in Table 4.[76] As with body fluids, swabs may be packaged together once air dried, assuming a single stain contributor. (If multiple contributors to stains are suspected, package swabs separately.) All swabs that require moistening should be dampened using sterile (distilled) or nuclease-free water. Clothing outside of underwear should be packaged individually in paper containers and appropriately labeled in accordance with jurisdictional guidelines for evidence labeling and chain of custody maintenance. Ideally, clothing should be doffed (removed) over medical examination or butcher paper to capture any trace evidence that may slough from the garments or body during removal. Package the butcher

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[73] Rape, Abuse and Incest National Network. 2022. About the National Sexual Assault Telephone Hotline. Retrieved from https://www.rainn.org/about-national-sexual-assault-telephone-hotline.
[74] National Institute of Justice. 2015. Sexual Assault Kits: Using Science to Find Solutions. U.S. Department of Justice. Retrieved from https://nij.ojp.gov/sites/g/files/xyckuh171/files/media/document/unsubmitted-kits.pdf.
[75] National Institute of Justice. 2017. National Best Practices for Sexual Assault Kits: A Multidisciplinary Approach. Retrieved from https://www.ojp.gov/pdffiles1/nij/250384.pdf.
[76] Ibid.

paper separately for laboratory processing. Underwear can be packaged into the SAK itself as long as it won't compromise the integrity of the SAK packaging or damage any of the other contents. Use paper (bindle, bag, or envelope) to separate the underwear from the rest of the samples to prevent cross-contamination or lab personnel exposure to hazardous materials or body fluids. General standards for developing victim DNA profiles often call for a blood draw from the victim, but this form of evidence extraction may be traumatizing; consider instead the use of buccal swabs in instances where a blood draw is not possible or would result in greater harm to the victim.

Table 4. Potential Sexual Assault Kit Samples[77]

Sample Source	Collection Method
Anal/Perianal (area surrounding anus)	• Moistened swabs
Body/Skin (e.g., hands, feet, applicable surfaces—bite marks, touched surfaces)	• If evidence is wet, dry swabs • If dried stain, moistened swabs (e.g., touched surfaces, bitemarks/spit/licked or other oral contact areas, blood/semen/saliva or other body fluid deposition)
Hair	• Combing, if applicable, over collection paper (e.g., butcher or examination paper) • If matted, clippings or moistened swabs should be used (victim preference)
Nails	• Clippings: Only collect if case nature indicates need (e.g., scratching of perpetrator, nail broken off during event); package accordingly (e.g., bindles, envelopes for collection) • Physical collection: Moistened swabs gently run underneath nail
Oral, Perioral Area	• Perioral: If evidence is wet, dry swabs • Perioral: If dried stain, moistened swabs • Oral Cavity: Dry swabs around gums, cheeks, teeth
Penis, Scrotum	• Moistened swabs across shaft and scrotum; process foreskin with swab as applicable; take care to avoid urethra (will yield swabbed-person DNA profile and has potential for infection/trauma)
Rectum	• Moistened swabs; sampling only recommended in children if significant injury with anesthesia or sedation required

[77] Ibid.

Vagina	• Vault (internal cavity beyond vaginal canal): Dry swabs; sampling only recommended in children if significant injury with anesthesia or sedation required • Vestibule (inner vulva): Moistened swabs; avoid penetration of introitus (opening of vagina)

Table 5 outlines other common evidence types that may be used in the commission of a sexual assault. Items where drainage of body fluids or cell sloughing may occur should be considered, including diapers, swaddles, and sanitary items (e.g., pads, tampons). Foreign or improvised objects or sexual devices and sexual aids may also be used in the commission of an act of child sexual abuse. Finally, biological materials or products of conception resulting from abortions, miscarriages, or pre-term/term delivery may be viable items of evidence in some cases. For these items, refer to laboratory physical evidence bulletins or jurisdictional policy, as applicable, and be mindful that traditional forensic laboratories may not process some items. In that scenario, work with your MDT to identify other laboratory service providers for processing.

Table 5. Atypical Sexual Assault Evidence Types[78]

Sample Source	Collection Method
Objects related to criminal act: • Condoms • Diapers • Foreign objects • Sanitary napkins/pads • Tampons	• Air dry, paper packaging • If item is wet and unable to dry, place the item in a non-porous, waterproof container and place under refrigeration
Conception products: • Fetus • Placenta	• After consultation, create policies for collection as necessary • Identify labs with relevant testing services

There are also many items that are no longer recommended for SAK collection. Vaginal and nasal washes and nasal swabbing can cause infection hazards for the victim and be traumatic in terms of the procedures necessary for evidence collection. Given the sensitivity of new DNA chemistries, use vaginal and surface area swabbing in lieu of washes, and have victims blow nasal discharge into sterile gauze or an applicable material as appropriate. Vomit (emesis) collection is typically unwarranted, as stomach acid and bacteria associated with the digestive system can make DNA extraction and profile development difficult. Likewise, hairs should never be plucked or pulled from

[78] Ibid.

the body. This is a traumatic method for sample collection, and swabbing or cuttings are sufficient. On the processing end, some laboratories may elect to not process urine or fecal samples directly for DNA analysis. While some modified procedures have been developed for successful urine and fecal material DNA extraction, these samples are typically challenging for forensic scientists to process.[79] Urine samples usually possess low DNA-yielding cell quantities, and urea in urine is known to inhibit DNA chemistry. Similarly, fecal material contains complex polysaccharides (sugars) and other waste products that can prevent DNA profile development, while at the same time containing bacteria whose DNA overshadow and obscure any human DNA profiles.[80]

SAK Considerations for Victims Unable to Provide Consent

The previous guidelines cover SAK collection best practices if the victim is living and able to describe what happened to pertinent investigators. There are times, however, where individuals are unable to consent to a sexual assault forensic examination, yet state or jurisdictional policy requires one (e.g., when the person is intoxicated, unconscious, or under the influence of substances impairing their ability to consent). Workaround solutions that can preserve evidence until the victim is able to consent are preferred. If no such workaround is feasible, the following locales are recommended for collection:

- Perioral area (lips, skin around lips, chin)
- Oral cavity
- Neck
- Chest/breast regions
- Hands (palms)
- Fingernails
- External genital organs
- Vaginal fornix/cervix
- Perianal/anal/rectum areas

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[79] Martin, L.R. No Date. STR-Typing of Nuclear DNA from Human Fecal Matter using the Qiagen QIAAMP Stool Mini Kit. Promega. Retrieved from https://www.promega.com/~/media/files/resources/conference%20proceedings/ishi%2012/poster%20abstracts/martin.pdf; Smuts, A.L. & Pogue, P.D. No Date. DNA from Urine as a Potential Source of Identification. Promega. Retrieved from https://www.promega.com/-/media/files/resources/conference-proceedings/ishi-10/poster-abstracts/38smuts.pdf?la=en.
[80] Healthline. 2020. “Does Urine Have DNA?” Retrieved from https://www.healthline.com/health/does-urine-have-dna; Bessetti, J. 2007. An Introduction to PCR Inhibitors. Promega. Retrieved from https://www.promega.es/-/media/files/resources/profiles-in-dna/1001/an-introduction-to-pcr-inhibitors.pdf?la=es-es.

- Visible stains
- Stains fluoresced via ALS
- Trace evidence (e.g., hairs, fibers, debris)
- DNA reference samples (blood draw, buccal swab), and
- Any toxicology samples (blood or urine), as applicable.

Factors Affecting Quality of SAK Evidence

Many factors may contribute to the quality and quantity of evidence collected via a SAK. Both the characteristics of the case and the timing of events affect the presence and viability of any deposited DNA. Relevant case characteristics include (but are not limited to):[81]

- Age
- Activity level
- Activity type, frequency (e.g., toothbrushing, bathing, douching, exercise)
- Consumption (e.g., eating, drinking, smoking)
- Contamination or adulteration (e.g., evidence sullied by dirt or chemicals—accidentally, during event, or in attempt to destroy evidence)
- Draining, sloughing
- Environmental exposure
- Location (e.g., skin surface versus penetration)
- Medical conditions (e.g., aspermia, oligospermia)
- Medically induced conditions (e.g., vasectomy)
- Nature of crime (e.g., touch DNA versus body fluid deposition, ejaculation)
- Prophylactic use (e.g., condom or other barrier)
- Temperature

Time is another critical factor that can affect the ability to generate substantive forensic information. As time passes, the likelihood of the intervening actions listed above increases—decreasing the amount of evidence left to process. But even without these factors, DNA can degrade over time,

[81] Lee HC, Ladd C. Preservation and collection of biological evidence. *Croat Med J.* 2001 Jun;42(3):225-8. PMID: 11387627; Acosta ML. Collecting evidence for domestic and sexual assault: highlighting violence against women in health care system interventions. *Int J Gynaecol Obstet. 2002* Sep;78 Suppl 1:S99-104. doi: 10.1016/S0020-7292(02)00053-X. PMID: 12429448; Magalhães, T., Dinis-Oliveira, R. J., Silva, B., Corte-Real, F., & Nuno Vieira, D. (2015). Biological Evidence Management for DNA Analysis in Cases of Sexual Assault. *The Scientific World Journal,* 2015, 365674. https://doi.org/10.1155/2015/365674

leading to the loss of partial or whole DNA sequences, thus making profile generation and statistical interpretation difficult.[82] The NIJ *Best Practice* guide outlines recommended collection timelines based on historic precedent and assault research (Table 6). However, the authors note that case circumstances should primarily drive the collection and processing timeline, as historic research data may be limited by everything from sample quality or quantity to chemistries and equipment used for analysis.[83] After all, as mentioned previously, studies have shown that both DNA and body fluids containing cells rich in DNA persist for days, if not weeks, after the commission of a simulated or real deviant act. In light of these considerations, MDTs with rigid timelines for evidence collection should review their practices.[84]

Table 6. NIJ-Recommended Time Frames for Evidence Collection[85]

Type of Assault	Collection Time
Vaginal	Up to 120 hours (5 days)
Anal	Up to 72 hours (3 days)
Oral	Up to 24 hours (1 day)
Bite marks/saliva on skin	Up to 96 hours (4 days)
Unknown	Collect respective samples within the time frames listed above

The discussion regarding timing and characteristics applies to those victims who are still living. Time constraints no longer apply in instances where the child victim is deceased. Thus, when investigating allegations of child maltreatment or homicide where the victim is deceased, all pertinent evidence should be processed, such as "…dental flossing(s), pulled scalp hair, pulled pubic hair, and swabs of the neck, breasts, mouth, external genitalia, vagina, cervix, anus, and rectum."[86] SAK items should be

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[82] Hanssen EN, Lyle R, Egeland T, Gill P. Degradation in forensic trace DNA samples explored by massively parallel sequencing. *Forensic Sci Int Genet. 2017* Mar;27:160-166. doi: 10.1016/j.fsigen.2017.01.002. Epub 2017 Jan 3. PMID: 28088090.
[83] National Institute of Justice. 2017. National Best Practices for Sexual Assault Kits. https://www.ojp.gov/pdffiles1/nij/250384.pdf.
[84] Alketbi, Salem. (2018). The Affecting Factors of Touch DNA. *J of Forensic Research*; Sessa, F. Touch DNA: Impact of Handling Time. *Sci Rep*; Ryan, S. 2018. Touch DNA. http://ryanforensicdna.com/touchdna/; Promega. 2018. PowerPlex® Fusion 6C System; Luisa V. Forger, Ashley L. Inmon, Mary K. Book, and Joseph Donfack. *Forensic Genomics.* Jun 2021.50-59. http://doi.org/10.1089/forensic.2021.0001.
[85] National Best Practices for Sexual Assault Kits. p.18. https://www.ojp.gov/pdffiles1/nij/250384.pdf.
[86] Ibid.

processed and submitted to a forensic laboratory according to typical guidelines for submissions involving a living victim.

Trace Evidence Best Practices

Not all evidence from child maltreatment cases is large in size or laden with traditional biological evidence. Trace evidence—minute amounts of material transferred among people, objects, or environments—may also be discovered. According to the FBI, trace evidence may include "…human hair, animal hair, textile fibers and fabric, rope, soil, glass, and building materials" that are associated with the commission of a crime.[87] While the FBI has published trace evidence recovery guidelines (through the FBI Laboratory's Scientific Working Group on Materials Analysis Evidence Committee), the guidelines are over 20 years old.[88] In 2020, NIST's Outreach Task Group of the Organization of Scientific Area Committees for Forensic Science (OSAC) Trace Materials Subcommittee created a trace materials evidence collection guide that has since been developed into a mobile app ("National Best Practices for Sexual Assault Kits") through a collaboration between NIST and NIJ's Forensic Technology Center of Excellence and developed by RTI International.[89]

Common Types of Trace Evidence

The following list outlines the types of trace evidence that may be pertinent to a child maltreatment investigation:[90]

- Bindings
- Chemicals
- Debris
- Fiber
- Fragmented/broken/torn materials (physical fit/edge, physical match comparison)
- Glass

[87] Federal Bureau of Investigation. No Date. Trace Evidence. Retrieved from https://www.fbi.gov/services/laboratory/scientific-analysis/trace-evidence.
[88] Office of Justice Programs. 1999. Trace Evidence Recovery Guidelines. U.S. Department of Justice. Retrieved from https://www.ojp.gov/ncjrs/virtual-library/abstracts/trace-evidence-recovery-guidelines.
[89] National Institute of Standards and Technology. 2021. Trace Evidence Collection App is Now Available. Retrieved from https://www.nist.gov/osac/trace-evidence-collection-app-available-now.
[90] Indiana State Police: Laboratory Division. 2021. Microanalysis Unit Test Methods. Retrieved from https://www.in.gov/isp/labs/files/Microanalysis_Test_Methods_11-18-2021.pdf; New Jersey State Police. 2022. Trace Evidence Analysis. Retrieved from https://www.njsp.org/division/investigations/trace-evidence.shtml#miscellaneous.

- Gunshot residue
- Hair
- Impressions
- Inks, dyes
- Paint
- Plastics
- Plant matter (leaf litter, pollen)

In most circumstances, trace evidence analysts can classify items, describe their individual characteristics, and compare them to determine if they may have originated from a particular source. Class characteristics are general features that could be shared by many items (e.g., color, width, texture) while individual characteristics are uniquely identifying features that allow the evidence to be attributed to a single source (e.g., specific striations, cuts/tears, fragments, stretch markings, perforations).[91] For instance, investigators could lift remnants of **bindings** from a victim who was subdued or muffled. Trace analysts could use the class characteristics of those bindings to broadly identify potential sources—particular types, colors, or materials of tape, rope, or cloth. By dialing in on individual characteristics, trace analysts can then associate an item of evidence with a specific source—such as comparing tear or bitemarks on a piece of tape to a tape roll from the crime scene.

Chemical analysis (e.g., of fuel, ignitable liquids, lubricants, clandestine lab components, gunshot residue) may shed light on myriad evidence-related questions, such as determining the materials used to manufacture drugs in the presence of a child, exposing attempts to start fires or create explosives, or confirming the source of a lubricant used during the commission of a sexual assault.[92] Inks or dyes could likewise be used to associate a writing implement to a given document or a printer at the crime scene.[93]

Debris can come in many forms: dirt, dust, powders, residues, or plant material, even remnants from a fire or proliferative (explosive) event. Such evidence could be used to correlate the presence of the

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[91] National Forensic Science Technology Center. 2008. Class and Individual Characteristics. Retrieved from https://projects.nfstc.org/firearms/module06/fir_m06_t04_05.htm.
[92] Verma KL (2015) Trace Evidence Analysis in a Child Sexual Abuse Case—Silence Dares to Speak. *J Forensic Res* S4: S4-001. doi:10.4172/2157-7145.1000S4-001.
[93] Noronha, S.J. 2017. A Comparative Study of Different Printed Documents to Estimate the Type of Printer Used. *J Forensic Res Crime Stud* 1: 1-7.

victim and suspect in a crime scene locale or to substantiate or refute claims regarding the nature of the criminal event.

Human or animal **hair** may possess a follicular tag or root that could provide DNA for profile development. The morphological features of hair could corroborate claims of animal-facilitated abuse or substantiate claims of animal presence during commission of crime.[94]

Fibers can be compared against other materials or evidence (e.g., garments, blankets, coverings, furniture) to determine an association with criminal activity. Perhaps the most well-known case example of fiber analysis resulted in the conviction of Wayne Williams, who was prosecuted for homicide based on textile comparative analysis.[95]

Sometimes, **physical implements** may be used in the commission of a child maltreatment crime. Perhaps a child is assailed with an item, such as a broom handle, and the item breaks from the force of the trauma. In this scenario, assume the perpetrator has then tried to hide a piece of the fragmented implement, and investigators eventually find the broken pieces in two separate locations. Comparing the characteristics of the fragments and aligning their physical edges could confirm the child's story, while DNA analysis on the item could also establish both perpetrator and victim profiles to further strengthen the prosecution's case. **Glass or paint** evidence could help associate a child with a given crime scene or criminal act in a similar manner. The shape of glass fragments or chips of paint could be matched together akin to a jigsaw puzzle to attribute these pieces of evidence back to a source. For example, shards of glass extracted from the body of an injured child could be matched to a broken mirror identified in a physical abuse case. Or paint left behind on a child's clothes or body from a fatal hit and run could be analyzed to determine the car manufacturer; then upon discovery of the vehicle, provide a match.[96] **Plastics** could also be analyzed in this way, such as by matching a piece of torn plastic left behind on a decedent with a larger plastic trash bag used to transport a body to a secondary site.[97]

Impressions can also be important in verifying events that transpired during the commission of a crime against a child. Impression-based evidence can vary, ranging from footprints (e.g., impressions

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[94] Lakshika Vaishnav, Srishti Parashar, Arun Kumar, M.P. Sachdeva. 2021. A study on hair analysis of different Canidae breeds. *Forensic Science International: Reports,* Volume 3, 100169, ISSN 2665-9107, https://doi.org/10.1016/j.fsir.2020.100169.
[95] Deadman, H.A. 1984. Fiber Evidence and the Wayne Williams Trial, Part I. Office of Justice Programs. Retrieved from https://www.ojp.gov/ncjrs/virtual-library/abstracts/fiber-evidence-and-wayne-williams-trial-part-i.
[96] Ajay Kumar. 2018. Exchange of Paint in Hit & Run Collisions and Its Significance as Forensic Evidence. *J Forensic Sci & Criminal Invest.* 8(1): 555728. DOI: 10.19080/JFSCI.2018.08.555728.
[97] Bily, C. 2010. "The Evidence is in the Bag." *Evidence Technology Magazine*, (Volume 8, Number 4). Retrieved from https://www.evidencemagazine.com/index.php?option=com_content&task=view&id=328.

in wet substrate such as mud), toolmarks (e.g., prybar pressed into wood), tire impressions, or binding/contact impressions (e.g., ligature marks). Class features (e.g., size, tread design, manufacturer) and individual features (e.g., binding and ligature mark comparison, wear pattern, striations from toolmarks and substrate) can be used to make associations between such items of evidence.

Trace Evidence Collection Methods

The following methods are derived from the OSAC Trace Materials Subcommittee trace materials evidence collection guide.[98] Table 6 outlines major collection methods for trace items. Note that the guide categorizes liquid residues for chemicals as fire debris (e.g., ignitable liquids or clandestine laboratory chemicals). As such, both the OSAC guide and laboratory physical evidence bulletin guidelines indicate that **ignitable components** post-fire should be packaged in airtight containers (e.g., non-oiled paint cans, glass canning jars, or heat-sealed fire debris bags where no proliferative residues or liquids were previously stored). **Other, nonflammable chemical liquid samples** should be collected in clear plastic bottles or jars.[99] Clandestine laboratory materials are not covered by the OSAC guide. **Clandestine-based liquids or pastes** should be collected in clear borosilicate (glass) containers with Teflon liners and screw cap lids.[100] Likewise, **plant material** is not explicitly included, but common physical evidence bulletin guidance indicates that plant materials should be dried when possible and stored in paper containers to prevent putrefaction.[101] This guidance is parallel to the submission of drugs and controlled-substance plant materials for forensic laboratory processing.

Firearm evidence, when possible, should be unloaded and marked as such on the collection packaging.[102] If a firearm cannot be reasonably unloaded, or its status (unloaded or loaded) cannot be determined, contact the laboratory to discuss submission of the item. Avoid the use of personnel who have recently handled or fired a service weapon or other firearm and always use gloved hands

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[98] Organization of Scientific Area Committees for Forensic Science Trace Materials Subcommittee. 2020. Trace Materials Crime Scene Investigation Guide. Retrieved from https://www.nist.gov/system/files/documents/2020/08/26/CSI_Guide_07302020_ForPublication.pdf.
[99] Indiana State Police Laboratory Division. 2021. Fire Debris Evidence. Retrieved from https://www.in.gov/isp/labs/files/PEB-05_Fire_Debris_11-18-2021.pdf.
[100] Indiana State Police Laboratory Division. 2021. Clandestine Drug Laboratory Evidence Submission Guidelines. Retrieved from https://www.in.gov/isp/labs/files/PEB-19_Clan_Lab_09-30-2021.pdf.
[101] Indiana State Police Laboratory Division. 2022. Drugs/Controlled Substances. Retrieved from https://www.in.gov/isp/labs/files/PEB-01_Drugs_01-21-2022.pdf.
[102] Indiana State Police Laboratory Division. 2021. Firearms Evidence. Retrieved from https://www.in.gov/isp/labs/files/PEB-11_Firearms_11-08-2021.pdf.

to avoid cross-contamination from unrelated gunshot residue.[103] Secure firearms to prevent jostling and possible transfer of evidence to the container when in transit.

Impression evidence should initially be photographed before any casting or lifting methods take place. Lifts are typically used for dust, powder, or hard surface impressions, while castings should be used for impressions left in a malleable material (e.g., mud). Environmental conditions (e.g., submerged impression) and substrate (e.g., clay, snow) will result in special considerations when casting. For instance, snow-based impressions need to be preserved using spray foam or print wax prior to casting, as the casting material itself could result in melting and obliteration of the impression. Likewise, submerged prints may require dry casting powder to be applied prior to trying to cast with wet casting compound.[104]

Paint and plastics are collected in a similar fashion. Scrapings of these items may be taken from impacted substrates or, when applicable, cuttings should be taken down to the substrate level to ensure all layers of evidence are collected.[105] For smaller fragments, forceps will suffice. Make sure to clean all implements between areas or items of collection. Collection of standard or reference samples from non-impacted surfaces where the transfer occurred should also be obtained. Containers for collection range from paper bindles and envelopes (small items) to paper boxes or bags (larger items). Toolmark items should be packaged in paper boxes, with any implementation surface that may possess trace evidence (e.g., paint, substrate remnants) wrapped in paper to avoid loss.[106] Any painted surfaces where paint may have been transferred to the tool should be scraped for a reference sample. Contact surfaces and substrates where the tool was used to create an impression should likewise be collected and secured in a paper container. If the item is too large to be secured in this fashion, consider removing the toolmark area alone. Take photographs prior to any collection of toolmark evidence; never re-integrate the tool or lay it over an impression, as it could destroy the evidence. If removing an item with toolmark evidence (e.g., door knob, latch, hinge), make sure to detail the item's orientation prior to removal to establish how it correlates to photographs.

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[103] Organization of Scientific Area Committees for Forensic Science Trace Materials Subcommittee. 2020. Trace Materials Crime Scene Investigation Guide. Retrieved from https://www.nist.gov/system/files/documents/2020/08/26/CSI_Guide_07302020_ForPublication.pdf.
[104] Indiana State Police Laboratory Division. 2021. Footwear & Tire Impressions. Retrieved from https://www.in.gov/isp/labs/files/PEB-12_Footwear_and_Tire_Impressions_03-23-2021.pdf.
[105] Indiana State Police Laboratory Division. 2021. Paint and Plastic Evidence. Retrieved from https://www.in.gov/isp/labs/files/PEB-02_Paint_and_Plastic_11-18-2021.pdf.
[106] Indiana State Police. 2018. Toolmark Evidence. Retrieved from https://www.in.gov/isp/labs/files/PEB-13_Toolmark_09-01-18.pdf.

Table 6. Trace Material Collection by Common Evidence Type[107]	
Bindings	• Place larger items in separate paper bag • If item was dried over or removed over exam/butcher paper, package the binding separately from the exam/butcher paper for submission • If tape or similar adhesive binding, cut to remove; mark cut areas • If adhesive still sticky, place on acetate sheet or non-stick aluminum foil, or package sticky-side up • Wadded tape can be placed in plastic container or paint can • Tape pieces should be adhered to clear plastic sheet; tape rolls should be packaged separately in a box or paper bag
Debris	• Package clumps in paper to avoid breakage • Rigid plastic containers will suffice for soil/geological components • Plant material should be stored in paper to avoid decomposition; dry plant material first when possible
Fiber	• Recover with sterile forceps or tape lifting • If forcep collection, place in paper bindle before placing in envelope • If tape lifted, place lift on clear plastic sheet and place sheet in paper envelope
Fragmented Materials	• Use puncture-resistant packaging—avoid paper or glass containers—and ensure all edges are sealed • Place tape on unsecured fragments to keep intact during transit if applicable • Document condition of fragmented item(s) prior to transport
Glass	*Refer to Fragmented Materials*
Impressions	• Photograph prior to casting or lifting • *Casting*: Do not remove debris pressed into impression; cast with sunken or depressed items still encased in substrate as removal could damage impression • Secure casts in paper container after drying • *Lifting:* electrostatic, gel, or adhesive lifters may be used; lift impressions on hard surfaces (e.g., dust or void impression) • Lifts may be secured in a paper container • Clothing should be packaged and secured to avoid impression disruption
Paint	• Scrapings of paint from surface (e.g., tool with paint) or forcep collection is advisable • Cut down through all layers of paint to substrate (e.g., wood, metal) • Collect in metal containers or paper bindles placed inside envelope for smaller items; larger items can be packaged or secured in paper bag or box
Plastic	*Refer to Paint*

[107] *Condensed from*: Organization of Scientific Area Committees for Forensic Science Trace Materials Subcommittee. 2020. Trace Materials Crime Scene Investigation Guide. Draft, p.4. https://www.nist.gov/system/files/documents/2020/08/26/CSI_Guide_07302020_ForPublication.pdf

Toolmark	• Wrap use-areas in paper to prevent evidence loss • Collect reference sample of painted surface by scraping it • Tool impression area should be collected; photograph first • Secure and place in paper box
Gunshot Residue	• Submit applicable clothing individually in paper bags • Adhesive lifts (stubs) can be used for residue collection (e.g., hands) • Any items with residue (firearms, cartridges) should be collected in paper
Hair	*Refer to Fiber*

New Horizons in Microanalysis

New forms of trace evidence and trace analysis methods are slowly manifesting that may be pertinent to child abuse case investigation. The field of Forensic Microbiology, where study of bacteria, fungi, and viruses intersects with criminal investigation, has seen great strides in recent years. Applications of this field originally focused on bioterrorism (notably during the anthrax attacks of 2001) but have more recently expanded to traditional investigations.[108]

Microbial genetics, whereby bacterial species and communities of microbes are identified similarly to DNA profiling of humans, has also advanced as a discipline. Researchers have been able to accurately identify individuals by the profiles of their bacterial communities derived from the contact transfer of pubic hair.[109] Other studies, however, have found that the skin of each body region often has varying microbial communities, making identification of individuals challenging.[110] Still, this promising research demonstrates how pubic hair or skin contact and the microbial "fingerprint" left behind during such an exchange could be used for identification purposes in child sexual assault cases one day.

The forensic application of microbial genetics is also being tested in child sexual assault cases to identify sexually transmitted infection (STI) vectors. A study by Hammerschlag and Gaydos (2012) examined public health-related guidelines for molecular analysis of STI sources. They then applied those guidelines in child sexual abuse cases to rapidly identify the particular strain of bacterial

[108] National Institute of Justice. 2021. The Forensic Microbiome: The Invisible Traces We Leave Behind. Retrieved from https://nij.ojp.gov/topics/articles/forensic-microbiome-invisible-traces-we-leave-behind.
[109] Williams DW, Gibson G. Individualization of Pubic Hair Bacterial Communities and the Effects of Storage Time and Temperature. *Forensic Sci Int Genet.* 2017 Jan;26:12-20. doi: 10.1016/j.fsigen.2016.09.006. Epub 2016 Oct 7. PMID: 27744226.
[110] Tozzo, P., D'Angiolella, G., Brun, P., Castagliuolo, I., Gino, S., & Caenazzo, L. (2020). Skin Microbiome Analysis for Forensic Human Identification: What Do We Know So Far? *Microorganisms*, 8(6), 873. https://doi.org/10.3390/microorganisms8060873.

infection.[111] Such information would help correlate the source of infection with the child victim and also lead to faster treatment. However, given the relatively few child study participants and validation studies to date, the scope of such methodology is currently limited—applicable to only a few specific bacterial species, evidence types, and types of abuse (namely, *C. trachomatis* in vaginal swabs and urine from girls suspected of being sexually assaulted).[112]

In addition to short, sequence-based analysis of bacterial DNA, the entire complement of DNA from bacteria could also be used akin to a "genetic fingerprint" for confirming the strain of STI pathogens. The promise of such methodologies was proposed as early as 2013, where whole-genome (full DNA sequence) analysis was suggested as a viable option for identifying bacterial STI sources for investigative purposes.[113] In fact, the first whole-genome sequencing case successfully brought to prosecution was published in 2019. Scientists were able to establish the specific strain of *gonorrhea* between the perpetrator and victim in a child sexual abuse case.[114] Thus, MDT members with child sexual assault cases involving STIs should consider molecular methods from clinical laboratories to help correlate the offender with the victim and strengthen the evidence base.

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[111] Hammerschlag, M. R., & Gaydos, C. A. (2012). Guidelines for the Use of Molecular Biological Methods to Detect Sexually Transmitted Pathogens in Cases of Suspected Sexual Abuse in Children. *Methods in Molecular Biology* (Clifton, N.J.), 903, 307–317. https://doi.org/10.1007/978-1-61779-937-2_21.
[112] Qin, X., & Melvin, A. J. (2020). Laboratory Diagnosis of Sexually Transmitted Infections in Cases of Suspected Child Sexual Abuse. Journal of clinical microbiology, 58(2), e01433-19. https://doi.org/10.1128/JCM.01433-19.
[113] Seth-Smith HM, Thomson NR. Whole-Genome Sequencing of Bacterial Sexually Transmitted Infections: Implications for Clinicians. *Curr Opin Infect Dis.* 2013 Feb;26(1):90-8. doi: 10.1097/QCO.0b013e32835c2159. PMID: 23221768.
[114] Francés-Cuesta, Carlos et al. (2019). Whole-Genome Sequencing of Neisseria Gonorrhoeae in a Forensic Transmission Case. *Forensic Science International: Genetics*. 10.1016/j.fsigen.2019.07.003.

Digital Evidence Best Practices

Much like DNA sequencing ushered in a new era of criminal investigation, digital evidence has opened a new avenue to improved child maltreatment investigations. The ability of digital evidence to substantiate claims of abuse and strengthen prosecution is increasing exponentially. Almost half of millennial households (47%) have at least one smart device or piece of technology that falls within the realm of the Internet of Things (IoT). IoT devices are physical objects that collect data through sensors, microphones, or other software and hardware and then pass that information to other systems across the internet.[115] They can range from smart assistants to thermostats, television sets to refrigerators. In fact, worldwide, over seven billion people have IoT devices—making them excellent sources for potential evidence in child abuse and neglect investigations.[116]

As life has moved increasingly online, perpetrators have taken advantage of the greater anonymity and wider audience, and cases of online exploitation and abuse have skyrocketed. The Internet Watch Foundation (IWF) found that child sexual abuse materials online have increased 15-fold in the last decade.[117] The COVID-19 pandemic triggered a particular spike: 2021 marked not only an increase in child abuse overall (and an increase in severity of cases) but also the most cases to date involving online child sexual exploitation.[118] Accessing IoT and electronic device monitoring data to corroborate these crimes is more important than ever. MDTs should be prepared to properly recognize and collect digital evidence items when investigating allegations of child maltreatment.

Traditional types of physical digital evidence sources include laptops, desktop computers, tablets, and mobile devices (e.g., phones, watches). Nontraditional sources of evidence include IoT devices

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[115] Stasha, S. 2021. An In-Depth View into Smart Home Statistics. Policy Advice. Retrieved from https://policyadvice.net/insurance/insights/smart-home-statistics/.
[116] Oracle. 2022. What Is IoT? Retrieved from https://www.oracle.com/internet-of-things/what-is-iot/.
[117] Internet Watch Foundation. 2021. "IWF Analysts Finding Fifteen Times More Child Sexual Abuse Content Online Than They Were Ten Years Ago." Retrieved from https://www.iwf.org.uk/news-media/news/iwf-analysts-finding-fifteen-times-more-child-sexual-abuse-content-online-than-they-were-ten-years-ago/.
[118] End Violence Against Children. 2021. "Why Did COVID-19 Supercharge Online Sexual Exploitation of Children?" Retrieved from https://www.end-violence.org/articles/why-did-covid-19-supercharge-online-sexual-exploitation-children; Sparks, S.D. 2021. "Child Abuse Cases Got More Severe During COVID-19. Could Teachers Have Prevented It?" *Education Week*. Retrieved from https://www.edweek.org/leadership/child-abuse-cases-got-more-severe-during-covid-19-could-teachers-have-prevented-it/2021/06; Mann, D. 2021. "Study: Child Abuse Rose During COVID Pandemic." *U.S. News*. Retrieved from https://www.usnews.com/news/health-news/articles/2021-10-08/study-confirms-rise-in-child-abuse-during-covid-pandemic; Business Standard. 2022. "Covid-19: 2021 Worst Year on Record for Online Child Sexual Abuse, Says IWF." Retrieved from https://www.business-standard.com/article/current-affairs/covid-19-2021-worst-year-on-record-for-online-child-sexual-abuse-says-iwf-122011600747_1.html.

such as smart-listening devices (e.g., Amazon Echo, Google Home), baby monitors, security systems with applicable storage (on-site or off-site), video game consoles (e.g., Microsoft Xbox devices, Sony Playstation consoles, Nintendo Switch), biometric monitoring devices (e.g., Fitbit), routers, internet connected toys, external hard drives, USB devices, software and applications (e.g., security monitoring software, VPNs, mobile apps), and assorted data backup, archive, or log records from the device itself or IoT service providers.[119]

Numerous pieces of digital evidence can be gleaned from the aforementioned sources, including details on motion, temperature, time, images, video/audio recordings, location/spatial changes, lighting, and biometrics (e.g., heart rate, sleep patterns, calorie differentials). These details can be useful in corroborating elements of the victim's testimony or in conjunction with other traditional types of evidence.[120] For instance, a home security camera could capture images of the alleged perpetrator entering or exiting the crime scene with a time stamp that supports the timeline of events leading up to the criminal activity.[121] A smart device could capture audio of an altercation leading to child physical, sexual, or emotional abuse.[122] A biometric wearable could corroborate timelines and indicate moments of distress or life-ending actions in homicide cases.[123] Even an IoT-based toy could record emotional abuse, physical threats, or audio of the abuse events.[124] Clearly, a multitude of items and types of child maltreatment evidence may be collected from digital evidence sources; thus, proper collection of this evidence is critical to the successful prosecution of a case.

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[119] National Forensic Science Technology Center. No Date. A Simplified Guide to Digital Evidence. Retrieved from http://www.forensicsciencesimplified.org/digital/DigitalEvidence.pdf.

[120] Kim, Soram & Park, Myungseo & Lee, Sehoon & Kim, Jongsung. 2020. Smart Home Forensics—Data Analysis of IoT Devices. *Electronics*. 9. 1215. 10.3390/electronics9081215.

[121] Hopkins, D. 2020. "Father arrested after teen daughter catches abuse on home security camera, police say." Fox 10. *Fox News.* Retrieved from https://www.fox10phoenix.com/news/father-arrested-after-teen-daughter-catches-abuse-on-home-security-camera-police-say.

[122] Whittaker, Z. 2018. "Judge Orders Amazon to Turn Over Echo Recordings in Double Murder Case." *TechCrunch*. Retrieved from https://techcrunch.com/2018/11/14/amazon-echo-recordings-judge-murder-case/.

[123] Hauser, C. 2018. "Police Use Fitbit Data to Charge 90-Year-Old Man in Stepdaughter's Killing." *The New York Times*. Retrieved from https://www.nytimes.com/2018/10/03/us/fitbit-murder-arrest.html.

[124] Martin, H. 2019. "Carer caught swearing at disabled teen with mental age of an 18-month-old when his taunts were recorded on patient's Buzz Lightyear toy is cleared of mistreating him." *Daily Mail*. Retrieved from https://www.dailymail.co.uk/news/article-6876965/Carer-caught-showering-abuse-disabled-teen-Buzz-Lightyear-toy-recording.html.

The following best practices outline general collection principles for digital evidence items:

- Plan with the MDT in advance regarding the destruction potential of digital evidence and team safety.
  - Perpetrators may use combustible, explosive, or other destructive devices to destroy evidence, which could jeopardize team safety upon collection.[125]
  - Consider challenges with encryption or electronic sabotage (e.g., data wipe upon power removal, software obliteration tools) and plan accordingly.
- Be aware of traditional forensic evidence co-presence. For example, touch DNA, fingerprints, or trace evidence may also be present alongside digital evidence sources. As such, take necessary precautions to preserve such evidence or collect it separately as appropriate.
  - Be aware of supplemental devices associated with electronic or digital evidence sources that may possess probative value (e.g., thumb drives/USB devices, mouse, keyboard, headsets, microphones).
- Recognize the potential for any supplemental devices or sources to contain supporting digital evidence, such as items that may store passwords, encryption key information, operating system/hardware/software username details, or other credentialing information).
- Determine the current operational state of any devices to be collected (e.g., powered on, powered off, or standby/sleep mode). **Do not attempt to alter the operational state of a device** unless the risk of evidence destruction is imminent.
  - "Volatile memory-based evidence" is evidence that will be obliterated once power is severed from the device. Examples of such evidence may include live, on-screen chatroom correspondences, open/unsaved documents, or other items (images/videos/audio data) that may be associated with obliterative software or hardware that will be destroyed upon removing power to the device.[126]
  - Volatile data and items in this state require specialized handling and collection. If you suspect that evidence may be of a volatile memory nature, contact experts with advanced skills and experience in preserving this data before proceeding with collection.

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[125] Scientific Working Group on Digital Evidence. 2018. SWGDE Best Practices for Digital Evidence Collection. Retrieved from https://drive.google.com/file/d/1zP4OgpRrj-t9sVGNcqndqIgsemq7u5XQ/view.
[126] National Institute of Justice. 2001. Electronic Crime Scene Investigation: A Guide for First Responders. Retrieved from https://www.ojp.gov/pdffiles1/nij/219941.pdf.

- If active destruction of evidence from an evidentiary item is occurring, unplug the devices and depower them to halt the destruction, when safe to do so.
  - Desktop computers may be unplugged.
  - Laptop or mobile devices may be unplugged or have the battery removed.
  - In addition, disconnect the device from network connectivity when possible.
  - Document any and all actions taken to prevent destruction of such evidence.[127]
- Be cognizant of both traditional, obvious digital evidence items and disguised evidence (e.g., devices altered or modified to appear non-device-related, damaged, or otherwise insignificant). Examples could include USB devices hidden in other physical locations, devices disguised as or in non-digital items (e.g., devices hidden in books, drawers), or older physical media (e.g., cassettes, VHS tapes, floppy discs, DVDs, CDs). Do not dismiss atypical items such as those mentioned previously—video game consoles, wearable trackers, or IoT toys or devices (e.g., media streaming sticks/devices, home listening devices/automation home service items).
  - When the potential for hidden digital evidence is present, consider the use of electronic detection (ED) K-9 units. Much like cadaver and arson K-9 units used to detect the odor of those evidence types, ED K-9s can be deployed to detect the odor of certain chemicals used in the manufacturing of electronic storage devices.[128] These specialized units have been successful in the detection of electronics containing evidence pertinent to the investigation and prosecution of crimes involving child sexual exploitation and internet crimes against children.[129] Thus, ED K-9 units can be a crucial component in searching for electronic evidence that may be hard to find or otherwise concealed when executing a search warrant.
- Store devices in paper, not plastic containers.[130]
- When possible, photograph the evidence location and position prior to unplugging or removing such evidence.[131]

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[127] Whittaker, 2018. "Judge Orders Amazon to Turn Over Echo Recordings in Double Murder Case." https://techcrunch.com/2018/11/14/amazon-echo-recordings-judge-murder-case/.
[128] Rayome, A.D. 2016. "Electronics-sniffing dogs: How K9s became a secret weapon for solving high-tech crimes." Tech Republic. https://www.techrepublic.com/article/electronics-sniffing-dogs-how-k9s-became-a-secret-weapon-for-solving-high-tech-crimes/
[129] Iowa Department of Public Safety. 2020. Electronic Detection K-9 and Mobile Digital Forensics Lab Tackle Rise in Online Child Sexual Exploitation. https://dps.iowa.gov/electronic-detection-k9-and-mobile-digital-forensics-lab-tackle-rise-online-child-sexual; Joran Detection K-9 Program. 2023. Jordan Detection K-9. https://www.electronicdetectionk9.com/.
[130] Illinois State Police. No Date. Evidence Packaging Procedures. Retrieved from https://www.crime-scene-investigator.net/evidence_packaging_IL.pdf.
[131] National Institute of Justice. 2020. Digital Evidence Policies and Procedures Manual. Retrieved from https://www.ojp.gov/pdffiles1/nij/254661.pdf.

The Scientific Working Group on Digital Evidence (SWGDE) has also published advanced policies on best practices for handling specific devices with digital evidence. When working with IoT devices, SWGDE highlights the importance of MDTs being able to recognize: an IoT device's connection to external services (e.g., cloud storage, product/vendor servers); internal storage considerations; and the need to isolate such devices from a given network to stop continued data-sharing beyond the point of collection.[132] Some IoT devices may be wired directly into the home (e.g., thermostats, smoke alarms) or too large to remove (e.g., home appliances, medical devices). In those instances, either work with professionals who can help remove the devices (such as electrical service providers), or with larger devices, consider whether network traffic suggests data transfer to a manufacturer source (e.g., hub/cloud/server location). If not, you may need to work onsite to pull original data or transactional information from the device itself.

Mobile device collection will differ based on operating systems (e.g., Android versus iOS), whether the device is powered on, and whether the system settings are accessible.[133] If the mobile device is powered on and settings are accessible, disable Bluetooth and Wi-Fi and enable airplane mode to prevent data-sharing and transfer. If the mobile device is not powered on, do not attempt to activate the device. Note that operating system or version-specific expertise may be needed, depending on the make and model of the mobile device.

SWGDE also offers detailed information regarding the collection of video evidence from electronic devices. Devices such as surveillance systems, rideshare/transit systems with recording devices, game/wildlife cameras, and other items may be viable sources for digital evidence collection.[134] Evidence may be collected on-site using dependable file-transferring devices or if the devices have storage that can be processed or removed for processing, as applicable (e.g., removable USB storage). Special prioritization should be given to digital video content and retention periods, as some programs and services may overwrite video content in a given time frame to make room for new recordings.

[132] Scientific Working Group on Digital Evidence. 2020. SWGDE Technical Notes on Internet of Things (IoT) Devices. Retrieved from https://drive.google.com/file/d/1zcDxCLSrwTbwFlTAtjwB6UxMgMHOj3GY/view.
[133] Scientific Working Group on Digital Evidence. 2020. SWGDE Best Practices for Mobile Device Collection & Preservation, Handling and Acquisition. Retrieved from https://drive.google.com/file/d/1sVko_Uo7o6iootWwn9IoLJ3mrMVXqTDg/view.
[134] Scientific Working Group on Digital Evidence. 2021. SWGDE Guidelines for Video Evidence Canvassing and Collection. Retrieved from https://drive.google.com/file/d/1PGxsQYECQIqwUj1RrjvVLHVNswOZDJAE/view.

New Digital Evidence Considerations

Digital evidence collection can be laborious and time-consuming, especially when manual file review is required. Therefore, much effort has been placed into improving the speed and efficiency of digital evidence review. NIJ has specifically funded Grier Forensics for the purpose of creating a new method for scanning disc regions that targets meaningful forensic evidence.[135] Conventional methods for producing disk images result in a 1:1 reproduction of the media source, including areas of irrelevance or that are unused. With the development of the Rapid Forensic Acquisition of Large Media with Sifting Collectors software, Grier Forensics hopes to identify and skip over these regions to better focus evidence identification efforts. The application rapidly recognizes irrelevant "third-party, unmodified applications and, instead, zeroes in on the regions that contain data, artifacts, and other evidence." NIJ also funded RAND Corporation to create a novel application that will reduce the time necessary to process data for forensic evidence from desktop computers. Specifically, the Digital Forensics Compute Cluster (DFORC2) application has improved server memory and speed and augmented processing via increased worker nodes. Worker nodes process tasks—in this case, processing items for meaningful evidence—as assigned by a cluster manager. As such, additional worker nodes means faster evidence processing.

Even the type of evidence processed from digital sources is expanding. Dame Sue Black, a forensic anthropologist, was able to take an eight-second clip of a video in which a perpetrator sexually abused a teenage victim, isolate an image of the perpetrator's hand, and compare the vein patterns in the image to the victim's father, the alleged perpetrator in the case.[136] This pioneering methodology has since been funded by a collaborative effort through the University of Dundee and the European Research Council and is now being used to examine not just vein patterns but also skin crease, scar, pigmentation, and tattoo patterns.[137] The methodology shows significant promise to help resolve cases: since its inception in 2006, 82% of perpetrators faced with evidence from this new forensic tool changed their pleas to guilty.[138]

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[135] Novak, M., Grier, J., & Gonzales, D. 2018. New Approaches to Digital Evidence Acquisition and Analysis. *National Institute of Justice Journal*. Retrieved from https://nij.ojp.gov/topics/articles/new-approaches-digital-evidence-acquisition-and-analysis.
[136] Benson, R. 2017. "To Catch a Paedophile, You Only Need to Look at Their Hands." *Wired*. Retrieved from https://www.wired.co.uk/article/sue-black-forensics-hand-markings-paedophiles-rapists.
[137] Lancaster University. 2019. "Lancaster Leads on Pioneering Hand Identification Research." American Association for the Advancement of Science (AAAS). Retrieved from https://www.eurekalert.org/news-releases/815306.
[138] Guay, J. 2017. "Forensics Expert Invents Way to Catch Paedophiles with a Photo of Their Hand." *Apolitical*. Retrieved from https://apolitical.co/solution-articles/en/forensics-expert-invents-way-catch-paedophiles-photo-hand.

The world of digital evidence collection and related forensic analysis appears to be evolving as rapidly as advances in biological casework. MDTs must keep pace with all possible digital evidence considerations in order to thoroughly explore allegations of child maltreatment. These sources of evidence may be rife with incriminating details, yet could be easily overlooked if investigators lack the training to identify and process such items.

Non-Traditional Corroborating Evidence Best Practices

Up to this point, the guide has focused predominantly on the main typologies of forensic evidence found during a child maltreatment investigation. However, there are other fields of scientific inquiry that could yield meaningful forensic interpretation to the savvy MDT. As such, the remainder of the guide will touch on other unique, situational sources of evidence that could help reconstruct the criminal act and improve case resolution.

Atypical Biological Evidence

Some child maltreatment investigations may involve unique situations where evidence not traditionally considered is available for examination based on the nature of the case, scene location, or the criminal act itself. Criminal activity may occur outdoors, the bodies of child homicide victims may be moved or concealed, or other barriers to traditional resolution may arise that require creative explorations. The following section will outline some key examples of atypical evidence that may improve child abuse and child homicide investigations on a case-by-case basis.

Child Homicide Biological Evidence

Child homicides rose between 2017-2019, and such deaths have only minimally reduced since that time, according to the Child Welfare Information Gateway; maltreatment-related injuries killed 1,820 children in 2021.[139] In these situations, children's bodies may be concealed or disposed of in such a way that considerable damage or decomposition affects identification of the body. In addition to traditional anthropological methodologies that use skeletal remains for identification, MDT personnel should also consider biological evidence from any remaining DNA-bearing tissues or remnants.

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[139] Child Welfare Information Gateway. 2021. Child Abuse and Neglect Fatalities 2019: Statistics and Interventions. Retrieved from https://www.childwelfare.gov/pubs/factsheets/fatality/.

Specifically, investigators should recognize the potential of tissue (e.g., skin or muscle), bones, and teeth to develop a genetic profile. As a result, the following are guidelines for collection of these evidence typologies:[140]

- **Tissues**:
  - Collect with sterile gloved hands and clean forceps.
  - For muscle, attempt to collect 1-2 cubic inches of red skeletal muscle if applicable.
  - Collect into an airtight plastic container free of preservative chemicals (e.g., formaldehyde, formalin), as such preservatives may result in suboptimal DNA processing.[141]
  - For preservation, evidence should be stored or shipped in a frozen state using ice packs as opposed to dry ice.
- **Bones**:
  - Collect with sterile gloved hands and clean forceps.
  - Submit whole bones when possible. Table 7 outlines the order of preference for bones submitted as DNA evidence.
  - Never attempt to cut whole bones; doing so may contaminate them and impair DNA recovery and analysis.
  - Store in paper or an envelope at room temperature if tissue does not exist; if the bone possesses tissue remnants, refrigerate the evidence.

Table 7. FBI Recommendations for Whole-Bone Submission[142]

FBI guidelines call for submitting bones in the following order:

1. Femur	5. Hand and foot bones
2. Tibia	6. Lower arm bone
3. Humerus	7. Vertebrae
4. Teeth, skull, and/or mandible	8. Ribs

[140] Federal Bureau of Investigation. 2019. FBI 2019 Handbook of Forensic Services, https://www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view.
[141] Ullah, S., Garg, R.K. & Noor, F. DNA Perspectives of Fixed and Paraffin Embedded Human Tissues as Resource Materials for the Identification. *Egypt J Forensic Sci* 7, 23 (2017). https://doi.org/10.1186/s41935-017-0027-5.
[142] FBI 2019 Handbook of Forensic Services, p.32, https://www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view.

- **Teeth**:
  - Collect with sterile gloved hands and clean forceps.
  - Submit whole bones when possible. Table 8 outlines the order of preference for teeth submitted as DNA evidence.
  - Store in paper or an envelope at room temperature if tissue does not exist; if the tooth possesses tissue remnants, refrigerate the evidence.

Table 8. FBI Recommendations for Tooth Submission[143]

FBI guidelines call for submitting teeth in the following order:

1. Nonrestored (no dental work) molar
2. Nonrestored premolar
3. Nonrestored canine
4. Nonrestored front tooth
5. Restored molar
6. Restored premolar
7. Restored canine
8. Restored front tooth

Entomological Evidence

In homicide casework, time of death is an important fact to establish, as it helps determine the timeline of events leading up to the homicide event and beyond. The post-mortem interval (PMI)—the period between the time of death and the investigation—can be a powerful clue toward determining time of death and reconstructing the history of events. PMI can be estimated in many conventional ways, such as examining the stages of decomposition for a body or exploring changes to eye chemistry (e.g., vitreous humor).[144] However, one commonly overlooked source of PMI may also be available to investigators: insects.

The field of forensic entomology is a budding subdiscipline, garnering increasing interest in the world of forensic science. Specifically, insect morphology (e.g., developmental features), stages of growth, and the species at hand can help MDTs estimate PMI when other sources of information are unavailable. Instances such as the absence of the vitreous humor, overall desiccation of the body, or environmental foraging could render forensic entomology a promising alternative for estimating PMI.

Many factors contribute to PMI estimates calculated using insects: habitat, insect sex, drug interference (e.g., the metabolic impact to insect growth and development if the body was drugged

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[143] FBI 2019 Handbook of Forensic Services, p.33, https://www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view.
[144] James, R.A., Hoadley, P.A., Sampson, B.G.. Determination of Postmortem Interval by Sampling Vitreous Humour. *Am J Forensic Med Pathol*. 1997. Jun;18(2):158-62. doi: 10.1097/00000433-199706000-00010. PMID: 9185933.

or poisoned), and temperature all play a significant role in determining the post-mortem interval.[145] With all these inputs to consider, researchers have begun to explore the development of a DNA database for rapid insect identification for PMI development purposes, and other studies have also collected weather station temperature data to improve insect PMI estimates.[146] The field is still quite new, with many non-traditional forensic laboratories and academic institutions providing the data for insect analysis. Researchers are continually looking for ways to account for these complexities and improve the accuracy of insect-driven PMI estimates.[147]

Insects can help provide more clues pertinent to child homicide investigators than only PMI. In 2011, one study successfully developed human DNA profiles from maggot crops—maggots raised in storage containers that are typically used as animal feed but that had, in this case, consumed human tissue. Another experiment was able to determine that maggots provided various diets—ranging from beef-fed to starved—still contained viable DNA for profile development from their food source anywhere from two to four days after consumption.[148]

Based on these studies, MDT members should always consider the potential of insects to provide insight into their child homicide casework.

Insect Collection Best Practices

The following collection guidelines apply to casework with relevant insect evidence for forensic analysis:[149]

- Always collect specimens with sterile gloved hands and forceps (when possible for larger insects).

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[145] Wells, J., & LaMotte, L. 2017. The Role of a PMI-Prediction Model in Evaluating Forensic Entomology Experimental Design, the Importance of Covariates, and the Utility of Response Variables for Estimating Time Since Death. *Insects,* 8(2), 47. https://doi.org/10.3390/insects8020047.
[146] Chimeno, C. et al. 2018. DNA Barcoding in Forensic Entomology — Establishing a DNA Reference Library of Potentially Forensic Relevant Arthropod Species. *J of Forensic Sci.* 64. 10.1111/1556-4029.13869; Hofer, I.M.J., Hart, A.J., Martín-Vega, D., & Hall, M.J.R. 2020. Estimating crime scene temperatures from nearby meteorological station data. *Forensic Sci International,* Volume 306, 110028, ISSN 0379-0738, https://doi.org/10.1016/j.forsciint.2019.110028.
[147] Matuszewski S. 2021. Post-Mortem Interval Estimation Based on Insect Evidence: Current Challenges. *Insects,* 12(4), 314. https://doi.org/10.3390/insects12040314.
[148] Li X. et al. 2011. Mitochondrial DNA and STR Analyses for Human DNA from Maggots Crop Contents: A Forensic Entomology Case from Central-Southern China. *Trop Biomed.* Aug;28(2):333-8. PMID: 22041753; Gachuiri Njau, Daniel, Muge, E.K., Kinyanjui, P.W., Omwandho, C.O.A., & Mukwana, Sophie. 2016. STR Analysis of Human DNA from Maggots Fed on Decomposing Bodies: Assessment of the Time Period for Successful Analysis, *Egyptian J of Forensic Sci*. Volume 6, Issue 3, Pages 261-269, ISSN 2090-536X, https://doi.org/10.1016/j.ejfs.2015.04.002.
[149] Amendt J, Campobasso CP, Gaudry E, Reiter C, LeBlanc HN, Hall MJ. 2007. European Association for Forensic Entomology. Best Practice in Forensic Entomology—Standards and Guidelines. *Int J Legal Med.* Mar;121(2):90-104. doi: 10.1007/s00414-006-0086-x. Epub 2006 Apr 22. PMID: 16633812.

- Sterile spoons may be used for collecting maggots.
- Fine paintbrushes can be useful for collecting eggs. Moisten the brush with water before collecting.

- Collect representative samples from all regions of the corpse (not just areas of high insect concentration); label and record accordingly:
  - Eyes/eye sockets
  - Natural orifices (e.g., nasal openings, mouth, urethra external orifice, anus, vagina, ear canals)
  - Corpse: substrate point of contact (e.g., body/soil interface)
  - Wound sites
  - Clothing pleats, creases, pockets, etc.
  - Vessel used to enshroud body (e.g., bag, carpet)
  - Vessel used to transport body (e.g., autopsy bag after transit)
- Recognize that insects may travel to or from the corpse. As such, process insect specimens from roughly 6 to 32 feet (2 to 10 meters) around the body.
- Take a control sample at a distance from the body.
- Make sure to examine all environmental components for potential control or investigative samples (e.g., under fallen branches or logs, on rocks, under carpets, or in bags).
- Killing the insects is recommended when insect rearing/life maintenance is not possible or when probative value is unclear.
  - The optimal killing method is using hot (at least 176°F) but non-boiling water. Immerse insects for three seconds before draining the water, rinse specimen with ethanol, and then preserve as indicated below.
  - An alternative killing method is to mix 1 part kerosene, 2 parts acetic acid, and 10 parts 70% alcohol to create K.A.A., a solution that can be stored indefinitely in a glass vial or jar for killing purposes.[150] Immerse insect until deceased; then preserve as indicated below.

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[150] Haskell, N. & Catts, E.P. (Editors). 2008. Entomology & Death: A Procedural Guide. 2nd Edition. East Park Printing, Clemson, SC. ISBN: 978-0-615-21455-9.

- Dead specimen preservation:
  - Store in glass container or vial containing 70-95% ethanol with tight (e.g., screw-cap) lid.
- Living specimen storage:
  - Eggs: Wrap in paper tissue moistened with water and place in glass vial or container. Container lid should provide means for ventilation but not escape (e.g., pinholes in lid). Transfer samples to entomology expert for rearing within 24 hours or kill if living maintenance is impossible.
  - Larvae (e.g., maggots): Store in known, recorded environmental conditions similar to the collection environment; 36°F-43°F (colder temperatures) is an ideal storage range. Line glass vial with tissue paper or sawdust to absorb fluid maggot byproducts. Container lid should provide means for ventilation but not escape.
  - Adult insects: Collect all beetles and flies as applicable.
    - Flying insects may be caught with a net.
    - Preference should be given to freshly emergent blowflies (e.g., silver-like appearance, shriveled wings).
    - Dead flies and beetles on or around the body are viable sources of evidence.

Ecological Evidence

Much like entomological evidence, ecological (environmental) evidence can play an integral, unique role in resolving child maltreatment cases. As noted in previous sections, leaf litter and plant material may be a core component of trace evidence. Specifically, the field of forensic botany can help validate the mode of death, location of crime, or PMI.[151]

Delving even deeper, the subdiscipline of botany that examines plant pollen and spores—known as **palynology**—may be deployed in certain child maltreatment investigations. Forensic palynology can establish correlations between people, items, and locations based on the pollen from specific plant

[151] Miller Coyle H, Lee CL, Lin WY, Lee HC, Palmbach TM. Forensic botany: using plant evidence to aid in forensic death investigation. Croat Med J. 2005 Aug;46(4):606-12. PMID: 16100764; Coyle HM, editor. 2005. Forensic botany: principles and applications to criminal casework. Boca Raton (FL): CRC Press. ISBN: 978-0849315299.

species.[152] In 2015, forensic palynology was used in the successful prosecution of a child homicide case. The National Center for Missing and Exploited Children (NCMEC) helped connect Boston police with U.S. Customs and Border Protection palynologist Andrew Laurence, who was able to identify the pollen grains from the blanket and pants of an unidentified child.[153] By narrowing down the location to an urban locale in Boston where the child had been prior to death, officials were able to identify the child and charge the child's mother and her boyfriend with murder and accessory after the fact, respectively.

Seeds, too, can be used to establish facts and make associations in child maltreatment cases. The subdiscipline of **carpology** examines the anatomy and composition of plant and fruit seeds.[154] In a Minnesota child sexual abuse case, forensic carpology was used to identify the source of blueberry seeds.[155] The child indicated that oral sexual abuse had occurred, and blueberry seeds were subsequently sampled from the child's mouth. Identical blueberry seeds were also discovered in the suspect's pants on the inside of the zipper. The suspect claimed the seeds in his pants were the result of the child vomiting on him. Yet if that were the case, the seeds and blueberry remnants should only have been found on the exterior surface of the pants; thus, seeds from a plant substantiated the child's claims of abuse.

Dendrochronology, the study of tree-ring growth, has also been used in forensic applications, namely to estimate PMI.[156] Two Massachusetts cases used samples from tree roots to estimate the approximate burial age of two bodies.[157] Such information may be feasible when significant time has passed and limited information can be gleaned from conventional means.

New research in forensic botany has delved into genetic analysis of plant seeds for identification and microscopic examination of seeds for exceptional detail regarding seed adulteration (e.g., if a tomato seed was cooked or not) that may be of forensic relevance.[158] Similarly, DNA from leaf material has been used to disassociate material retrieved from a suspect's vehicle from that retrieved from a

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[152] The Forensics Library. No Date. Forensic Palynology. Retrieved from https://aboutforensics.co.uk/forensic-palynology/.
[153] Green, E. 2015. Fighting Crime, With Pollen. The Atlantic: Science. Retrieved from https://www.theatlantic.com/science/archive/2015/11/fighting-crime-with-pollen/416259/.
[154] Doweld, Alexander B. & Shevyryova, Natalie A. Carpology, Seed Anatomy and Taxonomic Relationships of Galbulimima (Himantandraceae), *Annals of Botany*, Volume 81, Issue 2, February 1998, Pages 337–347, https://doi.org/10.1006/anbo.1997.0564.
[155] Coyle, H.M., Lee, C., Lin, W., Lee, H.C., & Palmbach, T.M. 2005. Forensic botany: using plant evidence to aid in forensic death investigation. *Croatian Medical Journal*: 46(4).
[156] Environmental Science. 2022. Dendrochronology: What Tree Rings Tell Us About Past and Present. Retrieved from https://www.environmentalscience.org/dendrochronology-tree-rings-tell-us.
[157] Pokines, James. 2018. Two Cases of Dendrochronology Used to Corroborate a Forensic Postmortem Interval. *Journal of Forensic Identification*. 68. 457-465.
[158] Lee, C. L., Huang, Y. H., Hsu, I. C., & Lee, H. C. 2019. Evaluation of Plant Seed DNA and Botanical Evidence for Potential Forensic Applications. *Forensic Sciences Research,* 5(1), 55–63. https://doi.org/10.1080/20961790.2019.1594599.

pregnant woman killed in a hit-and-run double homicide.[159] Consequently, consider plant materials not just for their class and individual characteristics, but also for the identification (both morphologically and genetically) that these potential evidence items can supply.

Plant-Based Evidence Guidelines

Environmental evidence should be collected in alignment with best practices outlined for trace evidence of this nature. Specifically:

- Plant materials (e.g., seeds, leaf litter) should be dried when possible and stored in paper containers to prevent putrefaction, as outlined in the "Trace Evidence Best Practices" section of this document.[160]
- Pollen collection using adhesive tape has shown success when exploring palynology-based results.[161]
- For forensic-related tree growth samples, manuals do exist to aid in the processing and collection of tree-ring samples, but MDT personnel should contact experienced dendrochronologists and dendrochronology service providers for relevant tree core sampling and interpretation.[162]

Non-Traditional Partners in Crime-Solving

Beyond evidence collected at the crime scene, another way to shore up an investigation is to think critically and expansively about non-traditional experts and other community stakeholders available to you. These potential collaborators or witnesses could provide additional avenues of corroboration.

[159] Craft KJ, Owens JD, Ashley MV. 2007. Application of Plant DNA Markers in Forensic Botany: Genetic Comparison of Quercus Evidence Leaves to Crime Scene Trees Using Microsatellites. *Forensic Sci Int. Jan* 5;165(1):64-70. doi: 10.1016/j.forsciint.2006.03.002. Epub 2006 May 2. PMID: 16632287.
[160] OSAC. 2020. Trace Materials Crime Scene Investigation Guide. https://www.nist.gov/system/files/documents/2020/08/26/CSI_Guide_07302020_ForPublication.pdf.
[161] Wu, Chun & Yang, Chiou-Herr & Huang, Tseng-Chieng. 2006. Forensic Pollen Evidence from Clothes by the Tape Adhesive Method. *Taiwania*. 51. 10.6165/tai.2006.51(2).123.
[162] Tenzin, Karma & Dukpa, Dorji. 2017. Dendrochronological Manual. UWICER Press. ISBN: 978-99936-743-0-6.

Novel MDT Collaborators

While forensic evidence typically entails physical sources of potential information collected on-scene by experienced investigators, external sources of testimonial and physical evidence could also substantiate claims of abuse. To that end, consider consulting with experts who interface with children in a professional capacity and who may, therefore, have related observations regarding allegations of abuse. Note that the following guidance applies to field-specific evidence pertinent to substantiating claims of abuse; as such, MDT personnel should follow up with the consulted professionals regarding any supplemental testimonial or observational evidence collected based on their expertise.

Forensic Optometry Considerations

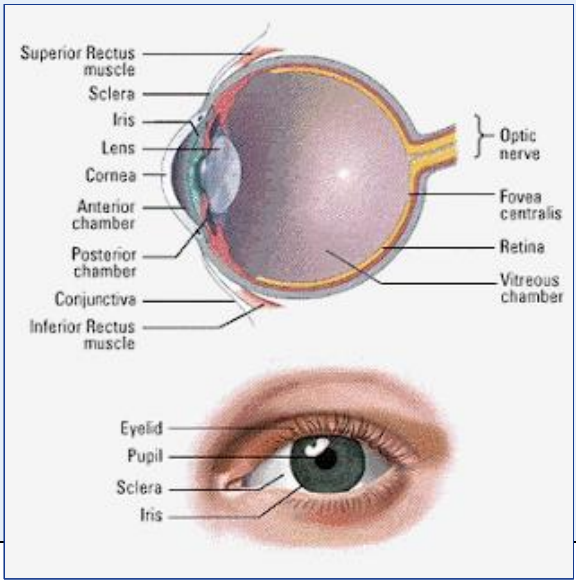
Physical child abuse has many key physical indicators, but MDT members may not realize that approximately 4-6% of cases first present during a visit with an ophthalmologist.[163] Observing ocular damage and then checking for further indicators of abuse is a well-documented phenomenon; one of the first diagnostic guides for ophthalmologists was published in 1988.[164] Retinal hemorrhaging is the most common eye-related abuse injury, present in 75% of abusive head trauma cases.[165] Table 9, below, lists potential maltreatment-related eye injuries and is accompanied by Figure 4, detailing the major parts of the eye.[166] Please note that this list is not comprehensive, as many other eye problems may occur as a result of child maltreatment—for instance, blindness resulting from neglect (e.g., malnourishment, poor hygiene), chemical/herbal adulteration, or an STI from sexual abuse.[167]

[163] Levin, A. 2022. Pediatrics: Eye in Child Abuse. Retrieved from https://www.cancertherapyadvisor.com/home/decision-support-in-medicine/pediatrics/eye-in-child-abuse/.
[164] Smith SK. 1988. Child abuse and neglect: a diagnostic guide for the optometrist. J Am Optom Assoc. Oct;59(10):760-6. PMID: 3053863.
[165] Bhardwaj G, Chowdhury V, Jacobs MB, Moran KT, Martin FJ, Coroneo MT. 2010. A systematic review of the diagnostic accuracy of ocular signs in pediatric abusive head trauma. Ophthalmology. 117(5):983-992.e17. doi: 10.1016/j.ophtha.2009.09.040. Epub 2010 Mar 27. PMID: 20347153; Christian CW, Levin AV; Council on Child Abuse and Neglect; Section on Ophthalmology; American Association of Certified Orthoptists; American Association for Pediatric Ophthalmology and Strabismus; American Academy Of Ophthalmology. 2018. The Eye Examination in the Evaluation of Child Abuse. *Pediatrics*. 142(2):e20181411. doi: 10.1542/peds.2018-1411. PMID: 30037976
[166] Levin, A. 2022. Pediatrics: Eye in Child Abuse. Retrieved from https://www.cancertherapyadvisor.com/home/decision-support-in-medicine/pediatrics/eye-in-child-abuse/.
[167] Chana, H. S., & Klauss, P. V. 2002. Ocular Manifestations of Child Abuse. *Community Eye Health*, 15(41), 11–12.

Table 9. Types of Ocular Trauma Correlated to Child Abuse[168]

- Cataract development in lens (unilateral or single-eye)
- Corneal scarring
- Ectopia lentis (eye lens displacement)
- Hyphema (blood in anterior chamber)
- Intracranial pressure
- Lacerations, punctures (lid, conjunctiva)
- Optic atrophy (unilateral or single-eye)
- Optic nerve avulsion (tearing, disconnect)
- Orbital bone fracture
- Periocular ecchymosis (blood in eye socket or eye orbit)
- Pupil margin tearing
- Retinal bruising
- Retinal detachment
- Retinal hemorrhage
- Subconjunctival hemorrhage (blood vessel breaks under conjunctiva)
- Vitreous base detachment

Figure 4. Components of the Eye.[169]



Any claims or evidence of the following types of abuse should be vetted by ophthalmological and traditional healthcare professionals: head trauma, strangulation, laceration/puncturing, burns (e.g., chemical, scalding, combustion) about the eye or head area, shaken baby syndrome, sexual assault involving activities on or around the face and eyes, or indications of food or water deprivation or hygienic deficiencies where eye damage could occur.[170]

When investigating abuse and neglect involving damage to the eye and surrounding areas, devote special care to eliminate alternative, medical reasons for ocular damage, such as undiagnosed medical conditions, comorbidities, or congenital defects that could present similarly to abuse-like

[168] Craft. 2007. Application of Plant DNA Markers in Forensic Botany. doi: 10.1016/j.forsciint.2006.03.002.
[169] Author unknown. Diagram is licensed under CC BY-NC-ND.
[170] Binenbaum, G., et al. 2013. Patterns of Retinal Hemorrhage Associated with Increased Intracranial Pressure in Children. *Pediatrics*, 132(2), e430–e434. https://doi.org/10.1542/peds.2013-0262; AlShehri, O. A., Almarzouki, H., Alharbi, B. A., Alqahtani, M., & Allam, K. 2017. Bilateral Posterior Crystalline Lens Dislocations in an Otherwise Healthy Child. *GMS Ophthalmology Cases*, 7, Doc26. https://doi.org/10.3205/oc000077

damage.[171] Likewise, recognize the forensic potential for eyewear when substantiating or disproving claims about crime scene presence or absence, visual acuity, or other relevant situations. Contact lenses or glasses may have epithelial cell DNA for processing, and prescriptions for those visual aids may indicate available optometry records for substantiating ownership of those items or noting previous physical anomalies.[172]

Forensic Dental Considerations

Like the potential for evidence gleaned from ophthalmological examination, dental examinations can also provide unique insight into situations involving child abuse. Physical and sexual abuse, along with dental neglect, are common typologies of abuse that can be detected by dentists and other oral health providers during routine medical evaluation.[173] Providers may also be consulted for forensic substantiation of abuse claims. Forensic odontologists, for instance, can aid in bitemark analysis.

The 2017 "Oral and Dental Aspects of Child Abuse and Neglect" article in the journal of *Pediatrics* provides a comprehensive overview of child maltreatment typologies and subsequent evidence that may be recorded through a dental examination.[174] Major signs of physical or sexual abuse specifically correlated to dentistry-related evidence may entail the following:

- Damage (lacerations, puncture wounds, contusions) resulting from injury sustained by utensils (e.g., bottle, fork, spoon) during a physical altercation or forced-feeding event.
- Damage sustained from digital or sexual penetration (e.g., fingers, penis, sexual implements; impromptu or improvised items used to inflict harm).
- Burns resulting from scalding or chemical exposure (e.g., caustic substances).

Oral injuries are most frequent on **lips** (54%), followed by:

- Oral mucosa (e.g., lining inside mouth)
- Teeth (fractured, displaced, avulsed—completely dislodged)

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[171] Ermilov VV, Tkachenko MV. 2013. The Eye as an Object of Forensic Medical Identification. *Sud Med Ekspert.* Jul-Aug;56(4):51-5. Russian. PMID: 24428060.
[172] R. Aparna, R. Shanti Iyer. 2020. Tears and Eyewear in Forensic Investigation—A Review, *Forensic Science International,* Volume 306, 110055, ISSN 0379-0738, https://doi.org/10.1016/j.forsciint.2019.110055.
[173] American Academy of Pediatrics Committee on Child Abuse and Neglect and the American Academy of Pediatric Dentistry Council on Clinical Affairs. 2016. Guideline on Oral and Dental Aspects of Child Abuse and Neglect. American Academy of Pediatric Dentistry. 38(6). Retrieved from https://www.aapd.org/assets/1/7/G_Childabuse1.PDF.
[174] Fisher-Owens SA, Lukefahr JL, Tate AR. 2017. American Academy of Pediatrics, Section on Oral Health; Committee on Child Abuse and Neglect; American Academy of Pediatric Dentistry, Council on Clinical Affairs, Council on Scientific Affairs; Ad Hoc Work Group on Child Abuse and Neglect. Oral and Dental Aspects of Child Abuse and Neglect. *Pediatrics*. Aug;140(2):e20171487. doi: 10.1542/peds.2017-1487. PMID: 28771417.

- Gums (e.g., gingiva)
- Tongue.[175]

Additional areas where localized abuse-related damage may be present include:[176]

- Alveolar mucosa (lining just beneath the attached gingiva, where gums encase junction of teeth with bone)
- Buccal mucosa (e.g., inner lip, cheek lining)
- Contusions or scarring around the mouth, corners of the mouth (from oral restraints or muffling items)
- Frenum (thin line of tissue connecting lips, gums)
- Palates (hard/bone, soft/tissue)
- Pulpal necrosis (death of soft pulp from damage)

Sexual abuse evidence is uncommon from a dentistry perspective. However, depending on the nature of the crime and the force applied, it may result in oral lacerations or contusions. If dentists observe evidence of potential child sexual abuse, they should provide an oral examination and can coordinate evidence collection with their MDT or a trained SANE for laboratory testing, if appropriate.[177] Ultimately, the dental professional should coordinate with other MDT professionals to properly process relevant sexual assault evidence (via a SANE examination/SAK) and report abuse allegations. In addition to assessing for MDT needs, be sure to gauge the immediate physical needs of the child and non-offending caregiver and provide appropriate information on resources for intervention and recovery.

Dental neglect is another form of maltreatment that may be observed by the dental healthcare professional.[178] Dental neglect arises when a caregiver willfully fails to provide access to care that would ensure optimal oral wellbeing. Diseases, dental caries (cavities), and advanced decay leading

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[175] Naidoo, S. 2000. A profile of the oro-facial injuries in child physical abuse at a children's hospital. *Child Abuse Negl.* Apr;24(4):521-34. doi: 10.1016/s0145-2134(00)00114-9. PMID: 10798841.
[176] Fisher-Owens, S.A, Lukefahr, J.L., Tate, A.R. 2017. American Academy of Pediatrics, Section on Oral Health; Committee on Child Abuse and Neglect; American Academy of Pediatric Dentistry, Council on Clinical Affairs, Council on Scientific Affairs; Ad Hoc Work Group on Child Abuse and Neglect. Oral and Dental Aspects of Child Abuse and Neglect. *Pediatrics*. Aug;140(2):e20171487. doi: 10.1542/peds.2017-1487. PMID: 28771417.
[177] Jenny C. Crawford-Jakubiak JE. 2013. Committee on Child Abuse and Neglect; American Academy of Pediatrics. The evaluation of children in the primary care setting when sexual abuse is suspected. *Pediatrics*. 2013 Aug;132(2):e558-67. doi: 10.1542/peds.2013-1741. Epub Jul 29. PMID: 23897912.
[178] Ramazani, N. 2014. Child Dental Neglect: A Short Review. *International Journal of High Risk Behaviors & Addiction*, 3(4), e21861. https://doi.org/10.5812/ijhrba.21861.

to pain, infection, and tooth-loss can occur in these situations. Care should be given in instances where alleged dental neglect occurred to differentiate between willful neglect and incidental neglect due to non-malicious factors.[179]

Veterinary MDT Insights

According to a 1997 study, abusers of animals are approximately five times more likely to commit violent crimes against other humans.[180] Children who commit harmful acts toward animals are two times or more likely to have been a victim of abuse themselves.[181] Pet abuse is also a demonstrated risk factor for domestic and interpersonal violence.[182] Altogether, the picture is clear: abuse of pets and abuse of persons are intertwined.

As far back as 1999, recommendations called for veterinary clinicians to receive increased training on recognizing animal abuse in its various forms.[183] Since that time, evidence indicates limited improvements in veterinary training and education regarding recognizing and responding to evidence of abuse—either during a home visit or while in a clinical setting.[184] This gap in knowledge extends to MDT professionals, as well. Only 19% of law enforcement personnel received animal cruelty training of any sort, according to a 2010 American Society for the Prevention of Cruelty to Animals (ASPCA) study.[185]

Given the intersection of animal and child abuse, MDTs should consider collaborating with veterinary practitioners where appropriate. A 2020 report in *Forensic Science International* provides fundamental guidelines for veterinarians aiding in animal examinations as part of abuse allegations.[186] These

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[179] Erickson, M.F., & Egeland, B. 2002. Child Neglect. In J. E. B. Myers, L. Berliner, J. Briere, C. T. Hendrix, C. Jenny, & T. A. Reid (Eds.). 1999. The APSAC Handbook on Child Maltreatment (pp. 3–20). Sage Publications, Inc.
[180] Arluke, A. & Luke, C. 1997. Physical Cruelty towards Animals in Massachusetts, 1975-1996. White Horse Press. Retrieved from https://www.animalsandsociety.org/wp-content/uploads/2015/10/arluke.pdf.
[181] Becker, Fiona & French, Lesley. 2004. Making the Links: Child Abuse, Animal Cruelty and Domestic Violence. Child Abuse Review. 13. 399 - 414. 10.1002/car.878.
[182] Newland X, Boller M, Boller E. 2019. Considering the relationship between domestic violence and pet abuse and its significance in the veterinary clinical and educational contexts. N Z Vet J. Mar;67(2):55-65. doi: 10.1080/00480169.2018.1559108. Epub 2019 Jan 15. PMID: 30557525; Robinson, C. 2021. The Link Between Animal Cruelty and Human Violence. FBI Law Enforcement Bulletin. Retrieved from https://leb.fbi.gov/articles/featured-articles/the-link-between-animal-cruelty-and-human-violence.
[183] Landau, R.E. A Survey of Teaching and Implementation: The Veterinarian's Role in Recognizing and Reporting Abuse. *J Am Vet Med Assoc*. Aug 1;215(3):328-31. PMID: 10434967.
[184] Newland X, Boller M, Boller E. 2019. Considering the Relationship between Domestic Violence and Pet Abuse and Its Significance in the Veterinary Clinical and Educational Contexts. *N Z Vet J.* 2019 Mar;67(2):55-65. doi: 10.1080/00480169.2018.1559108. Epub Jan 15. PMID: 30557525.
[185] American Society for the Prevention of Cruelty to Animals. 2010. ASPCA Announces Groundbreaking Research Study Underscoring Importance of Animal Cruelty Law Enforcement. Retrieved from https://www.aspca.org/about-us/press-releases/aspca-announces-groundbreaking-research-study-underscoring-importance-animal.
[186] R. Touroo, K. Baucom, M. Kessler, M. Smith-Blackmore. 2020. Minimum Standards and Best Practices for the Clinical Veterinary Forensic Examination of the Suspected Abused Animal, *Forensic Science International: Reports,* Volume 2, 100150, ISSN 2665-9107, https://doi.org/10.1016/j.fsir.2020.100150.

baseline standards can help veterinary clinicians with a range of maltreatment situations—verifying physical animal abuse allegations or determining whether an animal was sexually abused or used to perpetrate sexual abuse. Using this guidance, veterinarians could, for instance, help corroborate animal abuse in cases where a child discloses that the perpetrator physically abuses a cherished pet as a means of coercive control over the youth.[187]

Similarly, veterinary forensics has evolved as a subdiscipline of veterinary medical practice, and as such, forensic veterinarians may be consulted specifically in situations where allegations of abuse or cruelty to a pet have occurred or when an animal is identified as a source for direct or corroborating evidence.[188] ASPCA has launched the first MDT forensic veterinary laboratory in the United States (the ASPCA Veterinary Forensic Science Center, or AVFSC). The AVFSC supports frontline investigators with cases involving animal maltreatment to aid in child maltreatment investigations.[189] MDT professionals may reach out to the AVFSC directly for assistance or to consult with local veterinarians on cases already under MDT investigation.

Innovative Witness Assistance

In addition to the expertise and support of clinical practitioners, child maltreatment investigators can also collect accounts from community members who may have observed evidence of child abuse and neglect. Thanks to the Child Abuse Prevention and Treatment Act (CAPTA), 47 states designate specific workers who have a legal obligation to report abuse, and 18 states mandate that anybody who suspects child maltreatment must report it.[190] As such, there may be untapped sources of information who can provide potential insight into allegations of abuse. Common sources include teachers, doctors, nurses, childcare providers, counselors, social workers, and other child-centered professionals.

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[187] Animal Legal Defense Fund. 2021. Animal Cruelty's Link to Other Forms of Violence. Retrieved from https://aldf.org/wp-content/uploads/2022/01/Animal-Legal-Defense-Fund-Link-Factsheet.pdf.
[188] Nicola M.A. Parry, Alexander Stoll. 2020. The Rise of Veterinary Forensics. *Forensic Science International,* Volume 306. 110069, ISSN 0379-0738, https://doi.org/10.1016/j.forsciint.2019.110069.
[189] American Society for the Prevention of Cruelty to Animals. 2021. ASPCA Veterinary Forensic Science Center (AVFSC). Retrieved from https://www.aspcapro.org/about-programs-services/aspca-veterinary-forensic-science-center-avfsc.
[190] Child Welfare Information Gateway. 2019. Mandatory Reporters of Child Abuse and Neglect. Retrieved from https://www.childwelfare.gov/pubPDFs/manda.pdf.

However, many other community members interface with children and families on a regular basis—and often in a residential setting. For instance, landlords have both access to a residence as well as a vested interest in protecting tenants from abuse: many states have laws to protect the rights of abuse victims regarding rental agreement nullification, to provide fair treatment to victims of abuse, and to compensate property damage.[191] Residential tradespeople—plumbers, electricians, pest control service providers, or heating, cooling and ventilation professionals—may be in or near a residence regularly and could provide information regarding their observations: behaviors or statements made by the residents, the general state of the residence, or other potential signs of abuse or neglect.[192] Even atypical home service providers could be bastions of information pertinent to casework and should be considered as appropriate: parcel delivery workers, home healthcare aids, letter carriers, and food and grocery delivery providers may have key observations to support the case.

That said, there is little to no education provided to these frontline commercial and home service providers about recognizing and

Child Advocacy Studies:
Training the Next Generation

Since 2004, Zero Abuse Project's Child Advocacy Studies (CAST) program has attempted to bridge the gap in frontline child-serving and child-intersecting professional education. CAST has been deployed at more than 90 institutions across 30 U.S. states.

Over a half-dozen studies have demonstrated its ability to improve incoming professionals' recognition of and response to child maltreatment, and it has been listed as an evidence-based program by the California National Evidence-Based Clearinghouse.* The demand for nationwide, cross-discipline CAST implementation was recently highlighted in the U.S. National Blueprint to End Sexual Violence Against Children and Adolescents.**

Incorporating CAST into all education and training programs could truly prepare community stakeholders for recognizing and reacting to child maltreatment. Contact Zero Abuse Project to learn how to include CAST modules in your workplace development.

*Vieth, Victor et al. (2019) "Child Advocacy Studies (CAST): A National Movement to Improve the Undergraduate and Graduate Training of Child Protection Professionals," *Mitchell Hamline Law Review*. (45:4). https://open.mitchellhamline.edu/mhlr/vol45/iss4/5; California Evidence-Based Clearinghouse. 2021. Child Advocacy Studies (CAST). www.cebc4cw.org/program/child-advocacy-studies.
**Keep Kids Safe. 2021. U.S. National Blueprint to End Sexual Violence Against Children and Adolescents. https://uploads-ssl.webflow.com/5fd792b77f9a0e4a5c5992ba/618c23089490796860ed93bc_18Nov2021_KKS_NationalPolicyBlueprint_Final.pdf.

[191] Northwest Justice Project. 2022. Landlord/Tenant Issues for Domestic Violence Survivors. WashingtonLawHelp.org. Retrieved from https://www.washingtonlawhelp.org/resource/landlordtenant-issues-for-survivors-of-domest; Legal Aid Services of Oregon & Oregon Law Center. 2016. A Safe Place to Live. Housing Rights for Domestic Violence, Sexual Assault, and Stalking Victims. Retrieved from https://oregonlawhelp.org/files/CCDACC15-944D-570E-7F1F-7BBF3DEC0018/attachments/38BC8B56-EA28-4E57-B91E-5F3EAA239A9F/dv-housing-protections-w-subsidized-housing-info-2017.pdf..
[192] DePanfilis, D. 2020. Arizona Family Connections Intervention Manual. Retrieved from https://dcs.az.gov/sites/default/files/DCS-Forms/CSO-2479.pdf; Office on Child Abuse and Neglect, Children's Bureau.

reporting suspected child maltreatment—even for workers operating in states that mandate everyone report child abuse and neglect. For instance, despite a 70% increase in package delivery during the pandemic—meaning more delivery professionals were at more homes than ever before and could have observed evidence or incidence of child abuse—training programs and policies for parcel delivery personnel do not discuss the topic of child maltreatment.[193]

At the very least, extending child maltreatment training and education to these frontline professionals could vastly broaden the network of available witnesses. At best, it could help curtail abuse, identify offenders, and secure vital evidence in the work to keep kids safe.

2006. Child Neglect: A Guide for Prevention, Assessment and Intervention. Retrieved from https://www.childwelfare.gov/pubs/usermanuals/neglect/.

[193] Bogage, J. & Dawsey, J. 2020. Postal service to review package delivery fees as Trump influence grows. *The Washington Post*. Retrieved from: https://www.washingtonpost.com/business/2020/05/14/trump-postal-service-package-rates/; Law Offices of Dennis R. Fusi & Associates, PLC. What is UPS's Integrad? Retrieved from: https://www.fusilawfirm.com/what-is-upss-integrad/; FedEx. 2022. Citizenship. Retrieved from http://www.fedex.com/bt/about/citizenship/index.html.

Conclusion

Forensic Pioneer Paul L. Kirk, in his seminal publication *Crime Investigation: Physical Evidence and the Police Laboratory*, pontificated upon Locard's Exchange Principle—that every perpetrator will both bring something to the crime scene and leave with something from it—stating that:

> "Wherever he steps, whatever he touches, whatever he leaves, even unconsciously, will serve as a silent witness against him. Not only his fingerprints or his footprints, but his hair, the fibers from his clothes, the glass he breaks, the tool mark he leaves, the paint he scratches, the blood or semen he deposits or collects. All of these and more, bear mute witness against him. This is evidence that does not forget. It is not confused by the excitement of the moment. It is not absent because human witnesses are. It is factual evidence. Physical evidence cannot be wrong, it cannot perjure itself, it cannot be wholly absent. Only human failure to find it, study and understand it, can diminish its value."[194]

There is no more accurate statement to capture the importance of proper evidence collection—particularly in cases of child maltreatment. Evidence of abuse will always be present in some manner. It is up to the frontline defenders of justice to remain vigilant in their knowledge and training of evidence collection so that every child can be free from abuse.

[194] Kirk, P.L. 1953. Crime Investigation: Physical Evidence and the Police Laboratory. Interscience Publishers.

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