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Evidence Collection and Analysis for Touch Deoxyribonucleic Acid in Groping and Sexual Assault Cases

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ABSTRACT

Historically, evidence collection in sexual assault cases focused on obtaining foreign contributor bodily fluids through swab collection. With improvements in deoxyribonucleic acid (DNA) analysis methods, DNA profiles can be developed from touch DNA and applied to sexual assault cases. Following a literature review on factors affecting touch DNA transfer, a groping case study with innovative evidence collection is presented to support the expansion of touch DNA evidence collection in sexual assault cases. The groping case led to the development of a statewide sexual assault touch DNA form to guide evidence collection. DNA findings from additional groping sexual assault cases are reported to further show and justify the importance of evidence collection in groping cases. Implications on multidisciplinary practices are summarized to promote evidence collection and analysis in groping sexual assault cases. As forensic nurses are educated to accurately collect DNA evidence and provide trauma-informed, patient-centered care, they are best suited to provide nursing care for patients who have experienced groping sexual assaults. Optimal DNA findings in groping and sexual assault cases are best achieved through development of strong multidisciplinary, collaborative relationships between forensic nurses and forensic scientists.

KEY WORDS:

DNA analysis; evidence collection; groping sexual assault; sexual assault; sexual assault nurse examiner (SANE); touch DNA

Standardized protocols and procedures exist for sexual assault forensic medical examinations (SAFMEs) to provide optimal care for victims and to collect,

preserve, and document evidence contained in sexual assault kits (SAKs). In the United States, national protocols exist for both pediatric and adolescent/adult SAFMEs (Office

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on Violence Against Women, U.S. Department of Justice, 2013, 2016). Additional best practice guidelines regarding SAKs and evidence collection during SAFMEs are contained in *National Best Practices for Sexual Assault Kits: A Multidisciplinary Response* (National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 2017).

The best practice guidelines contained in the national protocol documents primarily address evidence collection when assailants' bodily fluids (i.e., seminal fluid, blood, saliva) contact victims' bodies during sexual assault (SA) as bodily fluids have high concentrations of assailants' deoxyribonucleic acid (DNA). Historically, with less sensitive DNA analysis methods, the detection of assailants' bodily fluids in SA cases was necessary to proceed with DNA analysis, but with the advent of more sensitive DNA analysis methods, assailants' DNA profiles can also be developed from touch contact (Bowman et al., 2018; R. A. H. van Oorschot et al., 2019; Wickenheiser, 2002). As the legal definition of SA generally includes nonconsensual groping or touching of genitals or breasts over or under clothes, collecting touch DNA to identify proper assailants is of merit. The purpose of this article is to explore the application of touch DNA evidence collection in groping and SA cases through a literature review, case study, and additional case findings and to provide guidance on collection of touch DNA.

Overview of Touch DNA

The possibility of developing DNA profiles from skin or epithelial cells from touch contact was introduced over 20 years ago (R. A. van Oorschot & Jones, 1997). Since then, DNA analysis methods have continued to improve, requiring smaller amounts of biological material to develop DNA profiles from touched objects or skin.

Touch DNA includes DNA from skin or epithelial cells, which is transferred to objects or individuals when touched by hands or other body parts. Although the outer layer of skin contains dead skin cells without nuclei, it is theorized that small DNA fragments exist on the surface of the skin and can be transferred to touched items (Kita et al., 2008). The mechanism for the transfer of touch DNA is believed to occur through skin cell shedding and perspiration or sweat (Burrill et al., 2019). As the amount of DNA deposited with touch is usually small, the term "trace DNA" is often used to describe low-level amounts of DNA (R. A. van Oorschot et al., 2010; Wickenheiser, 2002).

Factors Affecting Touch DNA Transfer

Researchers have identified factors that affect the transfer of touch DNA: skin-shedding status, type of touch contact, and substrate surface (see Table 1).

Skin-Shedding Status

Developing probative DNA profiles from touch DNA is largely dependent on the skin-shedding status of assailants.

Research studies exploring the amount of touch DNA deposited by individuals categorize subjects as high or low shedders (Goray et al., 2016; R. A. H. van Oorschot et al., 2019). Although the physiological mechanisms determining skin shedding rates are not clearly understood, some studies have found that individuals are consistently high or low skin shedders (Goray et al., 2016; Kanokwongnuwut et al., 2018). Yet, other studies have found substantial individual variability regarding shedder status indicating that complex mechanisms exist in the deposition of touch DNA (Manoli et al., 2016; Wickenheiser, 2002).

Factors found to influence an individual's shedding status include gender, age, amount of hand sweat, dryness of hands, and personal cleanliness habits. Multiple research studies indicate men are higher shedders than women (Goray et al., 2016; Lacerenza et al., 2016; Manoli et al., 2016). According to one study, young adult men (18–45 years) appear to have higher rates of shedding than women of the same age (Manoli et al., 2016). As young adult men comprise a high percentage of SA and groping perpetrators, analyzing touch DNA is especially useful in this demographic. Individuals with sweaty hands appear to have higher rates of shedding (Zoppis et al., 2014). Interestingly, individuals with dry hands have also been found to have increased skin shedding likely because of flaking of dead skin cells (Goray et al., 2016). Although sweaty hands and dry hands may seem like opposite skin conditions, each condition actually increases skin shedding as sweat and flaky skin both contain low levels of DNA that would be available for transfer during a touching or groping event (Akutsu et al., 2018).

Individuals' personal habits may also impact the amount of skin shedding. Hand washing appears to decrease the rate and amount of skin shedding; therefore, frequent hand

TABLE 1. Factors Affecting Touch DNA Transfer

Factor	Implications on touch DNA transfer
Skin-shedding status	Profiles of high shedders: <ul style="list-style-type: none"> • Men, ages 18–45 years old • Sweaty or dry hands • Lack of hand washing • Frequently touch their body with their hands
Type of contact	Touch DNA yield increases with: <ul style="list-style-type: none"> • Greater pressure of hands on object/body • Friction between hands and touched object/body • Increased touch time
Substrate surface	Touch DNA yield is greater when collected from porous or rough surfaces (such as wood or fabric) than nonporous or smooth surfaces.

DNA = deoxyribonucleic acid.

washers likely have lower shedding rates (Lowe et al., 2002; Phipps & Petricevic, 2007). Other studies have not found a significant difference related to hand washing and DNA transfer (Goray et al., 2016; Szkuta et al., 2018). Individuals who regularly touch their face or bodies with their hands have higher rates of skin shedding probably because of loading their hands with skin cells from other parts of their bodies (Wickenheiser, 2002).

Type of Contact

The type of contact including how an item is touched and length of touch time affect the amount of recovered DNA. Contact with increased pressure and friction has been found to increase DNA yield on objects (Goray, Eken et al., 2010; Goray, Mitchell, & van Oorschot, 2010). In addition, different parts of the hand are more likely to transfer DNA onto touched objects (McCull et al., 2017; Oleiwi et al., 2015). Fingers, especially fingertips, have been shown to shed higher quantities of DNA (McCull et al., 2017; Tobias et al., 2017). Increased touch time also appears to increase amount of recovered DNA (Oldoni et al., 2016).

When considering the type of touch that occurs in groping and SA cases, contact by the assailant often has significant pressure and friction. Researchers have explored the ability to develop assailant touch DNA profiles through mock SA scenarios. Farash et al. (2018) developed probative DNA samples of assailants in mock physical assault scenarios using a novel recovery method called “smart analysis” single cell recovery for enhanced separation and typing. Mock strangulation assaults have also resulted in retrieval of assailants' DNA from neck swabs after simulated assaults (Graham & Rutty, 2008).

Substrate Surface

Studies have been published on the effect of the substrate material, primarily the surface of the touched item or skin, on deposition of DNA. Touch DNA profiles are more likely to be developed from porous substrates, such as wood or fabric, than nonporous substrates, such as glass (Daly et al., 2012; Helmus et al., 2016). The texture or “roughness” of the substrate surface likely influences the amount of skin cells deposited. As clothing is often touched in groping SAs, the type of clothing material (porous or nonporous, smooth or rough) may impact the ability to obtain probative DNA profiles. Swabs collected from fabric or clothing, usually generated by forensic scientists, appear more likely to develop probative DNA profiles than swabs collected from human skin (Bowman et al., 2018).

Collection of Touch DNA Profiles in SA Cases

The authors propose that the most significant factor affecting the use of touch DNA evidence in groping SA cases is the lack of collecting touch DNA evidence, as these

cases may not be identified as needing DNA collection. Multidisciplinary education on the importance of collecting touch DNA evidence in groping cases is critical. Erroneously, some may still believe that DNA profiles can only be obtained in SA cases if there is penetration or oral contact by assailants with the deposition of bodily fluids.

Touch DNA is especially useful in stranger groping SA cases or other instances in which the assailant's DNA is not expected to be found on the victim's clothes or body, as also in cases with protective or no contact orders. The development of touch DNA profiles may be less meaningful in cases in which the assailant has been in close association with the victim as the assailant's background DNA on the victim is a possible finding (Fonnelløp et al., 2017; Graham & Rutty, 2008). For example, DNA from live-in family members or spouses (not mock assailants) was developed in 23% of mock manual strangulation simulations (Graham & Rutty, 2008). The relevance of finding touch DNA on a victim's body also depends on the swab location of the touch DNA. For example, if victims report that a date or friend had nonconsensual groping of their genitals, then swabs from the genital area for touch DNA would be considered useful swabs for evidence collection, whereas swabs collected from the victims' hands might contain alleles from casual contact.

The collection of touch DNA swabs is worthwhile in other SA cases as well as stranger groping SA cases, for example, in cases in which the assailant orally, vaginally, or anally penetrated a victim with his penis but did not ejaculate. Penile skin cells can be deposited on or within the victim's body. In addition, touch DNA can be collected from the assailant's hands, fingers, and/or fingernails to obtain the victim's epithelial DNA especially if the SA history includes the assailant touching, hitting, or scratching the skin of the victim.

Case Study on DNA Evidence Collection and Analysis in a Groping SA Case

A young, female university student was a victim of a groping SA in a campus parking lot in a Mountain West state. The victim reported fighting off the stranger assailant as she was forced into her car. The victim told police that she bit the assailant's finger when he tried to muffle her screams during the attack.

The campus police agency contacted the community-based sexual assault nurse examiner (SANE) team to request an examination, specifically asking for evidentiary swabs from the victim's mouth as she had bitten the assailant's finger. The SANE advised the police to not give the victim any food or drink to preserve oral evidence. When the SANE arrived at the police station, she learned three other assaults reportedly committed by the same perpetrator had occurred earlier that day with increasing aggression. The other victims had not received forensic examinations. The campus police

were gravely concerned about the string of SAs and eager to quickly identify the assailant.

When the SANE met the victim, the SANE found the victim finishing a sandwich and soda. In an attempt to provide victim-centered care, a police officer obtained food for the hungry victim. As eating and activation of oral digestive enzymes likely eradicated the assailant's DNA from the victim's mouth, the SANE opted to take a thorough history of the assault to identify where the victim was touched by the assailant. Although collecting evidentiary swabs from areas touched by an assailant was not the usual protocol at that point of time, the SANE realized that swabs with possible touch DNA were likely the only option.

The victim reported that, as she opened her driver's side car door, the assailant forcibly grabbed her by the shoulders and pushed her body down across the front seats. The victim screamed, so the assailant tried to muffle her screams by covering her mouth with one hand. In the struggle, one of his fingers went in her mouth and she bit it. With his other hand, the assailant attempted to undo the victim's smooth metal coat button to take off her coat. When he was unsuccessful at removing her coat, he forced one hand up her skirt and under her tights, touching her abdomen and the front portion of her underwear covered with lace material. His other hand remained on her face trying to muffle her screams. Somehow, the alarm button on her car keys was activated causing the suspect to run away. The victim locked her car and called 9-1-1.

Evidence and DNA Analysis Findings

The SANE moistened swabs to collect potential suspect DNA from locations on the patient's body and clothing touched by the assailant as follows: lower abdomen; around her mouth, chin, and cheeks; coat button; and front panel of underwear. The SANE collected and packaged the following patient's clothing individually in paper bags per recommended protocol: jacket, underwear, skirt, and tights. Oral

evidentiary swabs and blood standard sample were also collected, as was standard protocol at that time.

A day after the assault, law enforcement identified five potential suspects based on victims' descriptions. One possible suspect had been arrested the prior year for voyeurism in a campus women's restroom. Within a few days, the detectives located this suspect and found a bite mark on one finger. They obtained buccal swabs from the suspect, which were submitted to the crime laboratory as a suspect standard. DNA analyses were completed on swabs collected by the SANE and forensic scientist. Short tandem repeats (STRs) found on the Y-chromosome (Y-STR) and STR DNA findings successfully matched the identified suspect of the groping assault in selected swabs (see Tables 2 and 3).

The findings from this case study indicate that the use of touch DNA testing of body and clothing swabs for both Y-STR and STR DNA analysis methods can successfully identify a groping suspect. Current STR and Y-STR DNA kits used in state crime laboratories are more sensitive and able to detect smaller amounts of DNA from evidentiary samples (R. A. H. van Oorschot et al., 2019). The findings also support the premise that the texture surface of a touched object is important in the development of touch DNA profiles. The smooth, metal button of the victim's coat did not yield male DNA, although the suspect tried to undo the button. After the assault, the victim was noted to frequently fidget with the button during the interview process, which likely removed male DNA from the smooth surface. The lacy texture of the front part of her underwear did yield both Y-STR and STR probative profiles aligning with factors identified in Table 1. The rough, uneven surface of the lace cloth substrate material could be more likely to contain epithelial cells from the suspect's fingers than the smooth surface of the coat button.

The DNA analysis findings were crucial to the successful prosecutorial outcome in the case. The victim was unable to identify the suspect from a photo lineup. Until the DNA

TABLE 2. DNA Yield of Y-STR Analysis From Groping Case Study

Swab location	Male DNA quant	Y-STR DNA profile development	Suspect part of mixture
Swabs collected by forensic scientists			
Skirt	No male DNA		
Jacket shoulders	Yes	More than three men	Yes, matches major portion
Tights	Yes	More than one man	Yes, matches major portion
Underwear	No male DNA		
Swabs collected by SANEs			
Lower abdomen	Yes	Yes, match to suspect	Yes, matches major portion
Underwear	Yes	Yes, match to suspect	Yes, matches major portion
Jacket button	No male DNA		
Around mouth	Yes	Yes, low levels: match to suspect	Yes, matches major portion

DNA = deoxyribonucleic acid; SANEs = sexual assault nurse examiners; STR = short tandem repeat; Y-STR = short tandem repeat on the Y-chromosome.

TABLE 3. DNA Yield of STR DNA Analysis From Groping Case Study

Swab location	DNA profile developed from foreign contributors	STR DNA profile development	Suspect part of mixture
Swabs collected by forensic scientists			
Skirt	Not attempted		
Jacket shoulders	Yes	More than two foreign contributors	No
Tights	Yes	More than one foreign contributor	No
Underwear	No male DNA	Not attempted	
Swabs collected by SANEs			
Lower abdomen	Not attempted		
Underwear	Yes	Yes	Yes
Jacket button	No male DNA	Not attempted	
Around patient's mouth	Not attempted		

DNA = deoxyribonucleic acid; SANEs = sexual assault nurse examiners; STR = short tandem repeat.

findings were obtained, the suspect denied committing the assaults. After the DNA findings, the suspect accepted a plea bargain resulting in incarceration for aggravated SA. The prosecutor stated the DNA findings made all the difference in the successful prosecution of this groping SA case.

The DNA analysis findings from this case spurred changes to the state protocol of evidence collection in stranger assaults to incorporate specific swabs and clothing collection guidelines aimed at capturing very small amounts of DNA for potential Y-STR or STR DNA testing. In a collaborative effort between the state crime laboratory forensic scientists and SANEs, a new state form, Stranger Touch DNA Documentation (Appendix, Supplemental Digital Content 1, <http://links.lww.com/JFN/A60>), was created as a guide in collecting evidence swabs, clothing, or other items touched during a groping assault. This form directs SANEs to list clothing items touched by the suspect, as well as how and where the touch occurred, and draw the areas of touch on body diagrams. If victims are willing to submit their clothing as evidence, it is recommended that the SANEs do not collect swabs from the clothing but package the clothing to submit to the crime laboratory as detailed in national protocols (National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 2017; Office on Violence Against Women, U.S. Department of Justice, 2013, 2016). The state's SA examination form was also modified to include designation by the SANE on swabs collected from skin locations with A for amylase (indicating saliva), S for semen, and E for epithelial (indicating touch contact by assailant; see Figure 1). In addition, a section was created for SANEs to write notes about collected evidence to help with DNA analysis decisions.

DNA Findings From Additional Groping SA Cases

After development of the touch DNA form and resulting multidisciplinary education, 118 victims of groping/fondling

SA cases in the state received care from forensic nurses with SAK evidence collection. Forty-seven groping cases involved digital penetration of the vagina. The remaining cases involved groping/fondling of external genitalia and/or breasts. Of these, 54 cases (48%) involved groping without contact of bodily fluids, with law enforcement agencies submitting 42 SAKs (78%) to the state crime laboratory for analysis. Twenty-two of these 42 SAKs produced enough DNA to proceed with STR analysis. Six of these SAKs developed full or partial STR DNA profiles (see Table 4), leading to five DNA profiles entered into the Federal Bureau of Investigation Combined DNA Index System, whereas 13 SAKs developed low-level or mixed STR DNA profiles. Four SAKs had Y-STR DNA analysis completed with two developing full Y-STR DNA profiles and two developing partial Y-STR DNA profiles. Because of the state crime laboratory's resource constraints, Y-STR DNA analysis was placed on hold. The 13 SAKs with

Skin swab Yes No UQuik
 Location _____ A S E*

Skin swab Yes No UQuik
 Location _____ A S E*

Skin swab Yes No UQuik
 Location _____ A S E*

Skin swab Yes No UQuik
 Location _____ A S E*

* Patient indicates contact in area of swab: A=Amylase, S=Seminal fluid, E=Epithelial

FIGURE 1. Skin swab designation from a sexual assault examination form.

low-level or mixed STR DNA findings may develop Y-STR DNA profiles when Y-STR DNA testing recommences. Nine groping SA cases out of 42 cases with only touch contact developed either partial or full STR or Y-STR DNA probative profiles (21%). These additional cases augment the case study practice implications that groped SA victims should have DNA evidence collected and analyzed. Furthermore, SANEs should provide care to groped SA victims as these victims have experienced a traumatic event and would benefit from receiving trauma-informed, patient-centered care.

Guidance on DNA Evidence Collection and Recovery Options for Touch DNA

Collection of DNA from touch or bodily fluids in SA cases in the United States is conducted using cotton-tipped swabs moistened with sterile water or saline if the collection is from dry body parts, such as skin. Recommendations vary based on the guide being referenced. Recent guidelines for collecting swabs from skin for touch DNA are to “use two lightly moistened swabs across the affected area (as in cases of strangulation), packaged per jurisdictional policy” (National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 2017, p. 21). Some jurisdictions may still subscribe to the practice of one wet swab to collect DNA evidence, followed by a dry swab (Office on Violence Against Women, U.S. Department of Justice, 2013). Whichever method is used, the goal for swab collection is to “concentrate the collection of evidentiary samples by using no more than two swabs per collection area so as not to dilute the biological sample” (National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 2017, p. 19).

Although cotton-tipped swabs moistened with sterile water or saline are the most common type of swabs used to collect SAK evidence, other products are available for the collection of potential DNA evidence. Different swab materials have been studied to evaluate for higher yields of DNA: cotton wound, layered cotton, cell foam, nylon flock, polyester, and rayon (Brujins et al., 2018; Verdon et al., 2014). In one study, Verdon et al. (2014) explored DNA yield

specific to touched samples and found cotton wound swabs outperformed other swab materials, although recovering of alleles from touch samples was low overall. Different swabbing solutions, such as detergent-based solutions, have also been investigated to evaluate for increased yield of DNA. Although few research studies are published on the difference of DNA profile yield from sterile water versus detergent-based solutions, early findings indicate that detergent-based solutions surpass sterile water in increasing development of DNA profiles in touch DNA samples (Aloraer et al., 2017; Thomasma & Foran, 2013). Additional research is needed on swab types and moistening solutions.

Other options for collecting low-level DNA as found in touch samples from clothing or objects include FTA paper or card, minitape or adhesive tape, and M-Vac collection method (Kirgiz & Calloway, 2017; Stoop et al., 2017; Vickar et al., 2018; Wood et al., 2017). The consistent challenge for evidence collection methods in trace or touch DNA samples is the development of nonsignificant or background DNA alleles or profiles.

Addressing the Issue of Contamination of DNA Evidence

Contamination is a concern for DNA evidence, yet especially noteworthy in the collection and analysis of trace DNA samples. As DNA analysis methods have increased sensitivity, steps should be taken during evidence collection and analysis to avoid potential contamination. During SAFME evidence collection, the number of people in the room should be limited to include essential examination personnel and patient's designated support person. The SANE should wear a mask and gloves while collecting and packaging evidence (National Institute of Justice, Office of Justice Programs, U.S. Department of Justice, 2017). Swab drying boxes with fans are no longer recommended best practice as air movement from the fan may transfer DNA from one swab to another. Drying swabs should be placed in a protected location and packaged as quickly as possible. In forensic laboratories, laboratory space used for serological testing

TABLE 4. Sexual assault kits (SAKs) with full or partial STR DNA profiles from touch contact

	Suspect relationship	Swabs developing full or partial STR DNA profiles	Number of STR loci	CODIS entry
SAK 1	Initial meeting, online dating app	Vaginal, perianal, buttocks	Partial (not specified)	No
SAK 2	Stranger	Vaginal	15 loci	Yes
SAK 3	Stranger	Perianal, rectal	21 loci	No
SAK 4	Stranger	Fingernails, neck and wrist	16 loci	Yes
SAK 5	Stranger	Face, neck	12 loci	No
SAK 6	Acquaintance	Vaginal, perianal	21 loci	Yes

CODIS = Combined DNA Index System; DNA = deoxyribonucleic acid; SANEs = sexual assault nurse examiners; STR = short tandem repeat.

or DNA analysis should be considered a “clean laboratory” with individuals wearing personal protective equipment. In addition, laboratory workspaces should be cleaned with bleach solution before and after any analysis.

DNA Analysis of Touch DNA Samples Within Crime Laboratories

The development of probative or useful DNA profiles in SA cases is a collaborative effort between SANEs as the evidence collectors and forensic scientists as the evidence analyzers. Therefore, each discipline should have an understanding of the other disciplines' processes to benefit the final product—development of probative DNA profiles in SA cases.

Each laboratory will have a distinct case flow for evidence submitted for DNA analysis and utilize different technologies and processes for analyzing samples. Working as a team with the analyzing laboratory is critical to understand case processing and workflow. Common laboratory workflows include serology, DNA extraction, quantitation, normalization, amplification, separation and detection of DNA, data review/troubleshooting, and data interpretation (see Table 5). Every workflow step should pass specific validations of each process, technology, or instrument use including validations of low-level DNA samples, such as touch DNA samples. As many trace DNA samples are often mixtures of more than one person's DNA, validation studies of each laboratory process using mixed samples are important to determine how to interpret mixtures of DNA.

After validations of the laboratory processes, clear steps are consistently followed regarding DNA analysis and interpretation. Forensic scientists evaluate their instrumentation in terms of the interaction with the amplification kits. In addition to validation and evaluation of interactions between instrumentation and amplification kits, thresholds

are established to aid in the interpretation of touch or low-level DNA samples. Establishing clear guidelines for interpretation of results reduces inconsistencies between forensic analysts.

Implications for Clinical Forensic Nursing Practice

Multidisciplinary collaboration is necessary to achieve best DNA outcomes in SA cases. In the referenced case study, when the SANE discovered that oral evidence would likely not be probative, she problem-solved by collecting touch DNA samples, although it was not standard procedure at that time. The SANE considered this strategy as the SANE team was knowledgeable about crime laboratory testing and potential capabilities of new DNA testing methods. This innovative approach triggered the development of the touch DNA form and shift in practice to collect evidentiary swabs in groping and other SAs. After the form development, the SANE team collaborated with the state crime laboratory and law enforcement agencies to provide education about evidence collection in groping SA cases.

SANEs can provide expert evidence collection in groping SAs as they provide both nursing care and critical forensic evidence documentation during SAFMEs. As SANEs have expertise in trauma-informed and patient-centered care, they can also positively impact patient health outcomes (Valentine et al., 2020). Through multidisciplinary collaboration, SANEs are positioned to lead their communities in providing optimal nursing care for patients victimized by SA.

Conclusion

Collection of touch DNA in groping and other SAs is supported by findings shared in this article. Forensic nurses and forensic scientists need to communicate frequently to

TABLE 5. Laboratory Workflow Steps in DNA Analysis

Workflow step	Definition
Serology	Serology describes the use of physical and chemical methods to determine location and identification of bodily fluids such as blood, saliva, and semen.
DNA extraction	Extraction is the separation and removal of proteins and other cellular materials that are present in a biological sample from the DNA molecules. The result is isolating DNA from a biological sample in a liquid solution called a DNA extract.
Quantitation	Quantitation determines the quantities of human DNA present in the DNA extract.
Amplification	Polymerase chain reaction (PCR) is a process where a specific region of DNA is replicated over and over (amplified) to yield many copies of an otherwise small original amount of DNA. PCR targets specific locations, or loci, of interest on the DNA molecule that have been found to vary between individuals.
Separation and detection of DNA	The PCR products are separated according to size, visualized using a detection cell, and stored in an electronic format for later analysis.
Data review and troubleshooting	The analyst reviews all data produced in the previous step to ensure the results adhere to the basic criteria and interpretation guidelines developed by the laboratory.
Data interpretation	The sample profile is compared with a known sample profile to determine a match or an exclusion.

DNA = deoxyribonucleic acid.

optimize SA evidence collection. When SANEs respond to care for groping SA victims, they can provide both expert evidence collection and trauma-informed, patient-centered care.

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