Forensic Evidence Findings in Prepubertal Victims of Sexual Assault

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ABSTRACT. *Objective.* **The American Academy of Pediatrics recommends forensic evidence collection when sexual abuse has occurred within 72 hours, or when there is bleeding or acute injury. It is not known whether these recommendations are appropriate for prepubertal children, because few data exist regarding the utility of forensic evidence collection in cases of child sexual assault. This study describes the epidemiology of forensic evidence findings in prepubertal victims of sexual assault.**

Methods. **The medical records of 273 children <10 years old who were evaluated in hospital emergency departments in Philadelphia, Pennsylvania, and had forensic evidence processed by the Philadelphia Police Criminalistics Laboratory were retrospectively reviewed for history, physical examination findings, forensic evidence collection, and forensic results.**

Results. **Some form of forensic evidence was identified in 24.9% of children, all of whom were examined within 44 hours of their assault. Over 90% of children with positive forensic evidence findings were seen within 24 hours of their assault. The majority of forensic evidence (64%) was found on clothing and linens, yet only 35% of children had clothing collected for analysis. After 24 hours, all evidence, with the exception of 1 pubic hair, was recovered from clothing or linens. No swabs taken from the child's body were positive for blood after 13 hours or sperm/semen after 9 hours. A minority of children (23%) had genital injuries. Genital injury and a history of ejaculation provided by the child were associated with an increased likelihood of identifying forensic evidence, but several children had forensic evidence found that was unanticipated by the child's history.**

Conclusions. **The general guidelines for forensic evidence collection in cases of acute sexual assault are not well-suited for prepubertal victims. The decision to collect evidence is best made by the timing of the examination. Swabbing the child's body for evidence is unnecessary after 24 hours. Clothing and linens yield the majority of evidence and should be pursued vigorously for analysis.** *Pediatrics* **2000;106:100–104;** ***child abuse, sexual abuse, forensic evidence, sperm, semen.***

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The American Academy of Pediatrics recommends an immediate examination and forensic evidence collection when sexual abuse has occurred within 72 hours, or when there is bleeding or acute injury.[1] This recommendation closely follows the recommendations for the evaluation of adult rape victims,[2] and, in part, is based on the length of time that motile and nonmotile sperm can be identified in the vagina after sexual intercourse or adult assault.[3,4] Because the dynamics of child sexual abuse differ from adult rape, and may not include physical trauma or ejaculation, evaluation guidelines similar to those recommended for postpubertal victims may be inappropriate for young children. In addition, young children may be uncooperative in allowing for the collection of vaginal, anal, or oral swabs, especially after a traumatic sexual assault. Avoiding uncomfortable procedures would be of great benefit to child sexual abuse victims, if the advantage of such testing is negligible.

Data are needed to identify when forensic evidence collection should be recommended for young children. To date, no study has specifically examined forensic evidence data in prepubertal victims. This article describes the epidemiology of forensic evidence findings in prepubertal victims of sexual assault.

METHODS

Patient Population/Record Abstraction

A retrospective review of the medical records of children <10 years old who had forensic evidence processed by the Philadelphia Police Criminalistics Laboratory between 1991 and 1996 was undertaken. Patients were identified through review of all forensic evidence reports of the crime laboratory during the study. The medical records of the children <10 years old who had forensic evidence processed by the crime laboratory were obtained, and data were abstracted for demographics, history of abuse, physical examination findings, forensic evidence collected, and results of forensic analysis. This study was exempted from hospital institutional review board review and was approved by the Philadelphia, Pennsylvania Police Department.

Medical and Forensic Evaluation

Medical examinations were completed at 3 Philadelphia emergency departments. The examinations were performed by pediatric or emergency medicine residents and attending physicians together. Photographs were not taken routinely, and colposcopy was not used in any of the emergency departments. Standard forms for documenting sexual abuse evaluations were used by the 2 children's hospitals.

Forensic evidence was collected according to each hospital's protocol. The decision to collect forensic evidence was made by the emergency department attending physician, in collaboration with social work, and, in some cases, a child abuse expert. Generally, evidence was not obtained if the alleged contact occurred

>72 hours before the medical evaluation. Rape kits were supplied to all hospitals by the police department. Swabs were obtained from the genital, anal, and oral areas and stained skin, and were tested for blood, sperm, and chemical evidence of semen. Hair samples and foreign debris were collected when identified. Clothing was placed in paper bags and submitted separately for forensic evaluation. Forensic evidence was retrieved by the Philadelphia Police Department and processed by the criminalistics laboratory. In addition, the laboratory processed clothing and bedding samples collected at the crime scene by the police.

At the police crime laboratory, rape evidence kits were checked for intact evidence seals and chain-of-evidence data. Saline (1–2 mL) was added to each evidence swab submitted, and an aliquot was removed and centrifuged at 3000 rpm for 5 minutes. The supernatant was tested for the presence of acid phosphatase by reaction with tetrazotized o-Dianisidine reagent. Color intensity was graded on a 0 to 4 scale, with 3 and 4 recorded as positive reactions.

Sediment from the centrifuged tube was removed by transfer pipet and placed on a microscope slide. Slides were dried at room temperature for 1 hour, then on a 100°C hotplate for 2 minutes. Slides were stained with a Papanicolaou differential staining procedure and viewed microscopically at ×1000 under oil immersion. Both the relative amount and the number of intact spermatozoa were recorded.

Dark red or brown stains were tested for blood using the following tests: phenolphthalein, tetramethyl benzidine, and anti-human precipitin. A positive result in all 3 tests confirmed the stain as human blood.

Trace evidence brushed from clothing was examined with a reflected light microscope. Any relevant debris was isolated using a fresh syringe and placed on a glass slide with cover slip and examined. Hair fragments were placed on a glass slide and viewed by transmitted light microscope at ×100.

Statistical Methods

Descriptive statistics of the population are reported. Data were analyzed using EpiInfo, Version 6 statistical software (Centers for Disease Control and Prevention, Atlanta, GA).[5] χ^2 analysis, Fisher's exact test, and analysis of variance were used to analyze data. $P < .05$ was considered statistically significant.

RESULTS

Demographics

During the study, we identified 293 children <10 years old who had forensic evidence processed by the Philadelphia Police Crime Laboratory. Of this total, medical records for 273 (93%) were available for review. All children were seen at the Children's Hospital of Philadelphia (48%), Thomas Jefferson University Hospital (47%), or St Christopher's Hospital for Children (5%). Of the 273 children, 78% were girls, and 79% (of those for whom race was documented) were black. The mean age of the victims was 5.3 years (standard deviation: 2.2 years), with a range from .3 to 9.9 years. The time since the last assault was recorded for 222 children and ranged from 0 to 763 hours, with a mean of 47.9 hours (standard deviation: 93 hours) and a median of 16 hours. The time since last assault varied significantly by hospital, with a median of 6 hours for children seen at the Children's Hospital of Philadelphia, 38 hours at Thomas Jefferson University Hospital, and 15 hours at St Christopher's Hospital for Children.

Perpetrator Identification

The alleged perpetrator of the sexual assault was known to the child in 89% of cases. The perpetrator was a stranger in only 5 cases (2%), and the identity of the perpetrator was not recorded at the time of the examination 9% of the time. Men were the most common recorded perpetrators and were typically related to the victim. In one third of the cases, the alleged perpetrator was unrelated but known to the child.

History of the Assault

A history of sexual assault was provided in 81% of cases. Genital–genital contact was reported in 40% of cases, anal sodomy in 33% of cases, hand–genital contact in 32% of cases, and oral–genital contact in 19% of cases. More than 1 type of assault was reported by 28% of children. Information regarding ejaculation was recorded for 168 children, and of these, 20 children (11.9%) reported that the perpetrator ejaculated. Symptoms associated with the assault were reported in a minority of children who were asked, and when noted, most had eaten, bathed, urinated, defecated, and changed their clothes before their examination (Table 1). A history of pain was associated with significantly increased likelihood of genital injury ($P < .004$) and positive forensic evidence ($P < .002$). Likewise, a history of bleeding was associated with genital injury ($P < .001$) and positive forensic evidence ($P < .001$).

Physical Examination Findings

A minority of the children (23%) had anogenital injury. Of the 62 children with anogenital injury, 26 had >1 injury location identified. Of the injuries recorded, 24% were to the anus, 16% were to the hymen, 16% were to the labia minora, 19% were to the posterior fourchette, and 9% were to the perineum. Four children (3%) were believed to have had intravaginal injuries. Injuries to the labia majora and vestibule were recorded infrequently, and no injuries to the clitoral area were noted.

Excluding erythema, which was recorded in 38% of cases, the most commonly identified injury was a laceration or tear (55%). Of the remaining anogenital injuries, 38% were abrasions and 7% were bruises. Genital injury was associated with an increased likelihood of identifying forensic evidence (odds ratio: 3.23; 95% confidence interval: 1.67,6.20; $P < .001$). Of the children with genital injury noted by examination, 88% were seen within 24 hours of their assault. There were 5 children who had genital injuries identified after 24 hours, 4 of whom had no forensic evidence found.

Discharge was noted in 44 children (16%). The vast

TABLE 1. Child's Symptoms and Activities Since Assault

	n (% of Respondents)
Symptoms	
Pain	88 (41)
Bleeding	30 (14)
Discharge	25 (12)
Dysuria	31 (16)
Activities since assault	
Eaten/rinsed mouth	181 (88)
Urinated	206 (93)
Defecated	159 (75)
Bathed	130 (58)
Changed clothes	120 (79)

majority of the discharge noted was seen in the vulvar or vaginal area, although 1 child had a penile discharge, and 3 children had perineal or perianal discharge noted. A Wood's lamp examination was recorded in 12 cases, and the presence of possible semen was noted only twice: once on the vulva and once on the extremities.

Forensic Collection

Forensic evidence collection included swabs for semen and sperm analysis in 95% of cases, blood samples in 59%, clothing or linens from the child or house in 35%, a saliva sample from the victim in 34%, a hair (pubic or otherwise) in 7%, and foreign debris in 2%. Clothing or linens were more likely to be collected in children who had not changed their clothes or who were seen within 24 hours of their assault ($P < .001$).

Forensic Evidence Findings

Some form of forensic evidence was identified in 67 (24.5%) of children (Table 2). The yield of forensic evidence collection varied by institution (Table 3). The majority of forensic evidence (64%) was found on clothing or linens (Table 4). All children with forensic findings were examined within 44 hours of their assault. Over 90% of children with positive forensic evidence findings were seen within 24 hours of their assault. Except for 1 child, on whom a pubic hair was identified 44 hours after the assault, all evidence (semen, $n = 1$; blood, $n = 3$) found after 24 hours was recovered from clothing or linens. The time since assault was inversely correlated with finding forensic evidence (Figs 1 and 2). No swabs taken from the child's body were positive for blood after 13 hours or sperm/semen after 9 hours. Of the children with sperm/semen identified, 58% had no evidence of acute genital injury. Sperm/semen was found in 32% of the small number of children ($n = 19$) who reported ejaculation ($P < .01$) but was also found in 12 children in whom no report of ejaculation was recorded in the chart. The identity of the perpetrator and type of assault described were not predictors of finding forensic evidence.

DISCUSSION

There are good reasons to evaluate sexually abused children within 72 hours of their assault.[6] Because of the rapid healing of superficial mucosal injury, children seen within a few days of their assault are more likely to have identifiable physical evidence.[7,8] However, our data suggest that the yield of forensic evidence collection diminishes after 24 to 48 hours of the assault. Present recommendations for evidence collection might not be appropriate for prepubertal victims of sexual assault.

The time since assault is a useful clinical indicator for collecting forensic evidence. Sperm, semen, and blood on the child's body are unlikely to be identified after 24 hours, and swabbing the child's genitals may be futile after such a delay. Additionally, the results of this study suggest that any collection of forensic evidence from the child's body may not be necessary >2 days after an assault. Physicians may underestimate the importance of clothing as a means of securing forensic evidence. In fact, the majority of

TABLE 2. Forensic Findings ($n = 273$)

Forensic Findings	*n* (%)
Blood	37 (14)
Semen	30 (11)
Hair	8 (3)
Sperm	39 (14)
Other: grease stain, synthetic fibers	2 (<1)

TABLE 3. Forensic Evidence*

Institution	Forensic Evidence Identified (%)	Total
Children's Hospital of Philadelphia	54 (42)	130
St Christopher's Hospital for Children	3 (21)	14
Thomas Jefferson University Hospital	10 (08)	129

* The yield of forensic evidence varied by institution ($P < .001$).

TABLE 4. Location of Forensic Findings

Location	Number of Patients
Clothing/linens	54
Vagina	11
Vulva	5
Anal/rectal	8
Mouth	2
Secretions on body	5

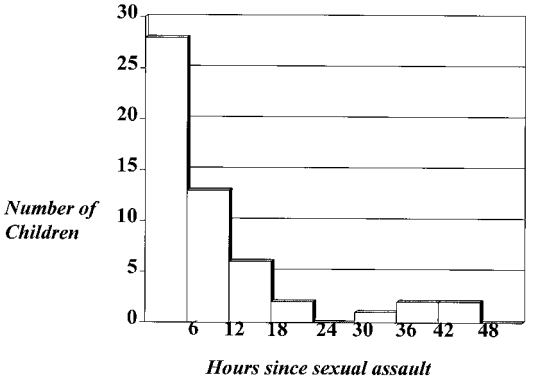

Fig 1. Identification of any forensic evidence versus time (odds ratio at ≤24 hours: 6.35; 95% confidence interval: 2.49,17.14; $P < .001$).

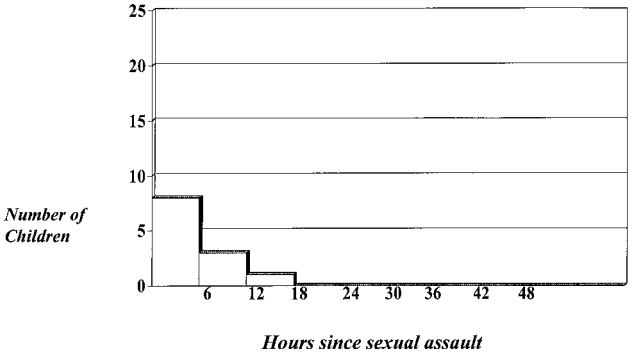

Fig 2. Forensic evidence from child's body versus time (odds ratio at <13 hours: 5.83; 95% confidence interval: 1.22,38.20; $P = .01$).

evidence was secured from the child's clothing or household linens. Only 35% of children had clothing collected as part of the evaluation. Our study included very few patients in whom clothing was obtained after 24 hours. However, in 4 of the 5 patients with forensic evidence found after that time, semen ($n = 1$) or blood ($n = 3$) was identified on clothing or linens. We speculate that more vigorous efforts at securing clothing may offer an opportunity to identify physical evidence many days after the assault. Clothing that has been changed before hospital evaluation may still be available in the home with evidence intact, and pursuit of this potential evidence by physicians or the police is particularly important.

Children who have been sexually abused may not provide a complete description of their assault. There was poor correlation between the child's description of the assault and the finding of forensic evidence. In fact, 2 children had evidence of semen on their body even though they gave a history of hand–genital contact only. A report of ejaculation increased the likelihood that sperm/semen was identified, but the majority of children with sperm/semen found on the body, clothing, or linens did not provide a history of ejaculation. Therefore, the decision to collect forensic evidence should not be determined by the child's description of the assault.

Genital injuries are uncommonly identified in sexually abused children.[6] Even in our sample of children selected for forensic evidence collection, injuries were identified in a distinct minority. The finding of a genital injury was associated with forensic findings. Our data support the recommendation of the American Academy of Pediatrics for collecting forensic evidence in children with genital injuries after assault. However, the lack of genital injury does not obviate the need to collect forensic evidence in children who otherwise would meet collection criteria. Identification of acute genital injury may corroborate a child's history of sexual assault, regardless of the forensic evidence results. Rapidly healing injuries may be missed if examination is delayed. Thus, forensic evidence collection is not the only reason to promptly examine children with an acute complaint of sexual abuse.

The yield of forensic evidence analysis varied by institution. Extremely low yields were noted at the hospital that treats both adults and children and is a regional referral center for adult rape victims. We speculate that experience with adult rape victims, who are more likely to present for evaluation immediately after a violent sexual assault, may incline the physicians who treat adults to routinely obtain forensic evidence for all patients being evaluated for sexual abuse, regardless of the patient's age. Nationally, many sexually abused children are evaluated in general emergency departments or rape centers. Physician practices regarding forensic evidence collection is not well-described, and our data suggest that practices vary considerably. In this study, >10% of children had forensic evidence collected when not indicated. For example, specimens were collected and analyzed for semen and sperm when the alleged perpetrator was prepubertal (11 cases), female (1 case), or when >96 hours elapsed from the time of assault (28 cases). The overwhelming majority of these children were evaluated in the hospital that treats both adults and children. In none of these cases was forensic evidence found. These pediatric data begin to define appropriate guidelines for forensic evidence collection in prepubertal victims of sexual abuse. The negligible yield from forensic evidence collection from the body after 24 hours and overall after 48 hours should reduce unnecessary collection procedures in a variety of medical settings.

There are limitations to this study worth noting. Because this was a retrospective study, data were not recorded in a standardized way. This may limit the ability to identify factors that predict finding forensic evidence. In addition, evidence was not collected in a standardized fashion, and, in most cases, selective samples were obtained. The level of training and experience of the physician caring for the child may have impacted the quality of the evaluation. It is possible that children with forensic evidence were not selected for evidence collection or that additional sample collection may have increased the yield of forensic analysis. In this study, however, the overall low yield of forensic evidence in children who were clinically thought to be at greatest risk for forensic findings suggests that this did not occur with great frequency. Finally, it is not known whether the total sample described represents all the children who had forensic evidence collected. It is possible that collected samples were not retrieved appropriately by the police or processed for other reasons. Because we identified our patients for study by reviewing completed forensic evidence reports, our report is based on a highly selected sample of patients. A prospective study in which all children have complete forensic samples obtained and processed would better answer these questions.

Methods used for forensic evidence analysis vary around the country. In some jurisdictions, P30 analysis for semen and other sensitive forensic tests are performed routinely. These tests were not used in Philadelphia at the time of this study. It is possible that alternative methods of forensic analysis might increase the yield of forensic analysis in children.[9,10]

Finally, it is beyond the scope of this study to examine the impact of forensic evidence evaluation on the legal outcome of pediatric sexual assault cases. Previous research suggests that although the testifying ability of the victim is often critical to the outcome of a criminal trial, physical injury and/or forensic evidence are associated with criminal convictions.[11,12] The effect that forensic evidence has on criminal prosecution in child sexual abuse cases has not been evaluated carefully and would be of interest to those involved with the evaluation, investigation, and prosecution of child sexual assault.

CONCLUSION

In summary, we believe recommendations for forensic evidence collection based on pediatric data, albeit retrospective, are better than recommendations based on adult rape protocols. Swabbing the genitals, anus, and throat of recently traumatized

children is uncomfortable and should be avoided if the yield is extremely low. With no positive swabs from a child's body >13 hours after the alleged sexual assault, we believe swabbing the body should be omitted from the forensic evaluation of children presenting >24 hours after the alleged event. The high yield of forensic evidence from clothing and linens, particularly in cases with delayed presentation, warrants aggressive pursuit of these items whether available in the emergency department or in the home.

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Drs Christian and Lavelle contributed equally to this research.

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"We're lost, but we're making good time."

—Yogi Berra, 1972

Submitted by Gary M. Gorlick, MD, MPH, FAAP