BRIEF REPORTS

An Alternate Light Source to Detect Semen

David G. Nelson, MD, Karen A. Santucci, MD

Abstract

The Wood's lamp (WL) has been used in sexual assault evaluations. Recent data have shown that semen does not fluoresce with a WL and that physicians are unable to differentiate semen from other common medicaments using a WL. **Objectives:** To determine whether physicians could differentiate semen from other products using an alternate light source (ALS), and to investigate whether a brief training period with the ALS would enhance physicians' ability to differentiate between semen and other commonly used products. **Methods:** An ALS, Bluemaxx BM500, was found to cause semen to fluoresce. Physicians were first asked to use this ALS to identify semen and then to distinguish between a semen sample and other products. Physicians then received a training class on the use of the ALS and were then asked to differentiate semen from other products. **Results:** All physicians identified the semen as fluorescing and 25% successfully differentiated the semen from the other products using the ALS. Products most commonly mistaken for semen were a hand cream, Castille soap, and bacitracin. After the training session, 83% of the physicians successfully differentiated the semen from other products. The ALS, while not specific for semen identification, was 100% sensitive for it. **Conclusions:** Physicians instructed in the use of an alternate light source (BM 500) are able to identify semen as fluorescing and can differentiate semen (after a training session) from other commonly used products. **Key words:** semen; fluorescence; Wood's lamp; sexual assault evaluation; forensic medicine. ACADEMIC EMERGENCY MEDICINE 2002; 9:1045–1048.

In cases of sexual assault and abuse, the detection of seminal fluid is important to forensic, medical, and legal personnel for the purpose of evidence collection and DNA testing. Traditionally, ultraviolet illumination has been recommended to aid in the identification of semen on skin and clothing of these patients. Ultraviolet light (wavelength less than 400 nm) has been shown to cause fluorescence of certain fungi, bacteria, chemicals,[1] and semen.[2] The Wood's lamp (WL) emits light at 360-nm wavelength. It has been used to detect semen both at crime scenes[3–5] and during sexual assault evaluations (SAEs).[3–9] Because the WL is inexpensive, is easy to use, and has ''accepted'' screening attributes, it has become an integral part of many emergency departments for SAE, and is commonly used by emergency personnel. In a survey of sexual assault nurse examiner programs in the United States, Ciancone et al. reported that 86% (51/59) of programs used a WL for SAE.[10]

From Brown University School of Medicine, Department of Pediatrics, Section of Pediatric Medicine, Hasbro Children's Hospital, Providence, RI (DGN, KAS); and the Section of Pediatric Emergency Medicine, Yale–New Haven Children's Hospital, New Haven, CT (KAS).
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Address for correspondence and reprints: Karen Santucci, MD, Yale–New Haven Children's Hospital, 20 York Street, Room WP143, New Haven, CT 06504. Fax: 203-688-4195. e-mail: karen.santucci@yale.edu.

The effectiveness of the WL for identifying semen has recently been challenged.[11] In a cohort of 42 physicians, Santucci et al. found that subjects using a WL were unable to differentiate semen from other substances commonly found on the perineum of children or adolescents.[11] In the same study, none of the 29 semen samples from 29 different donors demonstrated any fluorescence when illuminated with a standard WL emitting a wavelength of 360 nm.

Our study had two main objectives. The first was to evaluate the abilities of emergency medicine (EM), pediatrics, and pediatric EM (PEM) physicians to identify semen, and to differentiate between semen and commonly used ointments and creams when using an alternate light source. The second was to determine whether a 10–15-minute training session on the use of the alternate light source could enhance physicians' abilities to accurately identify semen, and distinguish it from other substances.

METHODS

Study Design. We performed an observational study that was granted expedited review by the institutional review board.

A dried semen sample was brought to the local police department for examination. There, the investigators used an adjustable-wavelength light source designed for forensic investigations (Omniprint 1000 by Omnichrome, Melles Griot Laser

Group, Carlesbad, CA) to examine the semen sample. This light source emits wavelengths in narrow (30–40-nm) band increments, between 320 nm and 510 nm (e.g., 320 nm, 350 nm, 380 nm, 410 nm, etc.). Investigators wore different-colored goggles (yellow, orange, red) to enhance contrast and improve visibility of the fluorescence. Semen was noted to best fluoresce at 420 and 450 nm, when viewed through orange goggles. Medical lamp companies were contacted. A portable forensic light with the appropriate range of wavelengths (a Bluemaxx BM500 with a broad-band wavelength of 390–500 nm, Sirche Finger Print Laboratories, Inc., Raleigh, NC) was identified and purchased for our study.

Study Setting and Population. Forty-eight physicians at an academic, urban, tertiary care medical center were enrolled in the study. All of the participating physicians practiced in an academic emergency setting. Participants completed a questionnaire that included queries regarding their academic training, number of years practicing EM, or performing SAEs, history of formal training in forensic evidence collection, and the number of SAEs they performed each year.

Study Protocol. Semen (0.5 mL) and 13 different products were placed on a clean white cotton cloth template, allowed to air dry, and labeled A through N. The products displayed on the template with the semen included: saliva, a hand cream, talc, spermicide, Phisohex (Chattem, Inc., Chattanooga, TN), Barrier cream (Carrington Laboratories, Inc., Irving, TX), A&D ointment (Cardinal Health, Inc., Dublin, OH), bacitracin zinc (Division of Atlanta, Inc., Melville, NY), Surgilube (Division of Atlanta, Inc.), toothpaste (Colgate, Colgate-Palmolive Co., New York, NY), Castille soap (Professional Disposables, Inc., Orangeburg, NY), Balmex (Block Drug Co., Jersey City, NJ), and Vaseline (Chesebrough-Ponds USA Co., Greenwich, CT). Participants individually scanned the samples with the WL, and then with the Bluemaxx BM500, in a darkened room, while being monitored by an investigator. The participants then indicated which sample they believed to be semen.

Training. Eighteen physicians at another academic, urban, tertiary care medical center were enrolled in this phase of the study in January 2001. Participants completed a questionnaire that included questions about their academic training, the number of years they had been practicing, the frequency with which they performed SAEs, and the number of times they have used a WL during a SAE. These 18 physicians (broken up as groups of 8, 4, and 6 participants) received a 10–15-minute training session on the utilization of the BM500, performed by one of the investigators (KAS). Participants were then given the opportunity to analyze a known semen sample on a white 100% cotton surface with the WL and the alternate light. The participants received instruction on proper use of the BM500, detail on the characteristic stain produced by semen when viewed (on clothing) with this alternate light source, and instruction regarding the importance of semen identification during SAEs.

The trainees were then presented with a preprepared template with one 0.3-milliliter aliquot of dried semen and 15 other samples of equal quantity of commonly used products for evaluation. Each participant was asked to view the template and identify the semen. They were given 2–3 minutes to perform this assessment. In a darkened room, the physicians used the WL and the BM500 to view the template. A researcher (KAS) monitored each participant. The 16 products and/or secretions used for this part of the study included semen, urine, saliva, bacitracin zinc, Surgilube, Castille soap, Balmex, A&D ointment, a lubricating jelly, a hand cream, a spermicide, toothpaste (Crest Tartar Protection, Procter & Gamble, Cincinnati, OH), Shower to Shower body powder (Johnson&Johnson, Inc., Skillman, NJ), LipMedex (Blistex Inc., Oak Brook, IL), Bactoshield CHG 4% antimicrobial skin cleanser (STERIS Corporation, St. Louis, MO), and baby cream (Little Forest, Walnut Creek, CA). These samples are similar to, but slightly different from, the original templates samples, and were chosen in this fashion to better simulate the medicaments participants might expect to be used in the patient population served by their institution.

Data Analysis. Simple statistical analyses were performed including sensitivity, specificity, and Fisher's exact test.

RESULTS

Using the Omniprint 1000 forensic light, the dry semen sample fluoresced optimally at both 420 nm and 450 nm and not above or below these wavelengths when the investigators viewed the sample through orange goggles. An alternative light source, the Bluemaxx BM500 (forensic light), was identified and obtained from Sirche Finger Print Laboratories. The BM500 is a hand-held lamp shaped like a flashlight with an attached orange barrier screen, which is the equivalent of using orange goggles. It emits (nonadjustable) light in wavelengths between 390 and 500 nm and may be purchased for a price comparable to that of the WL.

Part 1. Forty-eight physicians completed the questionnaire and scanned the samples. Sixty-nine percent of the participants were male. Sixty-three percent of the participants were trained in EM, 27% were subspecialty trained in PEM, and 10% were trained in pediatrics alone. The average practice experience of the participants in an emergency setting was 4.7 years (range: 0.5 to 15 years). Thirty-one percent of the participants reported formal training in SAEs and forensic evidence collection. Twenty-one percent performed five to ten SAEs per year, 13% performed 11 to 20 SAEs per year, and 8% performed more than 20 SAEs per year. One participant (the director of a child protection program) reported performing 100 SAEs per year.

None of the participating physicians correctly identified the semen sample using the WL. All participating physicians recognized the semen sample as fluorescing using the BM500. Only 12 of the 48 physicians (25%) positively identified the semen sample from among the other products. The products most commonly mistaken for semen were a hand cream, Castille soap, and bacitracin. There was no difference among the observers in their ability to correctly identify the semen based upon years of practice and the number of SAEs performed per year.

The WL sensitivity for the detection of semen was 0% (95% CI = 0% to 7.4%). Its specificity was 92.3% (95% CI = 89.9% to 94.3%). The BM500 sensitivity for detection of semen was 100% (95% CI = 92.6% to 100%) and its specificity was 94.2% (95% CI = 92.1% to 95.9%).

Part 2. A convenience sample of 18 physicians completed the questionnaire, training session, and examination. Forty-four percent were male. Thirty-three percent of the participants were trained in general pediatrics, 22% were subspecialty-trained in child development, 17% were subspecialty-trained in PEM, and 11% of the aforementioned specialized in child abuse and neglect. The average practice experience was 8.9 years (range: 0.5–32 years). Forty-four percent of the participants performed between two and 12 SAEs per year, another 44% performed less than two SAEs per year, and two of the physicians performed approximately 100 SAEs per year.

None of the physicians were able to positively identify semen as fluorescing with the WL. All the physician participants identified semen as fluorescing with the BM500. Eighty-three percent of the physicians who received the training session (regardless of their previous amount of experience in evidence collection) were able to correctly identify the semen sample as the true semen sample on a cloth surface using the BM500 equipped with orange barrier filter.

One hundred percent of the participants correctly identified semen as one of the fluorescing stains. The substances most commonly mistaken for semen were urine and the hand cleanser used in the ED. The WL sensitivity for the detection of semen was again 0% (95% CI = 0% to 18.5%). After a brief training period, the BM500 had a sensitivity of 83.3% (95% CI = 58.6% to 96.4%) in the correct identification of semen.

The template was re-examined at two-month intervals for a 16-month time period and the semen continued to fluoresce with what appeared to be equal intensity using the BM500 equipped with barrier filter.

DISCUSSION

Ultraviolet light and fluorescence have been used for years to aid in SAE. As recently as 2000, published reports claim that the WL should be used in SAE to aid in the recovery of semen.[8,9] However, Santucci et al. reported that in the light emitted from the standard WL (360 nm), semen does not fluoresce, and cannot be differentiated from other common products.[11]

We found a more appropriate tool (the Bluemaxx BM500) to aid in semen stain identification for SAE. With the Bluemaxx BM500, semen fluoresced and was readily identified using an orange barrier filter. A previous study by Gabby et al. in 1992 noted that the fluorescence of semen changed with time.[6] However, our semen sample continued to fluoresce with the same intensity months after the initial placement on cloth.

With the Bluemaxx BM500, equipped with barrier filter and no training session, 25% of the physicians, previously unable to differentiate semen from other products, were able to correctly identify semen. Although this is a considerable improvement, it is still a very low percentage for a useful screening tool. The reason that the percentage is low is probably because commonly used products (e.g., Bacitracin and Castille soap) also fluoresce and may be mistaken for semen. With the Bluemaxx BM500, an added orange barrier filter, and a brief training session, 83% of the physicians, previously unable to differentiate semen from other products, were able to correctly identify semen. This is a significant improvement over the WL, or the Bluemaxx without a training session.

While the semen could be detected and differentiated from other products some of the time, its identification with the BM500 was not highly spe-

cific. Other items were also found to fluoresce and were difficult to distinguish from semen. Two of the items most commonly mistaken for semen were a hand cleanser and urine. Physicians who received a 10–15-minute training session were more likely to be able to correctly identify the semen sample after the training session than before (83% vs 0% $p < 0.001$, Fisher's exact test).

More important than the specificity of the BM500 in differentiating semen from other substances that fluoresce is the reliability with which it causes semen to fluoresce, or the test's sensitivity. In a preliminary forensic assessment, as performed in the emergency department of major medical centers, it is more important to identify the presence of a suspicious substance and secure that sample for further definitive testing than it is to achieve confirmation of the suspicion. This will be accomplished through enzymatic analysis in a state or forensic laboratory at a later date. Using the BM500, all physicians included semen samples among the substances that they identified as fluorescent; thus, the BM500 was 100% sensitive in detecting semen as a fluorescing agent after a training session and 83.3% sensitive in detecting semen as semen. A brief training session improved the sensitivity of the BM500 more than threefold (83.3% compared with 25%) This is important, since sensitivity is the best test characteristic for screening tests, such as those used to collect forensic evidence.

Investigators and institutions involved with SAE should consider the use of a forensic light (such as the Bluemaxx BM500) that emits the correct wavelength that causes semen to fluoresce. Equipping this light with an orange barrier filter will maximize the detection of fluorescence and minimize scatter rays.

We strongly suggest securing any material that may be suspicious for fluorescence, and sending these samples for forensic analysis and enzymatic testing. Therefore, while performing SAEs even with an appropriate light source, the identity of semen samples must be confirmed with microscopic and chemical analysis.

LIMITATIONS

Our study has two important limitations. First, we used cloth, instead of human skin, as the template to evaluate the semen sample. During SAEs, both skin and clothing are inspected. Second, the sample size of the participants was small, and few had formal training for SAE. Nevertheless, we are encouraged that using the BM500, all semen samples were noted to fluoresce and were identified by the participants among those samples likely to contain semen.

CONCLUSIONS

The BM500 is superior to the Wood's lamp for detecting the fluorescence of semen, and is simple to operate with minimal training. Although not tested on the skin's surface, we anticipate that the BM500 would prove more useful for detection of possible deposits of semen during sexual assault evaluations than the Wood's lamp.

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