Risk Assessment for Gonococcal and Chlamydial Infections in Young Children Undergoing Evaluation for Sexual Abuse

Daniel M. Ingram, MSPH*; William C. Miller, MD, PhD, MPH‡; Victor J. Schoenbach, PhD*; V. Denise Everett, MD‖; and David L. Ingram, MD§

ABSTRACT. Objective. Testing for gonorrhea (GC) and chlamydial (Ct) infection in children who are being evaluated for sexual abuse is invasive and costly. We developed selective criteria to limit unnecessary testing for these infections.

Methods. Over a 10-year period (May 1988 to May 1998), clinical information was collected in a prospectively designed database for all children ages 0 to 12 years by the WakeMed Child Sexual Abuse Team in Raleigh, North Carolina. The study population comprised 3040 (2414 girls and 626 boys) of the 3064 children evaluated for sexual abuse. Children were interviewed, examined, and tested by culture for GC and Ct orally, rectally, and genitally. Information from referral sources, accompanying guardians, and previous recent physical examinations was recorded. Bivariate analyses and logistic regression were used to develop 2 sets of screening criteria to predict children at greatest risk of infection with: 1) GC and/or Ct (GC/Ct) and 2) GC alone.

Results. Fifty-eight children were identified with GC/Ct infections (37 with GC, 25 with Ct; 4 children were coinfectected). The proposed algorithm for GC/Ct infections would have identified all children who are being evaluated for sexual abuse. Because the medical and legal consequences of missing sexually transmitted infections in abused children are substantial, we aimed to develop a risk assessment algorithm that would identify virtually all cases (~100% sensitivity), while substantially reducing the number of tests performed (moderate to high specificity). These performance goals were coupled with the recognition that any algorithm must be simple and clearly defined to facilitate clinical application.

Conclusion. The use of a risk assessment algorithm for GC and Ct infections may reduce the cost and trauma of testing young children who are being evaluated for sexual abuse. Pediatrics 2001;107(5). URL: http://www.pediatrics.org/cgi/content/full/107/5/e73; sexual abuse, gonorrhea, Neisseria gonorrhoeae, chlamydia, Chlamydia trachomatis, sexually transmitted diseases, children.

ABBREVIATIONS: STD, sexually transmitted disease; GC, gonorrhea; Ct, chlamydia; AAP, American Academy of Pediatrics; CSAT, WakeMed Child Sexual Abuse Team; POR, prevalence odds ratio; CI, confidence interval.
TABLE 1. Previously Proposed Criteria for Selective Culturing of *N gonorrhoeae* and *C trachomatis*

AAP: “Evaluation should be performed if 1) the suspected offender has an STD or is considered at high risk; 2) the child has a history or physical findings indicative of penetrating trauma; 3) the child has signs or symptoms of an STD; 4) the victim is an adolescent or high-risk sexually active patient; 5) the patient or family is anxious about the possibility of acquiring an STD; and/or 6) follow-up is unlikely. Many experts advise culturing all children examined for sexual abuse for *C trachomatis* and *N gonorrhoeae*, regardless of circumstances.”

Prepubertal girls should receive oral, rectal, urethral, and vaginal cultures, whereas boys should receive oral and rectal cultures. Urethral cultures unless there is urethral discharge, dysuria, positive urine leukocyte esterase test, and/or erythema. Table 2.9 states that all prepubertal children being tested for sexual abuse receive vaginal, urethral, and rectal cultures for GC and CT as well as oral cultures for GC.

Centers for Disease Control and Prevention: “Examinations of children for sexual assault or abuse should be conducted so as to minimize pain and trauma to the child. The decision to evaluate the child for STDs must be made on an individual basis. Situations involving high risk for STDs and a strong indication for testing include the following:

- A suspected offender is known to have an STD or to be at high risk for STDs (eg, has multiple sex partners or a history of an STD).
- The child has symptoms or signs of an STD or of an infection that can be sexually transmitted.
- The prevalence of STDs in the community is high. Other indications recommended by experts include evidence of penetration or ejaculation, or STDs in siblings, or other children of adults in the household. If a child has symptoms, signs, or evidence of an infection that might be sexually transmitted, the child should be tested for other common STDs . . .”

Siegel et al.6: “In prepubertal girls, cultures for *N gonorrhoeae* need only be obtained when a discharge is present at the time of examination or if the child is felt to be at high-risk for STD acquisition. We define high-risk as having a STD diagnosed, a sibling with an STD, contact with a perpetrator known to have an STD, or contact with multiple perpetrators. The prevalence of *C trachomatis* in prepubertal girls is low and testing should be done only if a child falls into the high-risk group for STD acquisition.”

ian who accompanied the child. Additional information was available from the referral source regarding the reasons for referral and previous medical evaluations.

The children received thorough physical forensic examinations for possible evidence of sexual abuse. Experienced physicians conducted the examinations using established protocols.8 Children were examined for physical evidence of STDs, penetrating trauma, or other evidence of sexual contact. One hundred twenty variables related to physical examination findings, including physical evidence of STDs, penetrating trauma, and other evidence of sexual contact, were recorded.

Genital (urethral in boys and vaginal in girls), rectal, and oral specimens were collected for *N gonorrhoeae*. The specimens were plated on chocolate and modified Thayer Martin agar and incubated in 5% carbon dioxide for 3 days.1 Isolates were tested by Gram-stain and sugar fermentation and, if positive for GC, confirmed by the North Carolina Public Health Laboratories.

Genital (urethral in boys and vaginal in girls), rectal, and oral cultures were also performed for Ct. In June 1996, oral cultures for Ct were discontinued because of low yield. Vaginal Ct cultures were obtained by using a cotton swab on a wire to swab hymenal tissues and the vaginal opening. In males, the urethra was swabbed using a cotton swab on a wire. Rectal swabs were also obtained. The swabs were placed in transport media on ice and then transported within 24 hours to the North Carolina Public Health Laboratories or to the microbiology laboratory at WakeMed. Some samples were frozen at −70°C and cultured within 3 days. Ct cultures were performed on McCoy cells using standard techniques and isolates were confirmed by direct immunofluorescent assay.9

Culture results were obtained successfully in 99.5% of attempts across all sites. Unsuccessful culture attempts were attributable to specimens being lost en route to the laboratory or during subculture. All children with unsuccessful culture attempts were treated as positive at that site during the analysis. Children who were culture-positive when properly cultured by another health care provider, treated, and then referred within 3 months to CSAT were not recultured for diagnostic purposes and were considered positive in the analysis. Those with histories (>3 months) of GC/Ct infection were recultured and only counted as positive if they were positive on reculture. Children with previously negative cultures were retested in our clinic, regardless of how recently they were cultured.

Data Analysis

Data analysis was performed using Stata, Version 5.0.10 The data for all culture-positive cases were rechecked for accuracy against the original medical records and paper surveys.

We conducted analyses for 2 outcomes: 1) GC and/or Ct identified from any anatomic site (GC/Ct) and 2) GC identified from any anatomic site. For the GC/Ct outcome, a case was defined as a child having at least 1 confirmed positive culture for GC or Ct from any anatomic site. For the GC outcome, cases were those who had at least 1 confirmed positive GC culture at any anatomic site. This second analysis and algorithm for GC alone was conducted to provide guidance for centers without the capability to perform Ct cultures.

Descriptive analyses were performed to assess frequencies, means, and missing data. One hundred twenty variables of potential clinical relevance were selected from the ~550 variables available in the dataset. The relationships between each outcome and these 120 variables were assessed by determining prevalence odds ratios (PORs), sensitivities (frequency of risk marker presence among cases), and specificities (frequency of risk marker absence among noncases) in bivariate analyses.

Multivariate analyses were conducted using logistic regression. Separate models were developed for the 2 outcomes, GC/Ct and GC only. Clinical characteristics and referral information variables were included in the full logistic regression models if clinical relevance was suggested by previous studies as referenced below and/or unadjusted PORs were significantly >1.0. Variables that were not associated with case status were excluded.

The following 11 dichotomous variables (risk markers) were included in both full models: child disclosed genital-to-genital or genital-to-anal contact,11,12 or penetration,1,2,5,12,13 child exhibited obvious sexual play during interview,19 suspicious anogenital physical signs of any kind that caused a physician concern leading to referral to CSAT,1,2,11 child was referred because a sibling was thought to have been abused,14,15 child referred because of known or suspected contact with a person known to have an STD,1,2,15 current or recent history of a genital discharge on examination,1,4,13,16,18 current or recent history of painful urination (dysuria),1,2,11,18 vaginitis (redness and edema without a discharge),1,13 inferior hymenal clefts or tears from 3 to 9 o’clock,1,2,13 child disclosed genital fondling,11,12 and child had a previous history of sexual abuse investigation.

A backward elimination protocol was used to reduce the full model to a final model. The goal of this variable reduction was to minimize pain and trauma to the child. The decision to evaluate the child for STDs must be made on an individual basis. Situations involving high risk for STDs and a strong indication for testing include the following:

- A suspected offender is known to have an STD or to be at high risk for STDs (eg, has multiple sex partners or a history of an STD).
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- The prevalence of STDs in the community is high. Other indications recommended by experts include evidence of penetration or ejaculation, or STDs in siblings, or other children of adults in the household. If a child has symptoms, signs, or evidence of an infection that might be sexually transmitted, the child should be tested for other common STDs . . .”

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A backward elimination protocol was used to reduce the full model to a final model. The goal of this variable reduction was to produce clinically meaningful and applicable risk scores that maintained high predictive accuracy. Variables (ie, potential risk markers) were eliminated from the full model one at a time until all variables in the model had an associated POR >1.0 and likelihood ratio test P value >.10. This higher α-value was used to increase the predictive ability of the model because variables with a P value of .10 may still have relatively high predictive ability and to reduce the likelihood that important variables were excluded. Goodness-of-fit of the final models was assessed with the Hosmer-Lemeshow test.10

To develop a risk assessment algorithm, individual risk markers were assigned a score equal to the β-coefficients of the logistic models rounded to the nearest integer. These individual risk marker scores were summed to provide a cumulative risk score.
Our goal was to create a risk score that provided essentially perfect sensitivity (100%), while substantially reducing the number of tests performed. To achieve this objective, we chose the highest possible risk score cut point that provided a sensitivity of 100%. After developing the risk algorithm using specific scores for individual risk markers, we developed a simplified algorithm designating factors as major or minor determinants of risk.

The performance of the risk assessment algorithms was described using sensitivity and specificity. Ninety-five percent confidence intervals (CIs) were calculated for these proportions using exact binomial methods.

RESULTS

Characteristics of the Study Population

The children were referred from an 11-county area in Eastern North Carolina, with 66% being from Wake County. Children were referred by: social services (63%), police (10%), health departments (3%), WakeMed Pediatric Clinic (6%), WakeMed Emergency Department (3%), other physicians (10%), mental health professionals (1%), and others (3%). Based on the evaluation, sexual abuse was confirmed in ~40% of the children, abuse was suspected but not confirmed in 25% of children, and the remaining 35% were not considered to have been sexually abused given available evidence.

The mean age of the study population was 6.0 years (standard deviation: 3.0). The majority of children were female (79%; Table 2). Just over half of the children (52%) were white, 44% were black, 2% were Latino, and 2% were classified as another race/ethnicity or mixed race.

GC and Ct Occurrence

Thirty-seven children had positive cultures for *Neisseria gonorrhoeae* at any anatomic site (prevalence: 1.2%; 95% CI: 0.8–1.6; Table 3). Of these, 15 were diagnosed by culture at another facility and referred with the medical information from that visit. *Chlamydia trachomatis* was isolated in 25 children at any anatomic site (prevalence: 0.8%; 95% CI: 0.5–1.1). Of these, 5 were diagnosed by culture at another facility and referred to us. For those children diagnosed with GC and/or Ct infection at another facility, we had complete information on transient physical findings, including discharge, vaginitis, and dysuria, as recorded from their previous physical examination.

Fifty-eight children were culture-positive for 1 or both infections (prevalence: 1.9%; 95% CI: 1.4–2.4), with 4 children having both GC and Ct infection.

<table>
<thead>
<tr>
<th>TABLE 2. Demographic Characteristics of the Study Population</th>
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</thead>
<tbody>
<tr>
<td>Characteristic</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Gender</td>
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<tr>
<td>Female</td>
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<tr>
<td>Male</td>
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<tr>
<td>Age (y)</td>
</tr>
<tr>
<td>0–3</td>
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<tr>
<td>4–7</td>
</tr>
<tr>
<td>8–12</td>
</tr>
<tr>
<td>Race</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Latino</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Mixed/other</td>
</tr>
</tbody>
</table>

Fourteen rectal cultures were positive (10 GC and 4 Ct). One 3.5-year-old girl had a positive GC rectal culture that was not accompanied by a positive GC genital culture but was coupled with a positive genital culture for Ct. No oral cultures obtained at CSAT were positive.

Relationship of Possible Risk Markers and GC/Ct Infections

The majority of GC/Ct cases (53/58) were female (Table 2). GC/Ct cases were also likely to have a current or recent history of a genital discharge (41/58). The 3 characteristics most strongly associated with the presence of infection were: referred because of suspected contact with a person thought to have an STD (POR: 25.0; 95% CI: 13.0–48.2), vaginitis (POR: 16.6; 95% CI: 8.9–30.8), current or recent history of a genital discharge (POR: 14.8; 95% CI: 8.4–26.0; Table 4). Dysuria, genital fondling, history of previous sexual abuse investigation, and referral because a sibling was thought to have been sexually abused all had crude PORs close to 1.0. Characteristics associated with GC alone were similar (Table 5).

Multivariate Analysis

We examined the relationship of potentially predictive variables with GC/Ct and GC alone using logistic regression. Six risk markers were strongly related to GC/Ct (Table 4). Model fit was adequate ( Hosmer-Lemeshow goodness-of-fit test, $P = 0.20$). Factors from the clinical history included disclosure of genital-to-genital or genital-to-anal contact or penetration by penis. Factors related to referral included suspected contact with a person infected with an STD, suspicious physical findings, and abuse of a sibling. Important physical findings included genital discharge on a current or recent examination and vaginitis.

Because some facilities do not have the resources to properly perform cultures for Ct, we developed a similar model for GC alone (Table 5). Again, the model fit was acceptable ( Hosmer-Lemeshow goodness-of-fit test, $P = 0.90$).

Development of Risk Assessment Algorithms

Based on the logistic regression models, individual risk markers were assigned a risk score using the $\beta$-coefficient from the logistic model rounded to the nearest integer. For the GC/Ct outcome, referral for suspected abuse of sibling, and vaginitis were weighted with a score of 1; genital-to-genital or genital-to-anal contact or penetration, suspicious anogenital findings, and genital discharge were weighted with a score of 2; and referred for contact with a person suspected to have an STD was weighted with a score of 3. These individual risk scores were summed to create an overall risk assessment algorithm for GC/Ct.

Testing all children with a score of 2 or higher identified all culture-positive children (sensitivity: 100%; 95% 1-sided CI: 94–100) with good specificity (56%; 95% CI: 54–58). Application of this screening rule to our study population would have led to testing 45% of the children (1372/3040). Based on this...
algorithm and compared with testing all children, we avoid unnecessarily testing 1219 of 2414 girls (51%) and 449 of 626 boys (72%).

To facilitate clinical application, the risk assessment algorithm was further simplified (Table 6). Risk markers with scores of 2 or more were designated major and those with scores of 1 designated minor. Testing all children with at least 1 major or 2 minor risk markers retains the same performance characteristics as the full risk algorithm with a cut point of 2 or greater.

A similar risk assessment algorithm was developed for the GC-only outcome. Based on the β-coefficients from the logistic regression model, genital-to-genital or genital-to-anal contact or penetration, disclosure of fondling, sexual play during interview, referral for suspected abuse of sibling, and vaginitis were weighted with a score of 1; and suspicious anogenital findings, referred for contact with a person suspected to have an STD, and genital discharge were weighted with a score of 3.

Children with GC were almost all symptomatic (33/37 had a current or recent discharge), and all cases had more than 1 risk marker. Computing an overall risk score as above and testing children with a score of 4 or greater would have resulted in testing 17% of the children for GC and yields a sensitivity of 84% (95% CI: 83–86) and specificity of 3 or greater would result in 32% of children of 84% (95% CI: 83–86). Screening children with 100% (37/37; 95% 1-sided CI: 91–100) and specificity scores of 3 or greater would have resulted in testing children with a risk score of 3.

A simplified clinical risk marker algorithm was again created by designating risk markers with a score of 1 as minor and those with risk scores of 3 as major (Table 6). Screening all children with 1 major risk marker or at least 3 minor risk markers yields the same performance as screening children with a risk score of 3.

**DISCUSSION**

Among children undergoing evaluation of sexual abuse, 2 key questions related to Ct and GC infections are: 1) which children should undergo testing; and 2) which sites should be cultured? We have developed a risk assessment algorithm to guide the performance of GC/Ct testing in children undergoing evaluation for sexual abuse. In our population, the GC/Ct risk assessment algorithm would have led to diagnosis of all identified cases of GC/Ct infection, while requiring less than half of the children to be tested. A second algorithm developed to guide performance of GC culture also performed well. This second algorithm is intended for settings without the resources to perform Ct culture.

We also provide evidence that limiting specimen collection to genital sites may be adequate in most circumstances. In our study, oral cultures had very low yield, because no cases of oral GC or Ct infection were identified. One child had a positive rectal culture for GC without a positive genital culture for GC, although this child had a positive genital culture for Ct. Thus, if cultures for GC and Ct were obtained from only genital sites, no children known to have an infection would have been missed.
TABLE 5. Risk Markers for *N. gonorrhoeae* Infection Only in Children Undergoing Evaluation for Sexual Abuse

<table>
<thead>
<tr>
<th>Risk Marker</th>
<th>Cases (n = 37)</th>
<th>Noncases (n = 3003)</th>
<th>Unadjusted POR (95% CI)</th>
<th>Full Model Adjusted POR (95% CI)</th>
<th>Reduced Model Adjusted POR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical history</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Disclosed genital-to-genital or -rectal contact or penetration</td>
<td>17 (45.9)</td>
<td>628 (20.9)</td>
<td>3.2 (1.7–6.1)</td>
<td>2.5 (1.0–6.4)</td>
<td>2.4 (1.0–6.1)</td>
</tr>
<tr>
<td>Disclosed fondling of genitals</td>
<td>13 (35.1)</td>
<td>819 (27.3)</td>
<td>1.4 (0.7–2.8)</td>
<td>2.8 (1.0–7.6)</td>
<td>2.4 (0.9–6.1)</td>
</tr>
<tr>
<td>Previous history of sexual abuse investigation</td>
<td>16 (43.2)</td>
<td>916 (30.5)</td>
<td>1.7 (0.9–3.3)</td>
<td>1.6 (0.7–3.7)</td>
<td></td>
</tr>
<tr>
<td>Sexual play during interview</td>
<td>6 (16.2)</td>
<td>142 (4.7)</td>
<td>3.9 (1.6–9.2)</td>
<td>3.8 (1.0–14.3)</td>
<td>3.4 (0.9–12.6)</td>
</tr>
<tr>
<td>Referral reasons</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Suspected contact with person with an STD</td>
<td>10 (27.0)</td>
<td>46 (1.5)</td>
<td>23.8 (11.1–51.4)</td>
<td>25.5 (7.6–85.3)</td>
<td>25.7 (8.0–83.1)</td>
</tr>
<tr>
<td>Suspicious physical anogenital findings</td>
<td>29 (78.4)</td>
<td>583 (19.4)</td>
<td>15.0 (7.0–32.5)</td>
<td>16.4 (5.4–49.1)</td>
<td>13.4 (4.6–38.6)</td>
</tr>
<tr>
<td>Sibling was thought to have been abused</td>
<td>6 (16.2)</td>
<td>463 (15.4)</td>
<td>1.1 (0.5–2.5)</td>
<td>2.9 (0.8–10.6)</td>
<td>3.4 (1.0–12.1)</td>
</tr>
<tr>
<td>Physical findings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genital discharge: current or recent examination</td>
<td>33 (89.2)</td>
<td>427 (14.2)</td>
<td>49.8 (18.3–135.4)</td>
<td>20.0 (6.1–65.9)</td>
<td>21.8 (6.6–71.6)</td>
</tr>
<tr>
<td>Vaginitis</td>
<td>14 (37.8)</td>
<td>69 (2.3)</td>
<td>25.9 (12.9–51.9)</td>
<td>4.8 (2.0–11.9)</td>
<td>4.0 (1.7–9.2)</td>
</tr>
<tr>
<td>Dysuria</td>
<td>7 (18.9)</td>
<td>525 (17.5)</td>
<td>1.1 (0.5–2.5)</td>
<td>0.5 (0.2–1.3)</td>
<td></td>
</tr>
<tr>
<td>Inferior hymenal clefts or tears at 3–9 o’clock</td>
<td>8 (21.6)</td>
<td>174 (5.8)</td>
<td>4.5 (2.0–9.8)</td>
<td>0.6 (0.2–2.0)</td>
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</table>

In previous studies, however, the prevalence of infections at oral and rectal sites has varied widely. One study of GC infections in children identified 95% of cases with genital cultures, but an additional 5% were detected with oral and rectal cultures. Although some cases could be missed, these data suggest that significant savings in resources and reduction of trauma to children can be accomplished by performing only genital cultures, while still maintaining high sensitivity. The critical question is whether the additional expense necessary to detect a very small number of extragenital infections is justified.

The combination of the use of the proposed risk assessment algorithms and the limitation of culture sites to the genital area would result in dramatic cost savings. In our population, if only genital cultures were performed in all children, the number of cultures would have been reduced from 18,240 cultures to 6080 cultures (3040 for GC and 3040 for Ct). Combining this reduction with the application of the risk score for GC/Ct would reduce this by 55% to 6080 cultures (3040 for GC and 3040 for Ct). Therefore, we believed that inclusion of these markers might reduce the generalizability of the algorithms. Furthermore, targeted testing for STDs by racial/ethnic groups is highly controversial and, generally, should be avoided.

Many centers may not have the capability to perform cultures for *C. trachomatis*. Consequently, we have provided an algorithm for GC infections only, the number of children tested by 1668, at a savings of $280,224. Using our algorithm and performing only genital cultures would have cost $76,832 with no reduced yield in our study population. One must consider how many isolated rectal and oral infections would have to be missed to justify spending an additional $153,664 on rectal and oral cultures. Given the observed detection of 58 of 58 cases with testing only 1 site and based on the 95% CIs, the probability of missing 3 cases is ~5%. Detection of these 3 hypothetical cases would have cost over $50,000 per case.

Most children (81%) with GC and/or Ct infection in this study were black females, although they constituted only 36% of the study population. Currently, reported rates of GC and Ct infection in black adults in our region are roughly 20 times higher than those in white adults. Our data show that 90% of named abusers are the same race as the children who they allegedly abused, and so it is not surprising that the rates in children mirror those found in the adults with whom they have sexual contact. However, the demographic characteristics and the STD prevalence vary considerably in different geographic locations. Therefore, we believed that inclusion of these markers might reduce the generalizability of the algorithms. Furthermore, targeted testing for STDs by racial/ethnic groups is highly controversial and, generally, should be avoided.

Many centers may not have the capability to perform cultures for *C. trachomatis*. Consequently, we have provided an algorithm for GC infections only.


<table>
<thead>
<tr>
<th>Risk Marker</th>
<th>GC/Ct†</th>
<th>GC‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genital discharge: at examination or recent history</td>
<td>Major</td>
<td>Major</td>
</tr>
<tr>
<td>Referred because of suspected contact with person thought to have an STD</td>
<td>Major</td>
<td>Major</td>
</tr>
<tr>
<td>Referred because of suspicious physical anogenital findings</td>
<td>Major</td>
<td>Major</td>
</tr>
<tr>
<td>Disclosed genital-to-genital or genital-to-rectal contact or penetration</td>
<td>Major</td>
<td>Minor</td>
</tr>
<tr>
<td>Disclosed genital fondling</td>
<td></td>
<td>Minor</td>
</tr>
<tr>
<td>Exhibits obvious sexual play during interview</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Sibling was thought to have been sexually abused</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Vaginitis</td>
<td>Minor</td>
<td>Minor</td>
</tr>
</tbody>
</table>

* GC/Ct: culture children with at least 1 major risk marker or 2 minor risk markers. Performance: sensitivity, 100%; specificity, 56%.
† GC: culture children with at least 1 major risk marker or 3 minor risk markers. Performance: sensitivity, 100%; specificity, 69%.
specifically for application in such settings. This algorithm differs somewhat from the GC/Ct algorithm. Such a difference is expected because these infections are prevalent in different, but overlapping, adult populations.

Major strengths of the present study include the large database, the quality of the information collected, and the consistency of experienced staff. We used one of the largest databases of children undergoing evaluation for sexual abuse. The interviews, physical examinations, and laboratory work were standardized and recorded at that time into a computerized database. One physician (V.D.E.) performed 89% of the physical examinations and 2 other highly experienced clinicians performed an additional 10% of the examinations. Three highly experienced interviewers performed >90% of the interviews. These data are more detailed than is generally possible from a retrospective review of medical records. The large number of cases afforded the opportunity to use multivariate analysis techniques, and the availability of extensive data on the noncases allowed an assessment of the specificity of the proposed screening criteria, which was provided in only 1 other study.9

An important limitation of this study is the number of GC and Ct infections that were presumably missed because of the imperfect sensitivities of the culture methods used.22–24 Sensitivities for these culture methods have been estimated to be between 50% and 98% for GC24 and between 70% and 90% for Ct (depending on the anatomic site) in adults, but there are few data on their sensitivities in children.23,24 If the characteristics of children with undetected infections differed from those with detected infections, some bias would be introduced. Although such a difference seems unlikely, missed infections do raise the possibility that the sensitivity of the proposed screening algorithm could be below 100%.

Children with positive cultures obtained by other providers within the preceding 3 months were considered cases and the information collected by these providers was used in our analyses. These children are a distinct subset of the cases, because the examinations and cultures performed by these providers were not under the direct control of the CSAT. Although inclusion of these children could lead to some selection bias, this procedure allowed the linkage of symptoms and signs with the cultures in a timely manner. In addition, if these children had been retested at CSAT, they would have been culture-negative because the infections would have been treated.

Certain historical findings might have been unidentified because important information might not have been disclosed during the interview. Similarly, the physical examination findings might be obscured as the time from abuse to examination lengthens. In addition, the period of time since the last abusive encounter and the total number of abusive encounters is very difficult to determine accurately when dealing with young children, limiting the use of timing in the development of a risk assessment algorithms.

The performance and applicability of our screening algorithms in other settings depend largely on the similarity of the populations. The CSAT population was a referral population, arising from an 11-county area in eastern North Carolina with the majority from the urban Wake County. Much of the referral area is not urbanized, although the rates of reported GC infection in adults in this area are among the highest in the state and as high as those reported in large cities elsewhere.20

Referral patterns should also be considered to assess the applicability of these algorithms. Children from different demographic or socioeconomic backgrounds may be more or less likely to be referred to CSAT for various reasons, such as a genital discharge. Other medical centers may have different referral patterns. In addition, both the study population and availability of information may be different from those for primary visits of children to a physician who is not part of a regional child abuse referral center. Indeed, many of the risk markers are specific to referral issues. Nevertheless, the similarities of our risk score to previously published criteria for screening for these infections support its generalizability.1–4,6

Although we were able to predict successfully all identified cases and substantially reduce the number of cultures necessary, this high level of performance cannot be guaranteed, or perhaps even expected, in other populations. The 95% CIs of the sensitivity extend well below 100% and, therefore, performance may be less than perfect in other settings. Furthermore, the algorithms have been developed and assessed in the same population, without validation in another population. The relatively small number of cases in the study population prohibited the use of split sample techniques to validate the algorithms. This study provides evidence for the possibility of rationally limiting cultures performed in children being evaluated for sexual abuse in sexual abuse referral centers. We have developed a risk assessment algorithm for GC and Ct infection in children <13 years old undergoing evaluation for sexual abuse. This algorithm would have reduced the number of cultures performed, while retaining excellent sensitivity for detecting GC and Ct. Additional reduction in the number of cultures performed could be achieved by limiting cultures to genital sites only. The effectiveness of this approach may vary with the characteristics of the population, underlying infection prevalence, and referral patterns. Although each center must weigh the potential costs and benefits of their methods, we recommend performing only genital cultures for GC and Ct using the risk scores presented or those generated from data on the local population using similar methods.

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