A Prospective Cohort Study of Partner Testing for Herpes Simplex Virus and Sexual Behavior During Pregnancy

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Background. We investigated whether serotesting sexual partners of pregnant women for herpes simplex virus (HSV) improves adherence to safer-sex practices.

Methods. A total of 287 HSV-2–seronegative pregnant women were recruited, and their partners were invited for HSV serologic testing. On the basis of test results, women were placed into 4 groups: those at risk for HSV-2 infection, those at risk for HSV-1 infection, those whose partner was not tested, and those not at risk for HSV infection. Women received safer-sex counseling and completed diaries of sexual activity.

Results. Women in HSV-2–serodiscordant couples (ie, those in relationships in which they were at risk for HSV-2 acquisition) reported a smaller percentage of days with unprotected genital sex acts as compared to women who were not at risk (2% vs 8%; relative risk [RR], 0.3 [95% confidence interval [CI], 0.1–0.8]; P = .002) and to women whose partners’ HSV status was unknown (2% vs 11%; RR, 0.2 [95% CI, 0.1–0.8]; P = .02). Women in HSV-1–serodiscordant couples showed no difference in the frequency of genital sex acts, unprotected genital sex acts, or oral sex acts as compared to those not at risk and to those whose partners’ status was unknown.

Conclusions. Pregnant women at known risk of HSV-2 acquisition by partner serotesting were less likely to engage in unprotected genital sex acts than HSV-2–seronegative women with partners who were negative or not tested.

Neonatal herpes remains a serious albeit infrequent complication of pregnancy [1]. The incidence varies from 5 to 60 cases per 100 000 live births, depending on the population and the source of data [2–4]. Currently, treatment with high-dose acyclovir has reduced mortality. However, only 30% of infants with central nervous system infections are developmentally normal.

The principal risk factor for neonatal herpes is maternal acquisition of genital herpes simplex virus (HSV) infection near the time of delivery. Viral shedding in the genital tract during labor is associated with a >300-fold increased risk for neonatal HSV infection [4]. Women who are seronegative are at higher risk of transmitting HSV than women with established HSV-2 infection, and between 60% and 80% of infants with neonatal herpes are born to women who acquired HSV at the end of pregnancy [4]. However, current antepartum prevention strategies focus on women with symptomatic genital herpes, which is the group at lowest risk for transmission to the neonate.

Although there is some evidence that both women and their partners are willing to undergo HSV testing during pregnancy [5–7], information on whether partner knowledge of HSV status and maternal acquisition risk would affect sexual behavior during pregnancy is lacking. The goal of this study is to evaluate adherence to safer-sex practices in women identified as at risk for HSV acquisition from their partners. We hypothesized that adherence to safer-sex practices would be greater among women who were documented to be at risk for HSV-2 acquisition during pregnancy.

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MATERIALS AND METHODS

The HSV serologic status of pregnant women at the University of Washington was tested by Western blotting as part of routine prenatal care. Women who were HSV-2 seronegative were approached for enrollment into a study that offered HSV serologic testing to their male partners, as detailed previously by Gardella et al [5]. Between July 2001 and April 2008, pregnant women were approached if they were HSV-2 seronegative, at ≤31 weeks gestation, aged ≥18 years, and English speakers.

Participants completed a baseline questionnaire regarding demographic characteristics, sexual history, information about past and current sex partners, and current sexual behavior. Standardized counseling on safer-sex practices to prevent the acquisition of genital herpes during pregnancy was provided, including a booklet about HSV, a handout specific to HSV in pregnancy, and a card describing safer-sex practices (Figure 1). Enrollees were asked to invite their sex partners to undergo, at any time before delivery, free serologic testing for HSV-1 and HSV-2. Although partner testing was not required for the study, it was encouraged in order to better define the risk of exposure to HSV during pregnancy. Women completed daily diaries of sexual activity and sexual behavior questionnaires 1–2 times before delivery and once immediately after delivery.

The diaries and questionnaires were used to address variations in adherence depending on whether the pregnant woman was at risk for HSV acquisition. Safer sex education discussed that serotesting for HSV does not indicate a site of HSV infection (genital or oral). Education about safer sex practices included use of barrier methods and avoidance of oral-genital contact; education also reviewed abstinence. Only women who reported having had at least 1 sexual partner during pregnancy and who were followed for at least 30 days were included. Women with <15 valid diary-days after they learned their partner’s HSV status were excluded. We defined the frequency of genital sex as the number of days during which genital sex occurred divided by the total number of diary-days. The frequency of unprotected genital sex was defined as the number of days during which unprotected genital sex occurred divided by the total number of diary-days. We defined the frequency of oral sex as the number of days during which oral sex occurred divided by total number of diary-days.

Our hypothesis was that HSV-2–seronegative women with partners known to be serodiscordant would be more likely to comply with safer-sex practices than those who were not at risk or those with partners of unknown serostatus. Because partner testing is potentially burdensome, control women included those who were documented not to be at risk for HSV acquisition and those who may have been at risk but whose partners were not tested. To determine the sample size needed to answer our hypothesis, the target population was divided into a binomial distribution in which one group included patients who averaged >1 unprotected sex act per month and the other included patients who averaged <1 unprotected sex act per month. On the basis of prior data collected on this population, 60% of patients fell into the former group, and 40% fell into the latter group, with approximately 20% of patients found to be at risk for HSV acquisition during pregnancy. As assuming 80% power, 285 patients were required to detect a 33% reduction in the proportion of at-risk women who have at least 1 unprotected sex act per month, compared with the proportion of women not at risk who have at least 1 unprotected sex act per month.

![Figure 1](https://academic.oup.com/jid/article-abstract/206/4/486/867626)

**To avoid getting herpes from your partner we recommend:**
1. Not having sex with your partner is the safest way to avoid getting herpes.
2. If you do have sex, always use a condom.
3. Do not let your partner put his mouth on your genital area (oral sex).
4. If your partner puts his mouth on your genital area, use a rubber dam or saran wrap to cover your genital area before he puts his mouth on your genital area.

<table>
<thead>
<tr>
<th>Mother: HSV-1 &amp; 2 negative</th>
<th>Partner: HSV-1 positive, HSV-2 negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother: HSV-1 &amp; 2 negative</td>
<td>Partner: HSV-1 &amp; 2 positive</td>
</tr>
<tr>
<td>Mother: HSV-1 &amp; 2 negative</td>
<td>Partner: unknown status</td>
</tr>
<tr>
<td>Mother: HSV-1 positive, HSV-2 negative</td>
<td>Partner: HSV-1 &amp; 2 positive</td>
</tr>
</tbody>
</table>

**To avoid getting herpes from your partner we recommend:**
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2. If you do have sex, always use a condom.

<table>
<thead>
<tr>
<th>Mother: HSV-1 positive, HSV-2 negative</th>
<th>Partner: HSV-1 negative, HSV-2 positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother: HSV-1 positive, HSV-2 negative</td>
<td>Partner: unknown status</td>
</tr>
</tbody>
</table>

Figure 1. Information card for patients, summarizing safer-sex practices.
Generalized linear models with a Poisson distribution and a $\chi^2$ scale parameter were used to compare rates of genital and oral sexual activity among women at risk for HSV-1 or HSV-2 to those among women whose partners were not tested or who were not at risk. Additionally, distributions of demographic and sexual history characteristics were compared by risk group, using the Kruskal-Wallis test for continuous measures and the Fisher exact test for categorical variables. Two-tailed $P$ values of .05 were considered statistically significant. Stata, version 10.1 (StataCorp, College Station, TX), was used for the analyses.

This study was approved by the University of Washington Human Subjects Review Board, and all participants (women and partners) signed a written consent form before study participation.

RESULTS

A total of 1191 women who tested negative for HSV-2 antibody were approached for the study. Of these, 397 (33%) agreed to enroll. Among subjects who enrolled, participation by 27 was terminated early because of ineligibility. Eighty-three subjects were lost to follow-up or were not at risk because they did not have a partner, they had a partner who was out of the country during their participation in the study, or they were told by their physician to abstain from sexual activity. Overall, 287 pregnant women prospectively provided valid diaries about sexual activity (Figure 2). Women and their partners were placed into one of 4 groups. Group 1 included 13 patients who were seronegative for HSV-2 and had partners who were seropositive for HSV-2; these women were considered to be at risk for HSV-2 acquisition. Group 2 included 35 patients who were seronegative for HSV-1 and had partners who were seropositive for HSV-1; these women were considered to be at risk for HSV-1 infection. Group 3 included 94 patients who were HSV seronegative for HSV-2 and/or HSV-1 and had partners who were not tested; these women were considered to have an unknown risk for HSV acquisition. Group 4 included 145 patients who were HSV seroconcordant with their partner; these women were considered not to be at risk for HSV acquisition. The median number of days of observation was 82 (range, 30–235 days). The total number of diary-days (ie, days at risk for HSV acquisition) for women at risk for HSV-2 infection was 1131. Women at risk for HSV-1 infection recorded 2326 diary-days, women whose partners were not tested recorded 6788 diary-days, and women who were not at risk for HSV acquisition recorded 9925 diary-days. Thus, there were a total of 20 170 diary-days available for analysis.

Demographic characteristics were similar by risk group (Table 1). Maternal age, level of education, marital status, insurance status, and income level did not differ between the study groups. There was a trend toward a shorter relationship duration among women who were at risk for HSV-2.

![Figure 2. Participant recruitment, selection, and assignment to herpes simplex virus (HSV) risk group.](https://academic.oup.com/jid/article-abstract/206/4/486/867626)
acquisition as compared to women who were at risk for HSV-1 acquisition, those who were not at risk, and those who were not tested (4, 9, 6, and 6 years, respectively; \( P = .10 \)). Women at risk for HSV-1 infection were more likely to have partners with a history of oral herpes (\( P = .01 \)), whereas women at risk for HSV-2 infection were more likely to have partners with a history of genital herpes (\( P < .001 \)).

### Table 1. Demographic Characteristics of Study Participants, by Herpes Simplex Virus (HSV) Risk Group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>At Risk for HSV-2</th>
<th>At Risk for HSV-1</th>
<th>Partner Not Tested</th>
<th>Not at Risk</th>
<th>( P^a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>287 (100)</td>
<td>13 (4.5)</td>
<td>35 (12)</td>
<td>94 (33)</td>
<td>145 (50.5)</td>
<td></td>
</tr>
<tr>
<td>Age, years, median (range)</td>
<td>31 (15–51)</td>
<td>34 (23–39)</td>
<td>31 (21–47)</td>
<td>31 (18–44)</td>
<td>30 (15–51)</td>
<td>.30</td>
</tr>
<tr>
<td>Sex partners in past year, no., median (range)( b )</td>
<td>1 (1–12)</td>
<td>1 (1–2)</td>
<td>1 (1–3)</td>
<td>1 (1–3)</td>
<td>1 (1–12)</td>
<td>.47</td>
</tr>
<tr>
<td>Duration of relationship, years, median (range)( c )</td>
<td>6 (0.01–23)</td>
<td>4 (0.7–13)</td>
<td>9 (0.5–16)</td>
<td>6 (0.01–23)</td>
<td>6 (0.4–23)</td>
<td>.10</td>
</tr>
<tr>
<td>White</td>
<td>210 (73)</td>
<td>7 (54)</td>
<td>28 (80)</td>
<td>69 (73)</td>
<td>106 (73)</td>
<td>.36</td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some/no high school</td>
<td>15 (5)</td>
<td>1 (8)</td>
<td>0</td>
<td>7 (8)</td>
<td>7 (5)</td>
<td>.70</td>
</tr>
<tr>
<td>Some college</td>
<td>82 (29)</td>
<td>4 (31)</td>
<td>9 (26)</td>
<td>27 (29)</td>
<td>42 (29)</td>
<td></td>
</tr>
<tr>
<td>College graduate or higher</td>
<td>190 (66)</td>
<td>8 (62)</td>
<td>26 (74)</td>
<td>60 (64)</td>
<td>96 (66)</td>
<td></td>
</tr>
<tr>
<td>Marital status( d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married/not living with partner</td>
<td>16 (6)</td>
<td>0</td>
<td>1 (3)</td>
<td>11 (12)</td>
<td>4 (3)</td>
<td>.11</td>
</tr>
<tr>
<td>Never married/living with partner</td>
<td>20 (7)</td>
<td>0</td>
<td>2 (6)</td>
<td>10 (11)</td>
<td>8 (6)</td>
<td></td>
</tr>
<tr>
<td>Married/living with partner</td>
<td>246 (86)</td>
<td>13 (100)</td>
<td>32 (91)</td>
<td>71 (76)</td>
<td>130 (90)</td>
<td></td>
</tr>
<tr>
<td>Separated/divorced</td>
<td>4 (1)</td>
<td>0</td>
<td>0</td>
<td>2 (2)</td>
<td>2 (1)</td>
<td></td>
</tr>
<tr>
<td>Insurance( e )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>228 (79)</td>
<td>10 (77)</td>
<td>30 (86)</td>
<td>69 (73)</td>
<td>119 (82)</td>
<td>.07</td>
</tr>
<tr>
<td>Medicaid</td>
<td>50 (17)</td>
<td>3 (23)</td>
<td>2 (6)</td>
<td>23 (24)</td>
<td>22 (15)</td>
<td></td>
</tr>
<tr>
<td>None/other</td>
<td>8 (3)</td>
<td>0</td>
<td>3 (9)</td>
<td>2 (2)</td>
<td>3 (2)</td>
<td></td>
</tr>
<tr>
<td>Yearly income( e )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$15 000</td>
<td>25 (9)</td>
<td>1 (8)</td>
<td>1 (3)</td>
<td>12 (13)</td>
<td>11 (8)</td>
<td>.44</td>
</tr>
<tr>
<td>$15 000–30 000</td>
<td>43 (15)</td>
<td>0</td>
<td>5 (14)</td>
<td>17 (18)</td>
<td>21 (14)</td>
<td></td>
</tr>
<tr>
<td>$30 000–50 000</td>
<td>52 (18)</td>
<td>3 (23)</td>
<td>9 (26)</td>
<td>17 (18)</td>
<td>23 (16)</td>
<td></td>
</tr>
<tr>
<td>&gt;$50 000</td>
<td>163 (57)</td>
<td>9 (69)</td>
<td>20 (57)</td>
<td>47 (50)</td>
<td>87 (60)</td>
<td></td>
</tr>
<tr>
<td>History of STDs( f )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>204 (71)</td>
<td>9 (69)</td>
<td>31 (89)</td>
<td>62 (66)</td>
<td>102 (70)</td>
<td>.02</td>
</tr>
<tr>
<td>1–3</td>
<td>68 (24)</td>
<td>2 (15)</td>
<td>2 (6)</td>
<td>29 (31)</td>
<td>35 (24)</td>
<td></td>
</tr>
<tr>
<td>Woman has history of genital herpes( g )</td>
<td>9 (3)</td>
<td>3 (23)</td>
<td>0</td>
<td>4 (4)</td>
<td>2 (1)</td>
<td>.004</td>
</tr>
<tr>
<td>Partner has history of genital herpes( h )</td>
<td>9 (3)</td>
<td>6 (46)</td>
<td>0</td>
<td>2 (2)</td>
<td>1 (1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Woman has history of oral herpes( g )</td>
<td>62 (22)</td>
<td>3 (23)</td>
<td>0</td>
<td>15 (16)</td>
<td>44 (30)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Partner has history of oral herpes( i )</td>
<td>64 (22)</td>
<td>3 (23)</td>
<td>18 (51)</td>
<td>6 (6)</td>
<td>37 (26)</td>
<td>.01</td>
</tr>
</tbody>
</table>

Data are no. (%) of participants, unless otherwise indicated.

Abbreviation: STDs, sexual transmitted disease.

\( a \) The Kruskal–Wallis test was used for continuous data, and the Fisher exact test was used for categorical variables.

\( b \) Unknown for 2.

\( c \) Unknown for 5.

\( d \) Unknown for 1.

\( e \) Unknown for 4.

\( f \) Unknown for 15.

\( g \) Unknown for 7.

\( h \) Unknown for 83.

\( i \) Unknown for 81.

**Women at Risk for HSV-1 Infection**

We enrolled 35 women (12% of women who provided valid diaries of sexual activity), with a total of 2326 diary-days of observation, who were at risk for HSV-1 acquisition. The number of sex partners in the past year for this group was similar to that for women at risk for HSV-2 infection, women whose partners were not tested, and women who were not at
There was a fairly even distribution of women in this group with respect to the frequency of unprotected sex acts per diary-month: 34% reported 0 unprotected sex acts per diary-month, 29% reported 1–3, and 37% reported >3 (Table 2). The percentage of women in this group who never received oral sex (77%) was similar to that in other groups: 85% for those at risk for HSV-2 infection, 74% for those whose partners were not tested, and 78% for those not at risk (P = .88).

The frequency of genital sex and unprotected genital sex was compared using Poisson regression (Figure 3A and 3B). There was no difference in the frequency of genital sex among women at risk for HSV-1 infection as compared to those not at risk (12.0% vs 8.5%; relative risk [RR], 1.4 [95% confidence interval [CI], 1.0–2.0]) or to those whose partners were not tested (12.0% vs 11.3%; RR, 1.1 [95% CI, 0.7–1.7]). Women at risk for HSV-1 infection also showed no difference in rates of unprotected genital sex as compared to those who were not at risk (11.8% vs 7.8%; RR, 1.5 [95% CI, 1.0–2.2]) and to those whose partners were not tested (11.8% vs 10.9%; RR, 1.1 [95% CI, 0.7–1.7]).

Frequencies of oral sex were compared using Poisson regression (Figure 3C and 3D). Women at risk for HSV-1 infection had a rate of receptive oral sex that was similar to that among those who were not at risk (1.5% vs 1.0%; RR, 1.5 [95% CI, .6–3.5]) and among those whose partners were not tested (1.5% vs 1.8%; RR, 0.9 [95% CI, .2–3.2]). The frequency at which women at risk for HSV-1 infection gave oral sex also did not differ as compared to that among women who were not at risk (2.8% vs 1.9%; RR, 1.4 [95% CI, .7–3.1]) and among those whose partners were not tested (2.8% vs 2.2%; RR, 1.3 [95% CI, .5–3.3]). No participant reported the use of rubber dams or other barriers for oral sex during this study, so the frequency of unprotected oral sex is identical to the frequency of oral sex per diary-month throughout the analysis.

**Women at Risk for HSV-2 Infection**

We enrolled 13 women (4.5% of women who provided valid diaries of sexual activity), followed for a total of 1131 diary-days of observation, who were at risk for HSV-2 acquisition. The median number of sexual partners within the last year for this group was similar to that among women not at risk (median, 1 partner for all groups; P = .47) (Table 1). There was a fairly even distribution of women in this group with respect to the frequency of unprotected sex acts per diary-month: 34% reported 0 unprotected sex acts per diary-month, 29% reported 1–3, and 37% reported >3 (Table 2).

The percentage of women in this group who never received oral sex (77%) was similar to that in other groups: 85% for those at risk for HSV-2 infection, 74% for those whose partners were not tested, and 78% for those not at risk (P = .88). The frequency of genital sex and unprotected genital sex was compared using Poisson regression (Figure 3A and 3B). There was no difference in the frequency of genital sex among women at risk for HSV-1 infection as compared to those not at risk (12.0% vs 8.5%; relative risk [RR], 1.4 [95% confidence interval [CI], 1.0–2.0]) or to those whose partners were not tested (12.0% vs 11.3%; RR, 1.1 [95% CI, 0.7–1.7]). Women at risk for HSV-1 infection also showed no difference in rates of unprotected genital sex as compared to those who were not at risk (11.8% vs 7.8%; RR, 1.5 [95% CI, 1.0–2.2]) and to those whose partners were not tested (11.8% vs 10.9%; RR, 1.1 [95% CI, 0.7–1.7]).

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reported 0 unprotected sex acts per diary-month; however, 38% reported at least 1–3 unprotected genital sex acts per diary-month. Women at risk for HSV-2 infection were more likely to always use a condom with each genital sex act as compared to women in other HSV risk groups (40% vs 4% among those whose partner was not tested and 6% among those who were not at risk; \( P = .005 \)).

The frequency of genital sex and unprotected genital sex was compared using Poisson regression (Figure 4A and 4B). There was no difference in the frequency of genital sex between women at risk of HSV-2 infection as compared to women not at risk (7.7% vs 8.5%; RR, 0.9 [95% CI, 0.7–1.1]) or to those whose partners were not tested (7.7% vs 11.3%; RR, 0.7 [95% CI, 0.5–0.9]). However, women at risk for HSV-2 infection had a rate of unprotected genital sex that was 70%–80% lower than that among those who were not at risk (2.1% vs 7.8%; RR, 0.3 [95% CI, 0.1–0.8]) and among those whose partners were not tested (2.1% vs 10.9%; RR, 0.2 [95% CI, 0.1–0.8]).

The proportion of women at risk for HSV-2 infection who reported 0 oral sex acts per diary-month was 85%, while 8% recorded >2 oral sex acts per diary-month (Table 2). Frequencies of oral sex were compared using Poisson regression (Figure 4C and 4D). Women at risk for HSV-2 infection were 3.5 times more likely to engage in receptive oral sex than those who were not at risk (3.5% vs 1.0%; RR, 3.5 [95% CI, 1.5–8.2]). Rates of receptive oral sex were similar among those at risk for HSV-2 infection and those whose partners were not tested (3.5% vs 1.8%; RR, 2.0 [95% CI, 0.9–8.0]). The frequency at which women at risk for HSV-2 infection gave oral sex did not differ from that for women who were not at risk (3.2% vs 2.2%; RR, 1.5 [95% CI, 0.6–4.4]) and for those whose partners were not tested (3.2% vs 2.2%; RR, 1.5 [95% CI, 0.4–2.4]).

**DISCUSSION**

To our knowledge, this is the first study examining sexual behavior modifications in pregnancy following HSV serologic testing and educational interventions. In a prospective study, we found that safer-sex education for women at risk of acquiring HSV during pregnancy could change sexual behaviors, presumably to reduce transmission of HSV. HSV patient and partner serotesting during pregnancy resulted in 70%–80% lower rates of unprotected genital sex among patients at greatest risk for HSV-2 acquisition.
A common misconception is that neonatal HSV infections are caused predominantly by HSV-2. However, up to 50% of cases of neonatal HSV infections are caused by HSV-1 [8]. Unfortunately, there was no change in the frequency of genital or oral sex acts among women at risk for HSV-1 infection in this study. We hypothesize that, despite a growing incidence of HSV-1 genital infections [9, 10], many patients associate HSV-1 only with infections occurring in oral locations and resulting in cold sores. Thus, counseling information regarding avoidance of genital sex may have been less convincing to patients at risk for HSV-1 infection.

Among women at risk for HSV-2 acquisition, there was a 3.5-fold increase in the rate of oral sex acts, compared with the rate among those not at risk. Although serotesting does not identify the site of HSV infection, seropositivity for HSV-2 almost always means genital tract infection [11]. In terms of transmission of HSV during receptive oral sex, concern is predominantly about oral-to-genital transmission of HSV-1. We did not find a difference in the frequency of receptive oral sex between women documented to be at risk for HSV-1 infection and women documented to be not at risk for HSV-1 infection. Thus, the increase in receptive oral sex among women documented to be at risk for HSV-2 infection is unlikely to result in an increase in transmission of oral-to-genital HSV-1. With the 70%-80% observed decrease in genital sex among women at risk for HSV-2 infection, this shift toward receptive oral sex and away from genital sex among pregnant women at risk for HSV-2 infection may result in a reduction in maternal genital HSV-2 acquisition during pregnancy.

The intermediate clinical step between a reduction in sexual behavior by pregnant women that have an increased risk of HSV acquisition and a reduction in neonatal HSV infection is demonstration of decreased rates of HSV transmission between partners. To our knowledge, no intervention study to reduce rates of HSV transmission during pregnancy has been done. However, prior work has shown that condom use reduces the transmission of HSV-2 between sex partners [12]. Suppressive antiviral therapy has been shown to halve the risk of HSV-2 transmission to susceptible partners in monogamous relationships [13]; however, none of the susceptible partners were pregnant, which may alter susceptibility to HSV. A meta-analysis by Crepaz et al also showed that behavioral interventions regarding safer-sex practices reduced the frequency of unprotected sex acts, which resulted in a decrease in incident sexually transmitted infections [14]. Finally, in a time-to-event study, we previously showed that knowledge of a partners’ genital herpes status

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Figure 4. Frequency of genital and oral sex, by herpes simplex virus type 2 (HSV-2) risk group. A, Frequency of genital sex. B, Frequency of unprotected genital sex. C, Frequency of receptive oral sex. D, Frequency of performed oral sex. Bars denote percentage of diary-days on which the event occurred. Abbreviations: CI, confidence interval; RR, relative risk.
protected against HSV-2 acquisition [15]. Findings from the current study are consistent with the observation that behavior differs if the couple is aware of discordant HSV-2 serologic results. Further work will need to establish whether serologic testing would result in a lower rate of HSV-2 transmission during pregnancy, a key step toward reducing neonatal HSV. The substantial reduction in unprotected genital intercourse observed in this study suggests that HSV-2 transmission between partners would potentially be significantly decreased during pregnancy. A reduction in partner-to-partner transmission would likely decrease new genital HSV-2 infections in susceptible pregnant women, thus potentially resulting in a clinically significant reduction in neonatal HSV-2 infections.

When comparing women who were not at risk for HSV-2 acquisition to women whose partners were not tested, the frequency of unprotected genital sex acts was similar (7.8% vs 10.9%), indicating that testing only the pregnant woman did not result in a change in sexual behavior. Only when the partner was also tested, which demonstrated whether the pregnant woman was definitively at risk for HSV-2 infection, was there a resulting change in unprotected sex acts within the partnership. Thus, it is essential to test both the pregnant woman and her partner to alter sexual behaviors.

Strengths of this study include the 67% partner testing acceptance rate, which is higher than previously reported [16]. Additionally, completion of detailed diaries of sexual activity provided a level of information previously unreported about the effects of safer-sex counseling on sex acts among at-risk partners during pregnancy. We also had >20 000 diary-days reported, which provided enough power for a meaningful statistical analysis. Limitations include generalizability to other populations. Only 33% of patients who were approached consented to enrollment. These enrolled patients demonstrated a level of involvement that may not be representative of all patients. This study population was also predominantly white, in monogamous relationships, with higher socioeconomic status. Partner testing may also be challenging in many prenatal care settings. Potential strategies for testing and education outside of a research setting include prenatal identification of pregnant women at high risk to transmit HSV to their infant; however, neonatal HSV infection can occur regardless of maternal characteristics, and identification of such women has proven elusive [17].

Given that the current interventions and evaluation of universal screening cost-effectiveness focus on identification and treatment of HSV-positive pregnant women at risk for recurrent HSV infection, future interventions targeting HSV-negative susceptible women, who are the highest-risk group for transmitting to their neonate during a new infection, should be encouraged. Further research is required to evaluate whether educational counseling, resulting in sexual behavior modifications, can be a cost-effective intervention to reduce the incidence of neonatal HSV infection.

In this population of pregnant women willing to undergo HSV serologic testing, educational counseling regarding safer-sex practices to reduce the risk of HSV transmission during pregnancy resulted in changes in sexual behaviors. Results of many studies aimed at changes in sexual behavior to avoid sexually transmitted disease or human immunodeficiency virus acquisition have been negative [18, 19]. However, pregnancy perhaps presents a different opportunity for behavior change, as the duration of the altered behavior is limited, the potential outcome can be deleterious, and sexual activity usually takes place in the context of a committed relationship. Our data suggest that partner testing to identify HSV-discordant couples may be feasible. Additional research focusing on this specific population of HSV-susceptible pregnant women is essential to reducing neonatal HSV infection.

Notes

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