Low Birth Weight, Prematurity, and Postpartum Endometritis

Association With Prenatal Cervical Mycoplasma hominis and Chlamydia trachomatis Infections

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We studied associations of Mycoplasma hominis, Ureaplasta urealyticum, and Chlamydia trachomatis genital infections with pregnancy outcomes, controlling by logistic and multiple linear regression for known risk factors and for the presence of the other two infections. A sample of 1204 Navajo women enrolling for prenatal care had endocervical C trachomatis, M hominis, and U urealyticum cultures and serum samples taken at enrollment and when possible after 30 weeks. Low birth weight (<2500 g) was associated with M hominis infection among women with a history of spontaneous abortion. Mycoplasma hominis infection was also associated with postpartum endometritis, but only among women undergoing a cesarean section (odds ratio, 4.7; 95% confidence intervals, 1.22 to 18.3). Although women with recent C trachomatis infection (IgM titer>1:32) on either sample or IgG seroconversion) were at greater risk of low birth weight (19% [3/16]) than women with chronic infection (4.5% [6/133]; relative risk, 4.2), this subgroup at risk was small (11% of women with classifiable C trachomatis infection). Mycoplasma hominis and C trachomatis infections may be important preventable causes of adverse pregnancy outcomes in identifiable subgroups of women.

(METHODS)

The study sample (N = 1204), consisting almost entirely of Navajo women, was obtained at two Indian Health Service sites, located in Gallup and Crownpoint, NM. Women were enrolled in the investigation by a study nurse (J.B.A.) at their initial prenatal care visit; the study population comprised about 60% of all women seeking initial prenatal care at the clinics from Oct 15, 1980, to Oct 15, 1983. Women who sought prenatal care early in pregnancy (<24 weeks gestation) were overrepresented; the 40% of the women not enrolled either presented later in pregnancy or were excluded because of personnel constraints, maternal characteristics.

Endocervical cultures for C trachomatis, M hominis, and U urealyticum were obtained by clinic physicians at the initial prenatal visit and again, if possible, at a prenatal visit during the third trimester. At these visits we also obtained serum samples that were tested for IgG and IgM antibodies to C trachomatis. Patient charts and medical records were reviewed two months postpartum by

BECAUSE low birth weight is a major predictor of neonatal mortality and morbidity, identifying preventable causes and thereby decreasing the incidence of low birth weight are major public health goals. Since Elder et al first demonstrated that the risk of low birth weight (<2500 g) among women without bacteriuria was reduced by tetracycline, numerous investigators have sought to clarify the relationship between genitourinary tract infections and adverse pregnancy outcomes. Several studies have found low birth weight and other adverse outcomes associated with genital infections of Mycoplasma hominis, Ureaplasta urealyticum, or Chlamydia trachomatis. Unfortunately, the results of these studies have been inconsistent. Although some studies have demonstrated associations of these organisms with spontaneous abortion, low birth weight, decreased mean birth weight, preterm delivery, neonatal morbidity, or maternal postpartum morbidity, other studies have failed to confirm these observations. Explanations for these inconsistencies address issues such as study size, appropriateness of control groups, heterogeneity of populations studied, serological classification of infection, low prevalence in some study populations of the organisms of interest, adequacy of control for a multiplicity of confounding factors, and need to ascertain and control for the presence of coexisting infections. We performed a prospective, population-based study in a homogeneous sample of pregnant women who had a high prevalence of M hominis, C trachomatis, and U urealyticum genital infections. Possible sources of bias present in many previous studies appear to have been avoided in this population and with this study design.

METHODS

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some of the coauthors (H.R.H., W.T.B., M.L., and J.B.A.) who were unaware of the culture results. The charts provided the following information: maternal demographic characteristics, reproductive history, events during pregnancy, length of gestation, pregnancy outcome, duration of labor, duration of ruptured membranes, occurrence of premature rupture of membranes (the occurrence of membrane rupture more than one hour before the onset of labor), number of vaginal examinations while in labor, type of delivery, and postpartum complications (postpartum endometritis and postpartum fever). Postpartum fever was defined as a temperature of 38°C or higher on two occasions occurring more than 24 hours after delivery, without an identifiable source, and postpartum endometritis was defined as postpartum fever accompanied by either cervical discharge or uterine tenderness.

**Chlamydia and Mycoplasma Cultures**

Endocervical specimens were collected with calcium-alginate-tipped swabs, which were immersed in sucrose-phosphate transport medium for culture of *C trachomatis* and in trypticase-soy broth with added bovine serum albumin for culture of *M hominis* and *U urealyticum*. All specimens from both Gallup and Crownpoint were immediately frozen at −70°C and shipped to Tucson on dry ice, where they were stored at −70°C until inoculation. *Chlamydia trachomatis* was cultured in cycloheximide-treated McCoy cells, using a microtiter plate system. Thawed specimens were inoculated into urea broth and onto E agar and *Mes agar* plates. *Mycoplasma hominis* was identified by typical morphological features on subculture plates, and *U urealyticum*, by broth passage and calcium chloride stain of subcultured colonies on *Mes* agar.

**Chlamydia Serological Studies**

Immunoglobulin G and IgM antibodies to *C trachomatis* were measured with the microimmunofluorescence method. Antibody titers for IgG of 1:16 or greater, or for IgM of 1:32 or greater, as measured with fluorescein-conjugated immunoglobulin-class-specific goat anti-human globulins, were regarded as positive. We used serological data to classify *Chlamydia* infections as recent (either specimen IgM positive or IgG seroconversion), chronic (third-trimester specimen both IgG and IgM negative or initial specimen IgG positive and IgM negative), or unknown (unclassifiable because of missing serological data).

**Statistical Analysis**

Mantel-Haenszel $\chi^2$ test was used to assess differences in proportions and to generate 95% test-based confidence intervals. Differences in mean birth weight were assessed by Student’s *t* test. Logistic regression was used to determine odds ratios for the association of the different infections, *M hominis*, *C trachomatis*, or *U urealyticum*, with pregnancy outcomes. The initial model we employed contained the risk factors of interest, potential confounders, and interaction terms. We determined if the model with all interaction terms differed significantly from the model without interaction terms; only if these models differed significantly were the

### Table 1.—Comparisons of Characteristics of Women by Site of Enrollment and by Outcome Status: Unavailable for Follow-up vs Single Infant Delivery

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Enrollment (N = 1204)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gallup, NM (n = 949)</td>
<td>Crownpoint, NM (n = 254)</td>
</tr>
<tr>
<td>Age, y</td>
<td>% (No.)</td>
<td>% (No.)</td>
</tr>
<tr>
<td>&lt;20</td>
<td>23 (217)</td>
<td>25 (63)</td>
</tr>
<tr>
<td>20–29</td>
<td>58 (542)</td>
<td>57 (144)</td>
</tr>
<tr>
<td>&gt;29</td>
<td>20 (184)</td>
<td>18 (46)</td>
</tr>
<tr>
<td>Total</td>
<td>101 (949)</td>
<td>100 (254)</td>
</tr>
</tbody>
</table>

**Parity**

<table>
<thead>
<tr>
<th>Unknown</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35 (328)</td>
<td>33 (84)</td>
<td>34 (35)</td>
<td>34 (358)</td>
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<tr>
<td>≥1</td>
<td>65 (621)</td>
<td>67 (169)</td>
<td>66 (68)</td>
<td>66 (668)</td>
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<tr>
<td>Total</td>
<td>100 (949)</td>
<td>100 (254)</td>
<td>100 (100)</td>
<td>100 (100)</td>
<td>100 (100)</td>
</tr>
</tbody>
</table>

**Enrollment gestation, wk**

<table>
<thead>
<tr>
<th>Unknown</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤12</td>
<td>43 (406)</td>
<td>53 (130)</td>
<td>45 (55)</td>
<td>43 (447)</td>
<td></td>
</tr>
<tr>
<td>13–23</td>
<td>46 (435)</td>
<td>34 (83)</td>
<td>44 (35)</td>
<td>45 (466)</td>
<td></td>
</tr>
<tr>
<td>&gt;23</td>
<td>11 (101)</td>
<td>13 (33)</td>
<td>11 (11)</td>
<td>12 (120)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100 (949)</td>
<td>100 (254)</td>
<td>100 (100)</td>
<td>100 (100)</td>
<td>100 (100)</td>
</tr>
</tbody>
</table>

**Education, y**

<table>
<thead>
<tr>
<th>Unknown</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
<th>% (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12</td>
<td>48 (410)</td>
<td>56 (97)</td>
<td>50 (40)</td>
<td>51 (453)</td>
<td></td>
</tr>
<tr>
<td>≥12</td>
<td>52 (439)</td>
<td>44 (77)</td>
<td>50 (60)</td>
<td>53 (438)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100 (949)</td>
<td>100 (254)</td>
<td>100 (100)</td>
<td>100 (100)</td>
<td>100 (100)</td>
</tr>
</tbody>
</table>

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*Site unknown (n = 1).*

†Twins, stillbirths, and abortions (n = 59).

### Table 2.—Prevalence of Infections by Risk Factor Status Among Enrollees*

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Mycoplasma hominis</th>
<th>Chlamydia trachomatis</th>
<th>Ureaplasma urealyticum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevalence, %†</td>
<td>RR‡</td>
<td>Prevalence, %†</td>
</tr>
<tr>
<td>Age ≤29 y</td>
<td>936 (51.9</td>
<td>1.2 $</td>
<td>23.7</td>
</tr>
<tr>
<td>Education</td>
<td>&lt;12 y</td>
<td>494 (53.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Nulliparous</td>
<td>400 (53.6</td>
<td>1.1</td>
<td>24.4</td>
</tr>
<tr>
<td>Unmarried</td>
<td>467 (55.7</td>
<td>1.2</td>
<td>22.3</td>
</tr>
<tr>
<td>Prior gonorrhea</td>
<td>133 (57.9</td>
<td>1.2</td>
<td>32.1</td>
</tr>
<tr>
<td>M hominis</td>
<td>556 (53.4</td>
<td>1.1</td>
<td>31.2</td>
</tr>
<tr>
<td>C trachomatis</td>
<td>249 (71.1</td>
<td>1.6</td>
<td>...</td>
</tr>
<tr>
<td>U urealyticum</td>
<td>944 (56.7</td>
<td>2.4</td>
<td>24.6</td>
</tr>
</tbody>
</table>

*N = 1204.*

†Prevalence of infection among those with risk factor.

‡RR indicates relative risk, ratio of prevalence of organism among those with risk factor to prevalence among those without the factor.

§P < .05.
individual interaction terms evaluated. We retained first-order variables regardless of significance when an interaction term involving that variable was found to be significant. By eliminating interaction terms in this fashion, we decreased the likelihood of finding a significant interaction term by chance alone—a possibility associated with multiple testing as performed by backward stepwise elimination.

Multiple linear regression was used to assess the association of the infections with differences in mean birth weight. Associations between cervical infections and pregnancy outcomes (low and mean birth weight, postpartum endometritis, and postpartum fever) were assessed among the women who had single infant births (n = 1041).

**Associations With Low Birth Weight**

Associations between cervical infections and low birth weight were assessed among women enrolling before 24 weeks’ gestation. To avoid bias, we used culture results from the initial visit (available on 781, 801, and 804 enrollees for C trachomatis, U urealyticum, and M hominis, respectively) to define infection. A bias would have been introduced if we defined infection as a positive test result on either first or second culture. Because their pregnancies often terminated before a second culture could be obtained, women who were delivered of low–birth-weight infants were less likely to have been cultured twice than women who were delivered of larger babies. Since the sensitivity of a single endocervical swab is less than 100% (probably 70%), the infection is more likely to be correctly identified among women who are cultured twice than among those who are cultured only once. By using only the first culture we have ensured that infection was identified on the basis of the same number of cultures, whether women were delivered of low- or normal-birth-weight infants.

**RESULTS**

The women enrolled at the two sites were similar in demographic characteristics, although the women who enrolled at Gallup (n = 949) obtained initial prenatal care in gestation (P < .05) than did the women at Crownpoint (n = 254). Overall, 23% of the women enrolled were younger than 20 years, 34% were nulliparous, 45% sought prenatal care in the first trimester, 44% in the second. Fifty percent of the women had graduated from high school (Table 1). The pregnancy outcomes of 1100 (91%) were known (1041 were delivered of single infants).

The demographic characteristics of the 104 women unavailable for follow-up were similar to those who were delivered of single infants, although women in the former group were somewhat more educated and had obtained initial prenatal care earlier than women in the latter group.

**Characteristics of Those Infected**

Women were considered to be infected with an organism if a cervical culture on either visit was positive. The prevalences of the three infections were M hominis, 50% (586/1163); C trachomatis, 22% (251/1152); and U urealyticum, 81% (944/1163). The infections were more prevalent among younger, less educated, nulliparous women and among those with a history of gonorrhea. The factor most strongly associated with being infected with one organism was the presence of either of the other two organisms (Table 2).

**Low Birth Weight**

The overall incidence of low–birth-weight infants among women who enrolled in prenatal care by 24 weeks’ gestation and who were delivered of a single infant was 6.2% (55/892) (Table 3). The relative risk (RR) for the delivery of a low–birth-weight infant associated with M hominis infection was 1.8 (P < .05); the RRs associated with C trachomatis (1.5) and with U urealyticum (1.3) were less and not significant. (The power of the study at a = 0.05 to identify a twofold increase in the risk of low birth weight associated with C trachomatis was 0.69, and with U urealyticum, 0.78.)

The risks for low birth weight, associated with C trachomatis or U urealyticum, determined by logistic regression (odds ratios, 1.1 and 1.4, respectively; P > .5 for both) were similar to unadjusted results. However, the analysis of the risks associated with M hominis revealed a significant interaction between M hominis infection and a history of spontaneous abortion. The risk of low birth weight associated with M hominis among women without a history of spontaneous abortion was not significantly increased (odds ratio, 1.4).
Table 6.—Effects on Mean Birth Weight Associated With Mycoplasma hominis or Chlamydia trachomatis Infection at Enrollment

<table>
<thead>
<tr>
<th></th>
<th>M hominis</th>
<th>C trachomatis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect on Mean Birth Weight, g*</td>
<td>P</td>
</tr>
<tr>
<td>Unadjusted†</td>
<td>-103</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Adjusted‡</td>
<td>-101</td>
<td>.01</td>
</tr>
<tr>
<td>≥ 40 wk gestational age</td>
<td>-46</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Difference between mean birth weight of infants born to mothers with the infection and that of infants whose mothers were not infected.
†The number of women evaluated for effect of M hominis was 990; for C trachomatis, 986 women.
‡Controlling by multiple linear regression for parity, maternal height, weight, marital status, age, enrollment, gestation, and either M hominis or C trachomatis infections. For all gestations the number of women was 749, for 40 weeks or greater gestational age, 416 women.

Table 7.—Risk Factors for Postpartum Endometritis (PPE)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Incidence of Risk Factor, %*</th>
<th>Incidence of PPE, †</th>
<th>RR‡</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesarean section</td>
<td>16</td>
<td>9.4</td>
<td>2.6</td>
<td>.001</td>
</tr>
<tr>
<td>Age &lt;20 y</td>
<td>23</td>
<td>7.1</td>
<td>2.0</td>
<td>.02</td>
</tr>
<tr>
<td>Nulliparity</td>
<td>34</td>
<td>6.6</td>
<td>1.9</td>
<td>.02</td>
</tr>
<tr>
<td>Labor &gt;6 h</td>
<td>64</td>
<td>5.2</td>
<td>2.1</td>
<td>.04</td>
</tr>
<tr>
<td>PROM§</td>
<td>8</td>
<td>9.4</td>
<td>2.3</td>
<td>NS</td>
</tr>
<tr>
<td>Preterm &lt;37 wk</td>
<td>6</td>
<td>9.3</td>
<td>1.9</td>
<td>NS</td>
</tr>
<tr>
<td>ROM &gt;6 h‡</td>
<td>19</td>
<td>6.4</td>
<td>1.6</td>
<td>NS</td>
</tr>
<tr>
<td>Vaginal examinations &gt;4</td>
<td>46</td>
<td>5.4</td>
<td>1.5</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Percent of women delivered of single infants, with the risk factor.
†Incidence of postpartum endometritis among women with the risk factor. Overall incidence is 4.5% (46/1026).
‡RR indicates relative risk, ratio of incidence of PPE among women with the risk factor to incidence among women without the factor.
§PROM indicates premature rupture of membranes; ROM, duration from membrane rupture to delivery.

Table 8.—Association of Postpartum Endometritis (PPE) With Infections

<table>
<thead>
<tr>
<th>Infection Status*</th>
<th>Incidence of PPE, †</th>
<th>RR (95% CI)‡</th>
<th>Odds Ratio§ (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mycoplasma hominis</td>
<td>Positive</td>
<td>5.6 (28/504)</td>
<td>1.7 (0.9-3.1)</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>3.3 (16/491)</td>
<td>...</td>
</tr>
<tr>
<td>Chlamydia trachomatis</td>
<td>Positive</td>
<td>5.0 (11/218)</td>
<td>1.3 (0.7-2.5)</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>3.9 (30/770)</td>
<td>...</td>
</tr>
<tr>
<td>Ureaplasma urealyticum</td>
<td>Positive</td>
<td>4.8 (39/821)</td>
<td>1.7 (0.7-4.1)</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>2.8 (5/174)</td>
<td>...</td>
</tr>
</tbody>
</table>

*The number of women whose M hominis was unknown was 31; for C trachomatis, 36 women; and for U urealyticum, 31 women.
†RR indicates relative risk, ratio of incidence of endometritis among positive cultures to incidence among negative cultures, 95% confidence intervals (CI).
‡RR indicates relative risk, ratio of incidence of endometritis among positive cultures to incidence among negative cultures, 95% confidence intervals (CI).
§Odds ratio is determined by logistic regression, controlling for premature rupture of membranes, cesarean section, age, nulliparity, and coexisting infection.
∥Indicates vaginal delivery.
*Indicates cesarean section.

However, among those with a history of spontaneous abortion, the presence of M hominis was associated with a significantly elevated odds ratio for low birth weight of 9.4 (Table 4).

Among women having a history of spontaneous abortion, 8 (11.3%) low–birth-weight infants were born to the subgroup of M hominis–infected women (n = 71); one low–birth-weight infant (1.0%) was born among the M hominis–negative women (n = 105) (unadjusted RR, 11.8). Among those without a history of spontaneous abortion, 19 infants of low birth weight (5.4%) were born to the M hominis–negative women (n = 355), and 20 (7.3%) were born to M hominis–infected women (n = 273) (RR, 1.4).

We next categorized low–birth-weight infants as term (≥37 weeks’ gestation) or preterm (<37 weeks’ gestation) (Table 5). The association of M hominis with low birth weight is the result of a significantly increased risk of preterm low birth weight (RR, 3.0; P = .01); for term low birth weight, the association was not significant. The other infections are also associated with increased rates of preterm low birth weight, but the magnitude of the risks is less and not significant. Neither premature rupture of membranes nor spontaneous labor was predominantly responsible for the increase in preterm low birth weight among M hominis–infected women; there were proportional increases in both these categories of preterm deliveries.

Mean Birth Weight

Women with either M hominis or C trachomatis infection (based on culture results from the initial visit) were delivered of infants whose mean birth weight was significantly less than that of infants whose mothers were not infected with those organisms. Analysis by multiple linear regression, controlling for confounding variables, confirmed that M hominis infection was associated with significantly lower mean birth weight; C trachomatis infection was not associated with a significant effect. The same technique was used to assess the effect associated with M hominis or C trachomatis infections on mean birth weight of infants born after at least 40 weeks’ gestation. In this group, differences in length of gestation should not result in differences in birth weight. The differences in mean birth weight associated with M hominis or C trachomatis infections (46 and 31 g, respectively) were minimal and not significant (Table 6).

Postpartum Morbidity

Postpartum endometritis occurred among 46 women. Associations (though not all were significant) were found between postpartum endometritis and recognized risk factors (Table 7). Analysis by logistic regression revealed that M hominis infection was associated with postpartum endometritis among women undergoing cesarean section. Mycoplasma hominis infection did not contribute to the risk of endometritis among women with vaginal deliveries (Table 8). Fifteen cases of endometritis occurred among women undergoing a cesarean section (n = 160)—11 among M hominis–infected women (n = 75), and three among M hominis–negative women (n = 79). (One case occurred among six women whose M hominis status was unknown.)

Previous work had identified association between cervical infection and the...
occurrence of postpartum morbidity, defined as either postpartum endome-
tritis or postpartum fever (see “Methods” section). However, although we
found an association as noted above with endometritis, an association
was not found when we broadened the defini-
tion of postpartum morbidity to in-
clude postpartum fever (Table 9).

Serological Data

Among those women enrolled in the study and found to have C trachomatis
on either culture (n = 251), 89% (218/247) had a positive IgG titer in either of the
two serum specimens; only 5% (10/204) had a positive IgM titer.

The serological subgroups of C trachomatis–infected women, excluding
those who had a spontaneous abortion, whose pregnancy outcomes were known
were as follows: (1) recent infection (n = 16); (2) chronic infection (n = 138); and
(3) unclassifiable (n = 71). The women whose C trachomatis infections were
acquired recently were delivered of three infants (19%) of low birth weight
(one was stillborn); women with chronic C trachomatis infection were delivered of
six such infants (4.5%) (RR, 4.2; P = .06; by two-tail Fisher’s exact test).
The six women with unclassifiable infection were delivered of infants weighing
less than 2500 g (8.5%).

Therefore, although we found that most C trachomatis infections were
chronic, the few women we classified as having recent C trachomatis infection
were at increased risk for the delivery of a low–birth-weight infant.

COMMENT

This study has demonstrated that, among Navajo women, endocervical
culture can identify populations at risk for two important pregnancy outcomes.
We have shown that M hominis was associated with the delivery of
low–birth-weight infants among women with a history of spontaneous abortion
and associated with postpartum endometritis among women undergoing cesarean
section. However, the true magni-
de of the association between M hominis and the delivery of low–birth-weight infants among women with prior spontaneous abortion is uncertain.
The calculated odds ratio of 9.4 is certainly an overestimate. (This odds ratio represents a comparison between the rate of low birth weight among M hominis–positive women who have a history of spontaneous abortion and the rate of low birth weight among M hominis–negative women with a similar his-
tory. This latter group experienced an unrealistically low rate of low birth weight of 1%. ) These associations per-
sisted after controlling for important risk factors and for the presence of C trachomatis or U urealyticum. (One important risk factor for low birth weight not controlled for was smoking during pregnancy. However, it is
unlikely that our results would be altered by such a consideration since less than 5% of Navajo women smoke during pregnancy (Carol Milligan, CNM, oral communication, March 1986).) In addition, the increased risk of low birth weight was associated with preterm, not term, delivery.

It is unclear why these populations are at risk. Possibly, in women with a
history of spontaneous abortion, the cervical mucous plug does not function adequ-
ately, and allows ascending infec-
tion; another possibility is that prior loss may have occurred as a result of M hominis infection—an infection that then persisted until the study preg-
nancy. Obviously, this association of M hominis and prior spontaneous abortion
with low birth weight must be corroborated in other studies before it is appro-
appropriate to recommend that preg-
nant women be screened for M hominis,
regardless of history of pregnancy loss.

The association of M hominis with postpartum endometritis among women undergoing cesarean section suggests that surgical insult is neces-
sary to allow M hominis to become invasive. However, no association was
found between M hominis and postpartum morbidity, broadly defined as postpartum fever or endometritis—although an association was noted pre-
viously.1 In that study such postpartum morbidity complicated 2.9% of deliv-
eries; in our population, it occurred following 10.3% of births. It is possible that
this threefold difference in incidence may reflect the contribution of other risk factors that were not con-
trolled for—factors that may have ob-
scured the association.

These associations—and the risks of adverse outcome—may need to be con-
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highlight subgroups of infected women at particular risk for adverse pregnancy
outcome.15,24 Such a response may iden-
tify recently acquired, or possibly in-
vasive, infections. More chronic, less invasive infection may be associated with lower risks. In the population we studied, the great majority of C trachomatis infections were apparently chronic. Interestingly, the overall preval-
ence of all these infections was very high—as high as reported in any popula-
tion5—and cervical infection was still very prevalent among older (>29 years)
women. This suggests that infection may persist for prolonged periods, or that exposure to the infections is ongo-
ning and that prior exposure, and pre-
sumably antibody, does not prevent re-
aquisition of lower tract infection (but may protect against invasion).

Although we have no serological data concerning M hominis infections, our
study has demonstrated that most C trachomatis infections in this popula-
tion were chronic. Almost 90% of the C trachomatis–infected population had anti–C trachomatis IgG present in se-
rum and less than 5% had anti–C trachomatis IgM (a correlate of recent infection). This may explain why we found no association between cervical C trachomatis infection and either low birth weight or postpartum endome-
tritis. It is possible that nearly all the C trachomatis–infected women were
manifesting chronic local infection and were not susceptible to invasive C trachomatis infection, and furthermore,

Table 9.—Association of Postpartum Endometritis/Fever (PPE/F) With Infections

<table>
<thead>
<tr>
<th>Infection Status</th>
<th>Incidence PPE/F, %</th>
<th>RR (95% CI)</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mycoplasma hominis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>11.2 (57/509)</td>
<td>1.2 (0.8-1.7)</td>
<td>1.2 (0.8-1.9)</td>
</tr>
<tr>
<td>Negative</td>
<td>9.4 (47/500)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chlamydia trachomatis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>10.4 (23/222)</td>
<td>1.1 (0.7-1.6)</td>
<td>1.2 (0.7-2.0)</td>
</tr>
<tr>
<td>Negative</td>
<td>9.9 (77/780)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ureaplasma urealyticum</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>10.8 (90/833)</td>
<td>1.4 (0.8-2.3)</td>
<td>1.2 (0.6-2.2)</td>
</tr>
<tr>
<td>Negative</td>
<td>8.0 (14/176)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The number of women whose M hominis status was unknown was 26; for C trachomatis, 33 women; and for U urealyticum, 26 women.
†The overall incidence of PPE/F was 10.6% (110/1035).
‡Unadjusted relative risk (RR) indicates ratio of incidence of PPE/F among positive cultures to incidence among negative cultures, with 95% confidence intervals (CI).
§Adjusted odds ratio is determined by logistic regression controlling for parity, cesarean section, gestation less than 37 weeks, greater than six hours of labor, zero hours of labor, duration of membrane rupture less than six hours, age younger than 20 years, number of vaginal examinations, premature rupture of membranes, and coexisting infection.

(One insult low had that of unclassifiable with infection among women is unknown for—factors associated with pregnancy.

The unclassified risk for”) with the relationship of women of M hominis and the delivery of low–birth-weight infants among women with prior spontaneous abortion is uncertain. The calculated odds ratio of 9.4 is certainly an overestimate. (This odds ratio represents a comparison between the rate of low birth weight among M hominis–positive women who have a history of spontaneous abortion and the rate of low birth weight among M hominis–negative women with a similar his-
tory. This latter group experienced an unrealistically low rate of low birth weight of 1%. ) These associations per-
sisted after controlling for important risk factors and for the presence of C trachomatis or U urealyticum. (One important risk factor for low birth weight not controlled for was smoking during pregnancy. However, it is
unlikely that our results would be altered by such a consideration since less than 5% of Navajo women smoke during pregnancy (Carol Milligan, CNM, oral communication, March 1986).) In addition, the increased risk of low birth weight was associated with preterm, not term, delivery.

It is unclear why these populations are at risk. Possibly, in women with a
history of spontaneous abortion, the cervical mucous plug does not function ade-
ately, and allows ascending infec-
tion; another possibility is that prior loss may have occurred as a result of M hominis infection—an infection that then persisted until the study preg-
nancy. Obviously, this association of M hominis and prior spontaneous abortion
with low birth weight must be corroborated in other studies before it is appro-
appropriate to recommend that preg-
nant women be screened for M hominis,
regardless of history of pregnancy loss.

The association of M hominis with postpartum endometritis among women undergoing cesarean section suggests that surgical insult is neces-
sary to allow M hominis to become invasive. However, no association was
found between M hominis and postpartum morbidity, broadly defined as postpartum fever or endometritis—although an association was noted pre-
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tritis. It is possible that nearly all the C trachomatis–infected women were
manifesting chronic local infection and were not susceptible to invasive C trachomatis infection, and furthermore,
that only invasive infection leads to endometritis or low-birth-weight delivery. Our data do suggest that women recently infected with C trachomatis may be at risk, but the percentage of such women in this population was probably small—about 10% (although almost 30% of C trachomatis-infected women were unclassifiable). The public health utility of attempting to identify this subgroup is not clear.

This study failed to demonstrate associations between low birth weight and genital infections with either C trachomatis or U urealyticum—results consistent with some studies28 29 but not with others.30 31 Such inconsistencies may have occurred for reasons mentioned earlier—differences in study design or differences in the proportion of C trachomatis or U urealyticum infections that were legion in the populations studied. It is possible that our findings among Navajos cannot be generalized to other populations. However, a pathophysiologic effect of cervical infections should not be population dependent. Furthermore, it is reassuring that similar results were found in a study employing similar laboratory facilities and similar study design, but which evaluated an entirely different population.42

It is unlikely that the failure to identify pregnancy outcomes of 9% of the enrollees was responsible for inconsistent results. The Gallup facility is the regional center. Women from Crownpoint who had complications were cared for at Gallup, and women from Gallup were rarely, if ever, transferred elsewhere. Most of the women who were unavailable for follow-up moved or received care at other facilities. In addition, in terms of age, parity, enrollment gestation, and education, women unavailable for follow-up were at no greater risk for a low-birth-weight delivery than the women giving birth to single infants; likewise, among women unavailable for follow-up, the prevalence of M hominis, U urealyticum, or C trachomatis infection (42.6%, 69.2%, and 18.7%) was very similar to that among the mothers of single infants (42.7%, 69.5%, and 17.4%).

Although adverse outcomes were associated with M hominis infection, it is unclear what the appropriate treatment for this infection is or if M hominis is indeed the causal agent associated with these adverse events. Both Bacteroides infection and bacterial vaginosis—conditions each highly correlated with M hominis infection—have also been associated with adverse pregnancy outcomes.32 33 It may be that M hominis infection is a marker for the presence of the causative organism.

In summary, we have found that M hominis, but not C trachomatis or U urealyticum, was related to low birth weight and postpartum endometritis. In addition, we identified subpopulations at particular risk for these outcomes. The association with low birth weight reflects an increase in preterm low birth weight, but not term low birth weight, and our results suggest that women with a history of abortion are at greatest risk. Similarly, women undergoing cesarean section constitute a subgroup whose risk of endometritis is increased by M hominis infection.

Although recently acquired C trachomatis infection appears to increase the risk of low birth weight, the percentage of patients with such infection in the study population, and probably in most populations, was small. Notwithstanding the size of the subgroup at risk, it does appear that C trachomatis infection is a preventable cause of low birth weight. However, C trachomatis infection in most women was chronic and our results suggest that the course of their pregnancies was not adversely affected by such infection.

The use of serological tests to classify M hominis infections in a similar manner may further clarify the relationship between M hominis and pregnancy complications. In the meantime, we believe this study provides strong evidence that M hominis and, probably, C trachomatis infections are indeed associated with adverse pregnancy outcomes and that there are specific, identifiable subpopulations at risk.

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References