# Low Risk of Post-Cesarean Section Infection in Insulin-Requiring Diabetic Women

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**OBJECTIVE** — The purpose of this study was to determine if insulin-requiring diabetic women undergoing nonelective cesarean section are at higher risk for postoperative infection than nondiabetic women.

**RESEARCH DESIGN AND METHODS** — Medical records of a cohort of insulin-requiring diabetic women who underwent cesarean section after labor or rupture of membranes and nondiabetic control subjects matched for age and insurance status were retrospectively reviewed. Data abstracted included maternal characteristics, antepartum, intrapartum, and postpartum events.

**RESULTS** — Post–cesarean section infection including endometritis, wound infection, and septic pelvic thrombophlebitis occurred in 10.2% of 205 diabetic women and 12.1% of control subjects, in whom antibiotic prophylaxis was used in 79% of diabetic women and 84% of control subjects. Duration of rupture of membranes was a significant risk factor for post–cesarean section infection in both groups.

**CONCLUSIONS** — Insulin-requiring diabetic women undergoing nonelective cesarean section with antimicrobial prophylaxis have a rate of postoperative infection similar to that for nondiabetic women.

Diabetes is often identified as a risk factor for postoperative infection. Investigators have shown that diabetic patients have defects in granulocyte chemotaxis, adherence, and phagocytosis, which renders them less able to fight fungal and bacterial infections (1). The majority of infections after caesareans include endometritis, wound infections, and urinary tract infections. Although several series show a significantly increased rate of post–cesarean section infection in insulin-requiring diabetic women, few series address the rates of infection in an era where antibiotic prophylaxis for cesarean section is routine (2,3).

The incidence of post–cesarean section endometritis has been reported as 5–85% depending on the patient populations studied (4). Multiple risk factors for post–cesarean section infection have been identified in various studies. These risk factors include low socioeconomic status, extended duration of labor, rupture of membranes >6 h before delivery, multiple vaginal examinations, and delivery for cephalopelvic disproportion (4,5). Duration of surgery, type of anesthesia, intraoperative blood loss, hematocrit, and obesity have been inconsistently cited as potential risk factors (4,6). The use of prophylactic antibiotics in patients undergoing high-risk cesarean sections accounts for the dramatic decrease in post–cesarean section infectious morbidity previously reported (7,8).

Our clinical observation has suggested that the incidence of post–cesarean section endometritis and wound infection is similar in insulin-requiring diabetic women and nondiabetic women. Therefore, we undertook a retrospective review of primary nonelective cesarean sections after labor of insulin-requiring diabetic women and nondiabetic control subjects to examine the incidence of endometritis, wound infection, and septic pelvic thrombophlebitis, during a period when antimicrobial prophylaxis for these procedures was standard.

## RESEARCH DESIGN AND METHODS

— Between January 1983 and December 1992, 223 insulin-requiring diabetic women who delivered at Brigham and Women's Hospital by primary nonelective cesarean section after labor were identified through a prospectively maintained electronic database. All of these women were on insulin therapy before pregnancy. To eliminate the potential bias of socioeconomic status and possible shifts in practice trends during this time, a matched cohort design was selected. An equal number of nondiabetic control women delivered following labor at Brigham and Women's Hospital were identified. This control group was selected from the birth log of consecutively recorded deliveries as the next primary cesarean section without diabetes with the same insurance status and maternal age (±5 years).

All available charts were extensively reviewed. The information obtained included gravidity, parity, BMI, duration of labor, duration of rupture of membranes, antepartum complications, duration of and indication for cesarean section, number of vaginal examinations, use of fetal scalp electrodes or intrauterine pressure catheters, type of anesthesia, admission hematocrit, postpartum complications, and postoperative glucose levels.

All insulin-requiring diabetic patients were managed on the Joslin Clinic/Brigham and Women's Hospital Service during at least six prenatal visits. These patients were treated with split-mixed dose insulin to achieve optimal glycemic

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Received for publication 28 August 1995 and accepted in revised form 25 January 1996.

control (fasting blood glucose <105 and 2 h postprandial glucose <120). Patients were examined by ultrasound before delivery for estimation of fetal weight. After fetal lung maturity was documented, patients underwent either induction of labor at 37–40 weeks or primary cesarean section for macrosomia. Women who underwent primary elective cesarean section for macrosomia, active proliferative retinopathy, or breech without labor were excluded from the study. Intrapartum management of glucose was accomplished by bedside hourly capillary blood glucose determinations with the addition of continuous intravenous insulin infusions to maintain glucose levels between 70–120 mg/dl. Postpartum blood glucose levels were checked every 4 h, and the patient was treated with a standard split-mix subcutaneous insulin regimen to a target glucose of <140 mg/dl 2 h postprandial.

The women in the control group were managed by a variety of private and staff obstetricians. The uniformity of prenatal and intrapartum care in this group could not be determined.

Antibiotic prophylaxis for nonelective caesareans preceded by labor or rupture of membranes was recommended and adopted by the majority of obstetricians at Brigham and Women's Hospital in 1980. Patients routinely received one dose of a first-generation cephalosporin (i.e., Cefazolin) or second-generation cephalosporin (i.e., Cefoxitin) after the cord was clamped and two doses postoperatively.

Endometritis was diagnosed by fever >100.4°F on two consecutive readings, in addition to uterine tenderness or foul-smelling lochia. Incisional wound infection was identified by fever >100.4°F, erythema, or purulent drainage plus a positive wound culture. Septic pelvic thrombophlebitis was identified if the diagnosis was stated by the obstetrician and the patient received intravenous heparin therapy and antibiotics with resolution of the fever. Preoperative use of antibiotics and length of stay were also evaluated.

Comparison of diabetic and control women was performed through the uncorrected $\chi^2$ test with 1 df or Fisher's exact test when an expected frequency was <5. Infection rates in each of the groups were presented through 95% CI, with exact CI used when the observed number of infections was six or less. Univariate and multiple logistic regression analyses were used to determine risk factors potentially significant for post–cesarean infection. A $P$ value <0.05 was considered significant.

**Table 1—*Demographic data in diabetic and control populations***

| | Diabetic subject | Control subject | Significance |
|---|---|---|---|
| *n* | 205 | 206 | — |
| Age (years) | 28.3 ± 0.4 | 28.9 ± 0.5 | NS |
| Gestation (weeks) | 37.1 ± 0.2 | 38.7 ± 0.2 | $P < 0.01$ |
| Payer status | | | |
| Medicaid | 33 (15.7%) | 33 (15.7%) | — |
| Private | 177 (84.3%) | 177 (84.3%) | — |

Data are means ± SE. Data are absolute number and percentages.

**RESULTS** — Of 223 insulin-requiring diabetic women identified through our database, 13 were excluded because of incomplete medical records. Five diabetic women and four control patients were excluded because they received preoperative antibiotics for intra-amniotic infection, subacute bacterial endocarditis prophylaxis, or urinary tract infection. The demographics of our patient populations are presented in Table 1. Of note is the fact that 84% of our subjects were privately insured. The distribution of diabetic women by White's classification is presented in Table 2.

The infection rate for insulin-requiring diabetic women and control subjects is presented in Table 3. There was no significant difference in the number of patients with endometritis in diabetic women versus control subjects (4.9 vs. 9.2%, NS). Likewise, there was no statistically significant difference in the number of wound infections in diabetic women versus control subjects (2.9 vs. 2.4%, NS) or the number of septic pelvic thrombophlebitis cases (2.4 vs. 0.5%, NS).

**Table 2—*Distribution of diabetic women by White's classification***

| White's class | Frequency | Percent |
|---|---|---|
| B | 44 | 21.5 |
| C | 57 | 27.8 |
| D | 50 | 24.4 |
| F | 7 | 3.4 |
| FR | 19 | 9.1 |
| H | 1 | 0.5 |
| R | 24 | 11.7 |
| RF | 1 | 0.5 |
| RT | 1 | 0.5 |
| T | 2 | 1.0 |

Comparative rates of potential risk factors for post–cesarean endometritis and wound infection in diabetic and control women is presented in Table 4. Admission hematocrits were significantly lower in diabetic women versus control subjects (36 vs. 37%, $P < 0.01$). However, BMI was not different in both groups. Likewise, the use of fetal scalp electrodes was not different. Intrauterine pressure catheters were used significantly more frequently in diabetic patients than in control subjects (17.1 vs. 10.2%, $P < 0.05$). Although the mean duration of labor was similar in diabetic women versus control subjects, the percentage of women with long labor (i.e., >18 h) was significantly lower in diabetic patients than control subjects (10.2 vs. 21.8%, $P = 0.006$). The mean duration of rupture of membranes was 11.6 h in diabetic pregnant women versus 28.6 h in control subjects, which was of borderline significance ($P = 0.058$). Last, the number of vaginal examinations performed in diabetic patients versus control subjects reached borderline significance (4.4 vs. 5.2 exams, $P = 0.053$).

Within the diabetic population, there were no significant differences in infection rates among White's classes. The mean of four consecutive glucose measurements during the first 24 h post–cesarean section was available for 12 infected and 124 uninfected diabetic patients. While those with high postoperative mean glucoses (>75th percentile for the sample: i.e., mean glucose ≥225) had twice the rate of postoperative endometritis and wound infection, this difference was not statistically significant. The mean glucose level for the uninfected group was 180 (SD 67) and for the infected group was 218 (SD 120), $P = 0.95$.

Univariate logistic regression

Table 3—*Post–cesarean section infections in diabetic and control populations*

| | Diabetic subjects | Control subjects | Significance |
|---|---|---|---|
| *n* | 205 | 206 | NS |
| All infections | 21 (10.2%) | 25 (12.1%) | |
| | (6.1–14.3) | (7.6–16.6) | |
| Endometritus | 10 (4.9%) | 19 (9.2%) | NS |
| | (1.9–7.9) | (5.3–13.1) | |
| Wound infection | 6 (2.9%) | 5 (2.4%) | NS |
| | (1.1–6.3) | (0.8–5.6) | |
| Septic pelvic | 5 (2.4%) | 1 (0.5%) | |
| Thrombophlebitis | (0.8–5.6) | (0.0–2.7) | NS |

Data are *n* (%) (95% CI).

analysis showed that duration of rupture of membranes ($P = 0.014$), duration of labor ($P = 0.029$), and number of vaginal examinations ($P = 0.058$) were risk factors for infection. In a multiple logistic regression analysis including all three factors, duration of rupture of membranes remained significant ($P = 0.006$), while duration of labor ($P = 0.075$) and number of examinations ($P = 0.075$) were of borderline significance.

Intraoperative antimicrobial prophylaxis was used in 79.0% of diabetic women and 84.0% of control subjects (NS). Of note, infection occurred in 2 of 41 diabetic women and in 4 of 29 control subjects who did not receive antibiotic prophylaxis.

**CONCLUSIONS** — The association of insulin-requiring diabetes and severe bacterial and fungal infections has been observed. There was no evidence from our study that insulin-requiring diabetic women who delivered by nonelective cesarean section with frequent administration of antimicrobial prophylaxis were at any greater risk for serious postoperative infections than nondiabetic control subjects.

Diamond et al. (2) retrospectively compared the incidence of post–cesarean section endometritis and wound infection in 79 IDDM women to 158 nondiabetic control subjects. Patients within each group were further divided into low risk or high risk categories. The high-risk category included those patients with rupture of membranes or labor before cesarean section while low-risk patients were delivered by elective cesarean section without either labor or rupture of membranes. Low-risk diabetic subjects had a 9% incidence of endometritis or wound infection versus 2% in low-risk control subjects. Prophylactic antibiotics were used in only 25% of high-risk diabetic and control patients. High-risk diabetic women had a 25% incidence of endometritis or wound infection versus 6% in high-risk control subjects. Stamler et al. (3) prospectively evaluated 65 IDDM women with intact membranes and no labor delivered by elective repeat cesarean section. This group was retrospectively compared with 65 nondiabetic control subjects for the incidence of antepartum and postpartum infections. These investigators found that 8% of diabetic subjects versus 0% of control subjects had post–cesarean section endometritis or wound infections. They found no correlation between glycemic control as measured by HbA1 or postpartum glucose and infection among the diabetic patients. Prophylactic antibiotic use in these groups was not discussed.

Our retrospective study evaluates a large cohort of insulin-requiring diabetic women all undergoing high-risk cesarean sections, the majority of whom received antibiotic prophylaxis. Therefore, we would anticipate a low incidence of post–cesarean section infection. Socioeconomic status was not reported in the two previous studies. Our population was mostly insured patients who are known to be at lower risk of post–cesarean section infection. In addition to socioeconomic status, there are many other patient characteristics and institution practices that may account for a higher prevalence of post–cesarean section infection observed at other institutions.

As in previous studies, we were unable to correlate mean postpartum glucose with the incidence of postoperative infection. This may in part be due to our small sample size. We did, however, observe in both diabetic and control populations that duration of rupture of membranes was a clear independent risk factor for post–cesarean section infection. The number of vaginal examinations and duration of labor were of borderline significance when duration of rupture of membranes was controlled for.

Septic pelvic thrombophlebitis is an unusual complication. While not significant, our data raises the question of whether septic pelvic thrombophlebitis is a more common complication among women with insulin-requiring diabetes.

Limitations of our study include its size and its retrospective design. Although relatively large compared with other available studies, our inability to find a statistically significant difference in post–cesarean section infection rates between diabetic and nondiabetic women could be due to inadequate sample size. To determine the sample size necessary to demonstrate a statistically significant difference in the observed rates of infection, we performed a power calculation. This

Table 4—*Risk factors potentially associated with post–cesarean section endometritis and wound infection in diabetic and control populations*

| | Diabetic subjects | Control subjects | *P* value |
|---|---|---|---|
| Hematocrit (%) | 36 ± 0.2 | 37 ± 0.2 | < 0.01 |
| BMI | 27.6 ± 0.4 | 26.6 ± 0.4 | NS |
| Fetal scalp electrode use | 50.2 | 47.6 | NS |
| Intrauterine pressure catheter use | 17.1 | 10.2 | < 0.05 |
| Duration of labor (hours) | 13.7 ± 1.4 | 11.9 ± 1.1 | NS |
| Duration of rupture of membranes (hours) | 11.6 ± 0.9 | 28.6 ± 8.1 | 0.058 |
| Number of vaginal exams | 4.4 ± 0.3 | 5.2 ± 0.3 | 0.053 |

Data are means ± SE or %.

indicates that to have an 80% probability of demonstrating a 20% difference in the rate of all post–cesarean section infections (i.e., 0.10 vs. 0.12) at the 95% confidence level, a study would need cohorts of 3,200 patients in each group. It is unlikely that a study of this magnitude will soon be available. Due to the retrospective study design, it is likely that the rate of infection (in particular, wound infection) may be underestimated because the study did not systematically ascertain postdischarge infections. There is no reason to believe, however, that there has been any differences under ascertainment between the groups that would introduce bias.

In our cohort of diabetic women and nondiabetic control subjects, there may have been significant differences in intrapartum management between the groups. These differences may obscure an increased risk for infection among women with diabetes. Nonetheless, when we control for a series of known risk factors, we conclude that insulin-requiring diabetic women undergoing nonelective cesarean section with routine antimicrobial prophylaxis have a rate of postoperative infection similar to that of nondiabetic women. Antimicrobial prophylaxis may eliminate the excess risk for post–cesarean section infection in insulin-requiring diabetic women reported in prior studies.

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