# Maternal Morbidity Associated With Cesarean Delivery Without Labor Compared With Induction of Labor at Term

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**OBJECTIVE:** To estimate the maternal morbidity associated with cesarean deliveries performed at term without labor compared with morbidity associated with induction of labor at term.

**METHODS:** A 15-year population-based cohort study (1988–2002) using the Nova Scotia Atlee Perinatal Database compared maternal outcomes in nulliparous women delivering by cesarean delivery without labor and nulliparous women at term undergoing induction of labor for planned vaginal delivery with singleton, cephalic presentation.

**RESULTS:** A total of 5,779 pregnancies satisfied inclusion and exclusion criteria, 879 of which were cesarean deliveries without labor. There were no maternal deaths. There was no difference in wound infection, puerperal febrile morbidity, blood transfusion or intraoperative trauma. After controlling for potential confounders, women undergoing cesarean delivery without labor were less likely to have complications of early postpartum hemorrhage (relative risk 0.61, 95% confidence interval 0.42–0.88, number needed to treat 32) and composite maternal morbidity (relative risk 0.71, 95% confidence interval 0.52–0.95, number needed to treat 34) compared with women undergoing induction of labor. Subgroup analyses of maternal outcomes after induction of labor in women by method of delivery were also performed and demonstrated additional risks of traumatic morbidity after induction of labor. The highest morbidity was found in the assisted vaginal delivery and cesarean delivery in labor groups.

**CONCLUSION:** Early postpartum hemorrhage and composite maternal morbidity were decreased in cesarean delivery without labor compared with induction of labor. Hemorrhagic and traumatic morbidities with labor induction are increased after assisted vaginal delivery and cesarean delivery in labor compared with cesarean delivery without labor.

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**LEVEL OF EVIDENCE: II-2**

Elective obstetric interventions are those that are performed without a medical or obstetric indication. As elective interventions such as elective cesarean delivery and elective induction of labor become more commonly performed, the implications for maternal risks in the current and in future pregnancies gain importance. Induction of labor in general is known to be associated with increased risks of cesarean delivery in different populations[1–5] and small studies evaluating elective induction in particular have addressed risk factors for cesarean delivery and have determined risks for other limited outcomes, such as maternal length of stay.[5–7] The effect of cesarean delivery in labor on adverse maternal and perinatal outcomes has received increasing attention in the lay and scientific literature,[8–13] yet the safety for the mother undergoing elective cesarean delivery or elective induction of labor with planned vaginal delivery remains unresolved. In the absence of a large cohort of women undergoing elective obstetric interventions, we used data for a low-risk, nulliparous population at term to approximate the short-term risks of these elective interventions. Pregnancy and perinatal data from a large, provincial database was used to compare maternal morbidity outcomes in women delivering by cesarean without labor and in women undergoing induction of labor.

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## MATERIALS AND METHODS

Maternal data included in this study consisted of information from pregnancies in Nova Scotia residents between January 1, 1988, and December 31, 2002. The Nova Scotia Atlee Perinatal Database is a provincial, population-based, computerized database in which codes for maternal and newborn data (such as demographic variables, procedures, maternal and newborn diagnoses, and morbidity and mortality information) are available for every pregnancy and birth (500 g or more) occurring in Nova Scotia hospitals and to Nova Scotia residents since 1988. Nova Scotia has approximately 10,000 live births per year[14] and a homogeneous, predominantly white population of approximately one million.[15] Inclusion and exclusion criteria defined a low-risk obstetric population. Pregnancies were included if there was a live-born singleton at term (37–42 weeks) born to a nulliparous woman. For women undergoing cesarean delivery without labor, pregnancies were included regardless of presentation. Women were included in the induction of labor group if they required medical (prostaglandin) or mechanical (foley catheter) cervical ripening or medical (oxytocin) or surgical (amniotomy) induction. Pregnancies were excluded if there was nonvertex presentation with planned vaginal delivery with induction of labor, if there was a major fetal anomaly, or if there was preexisting maternal disease, fetal growth restriction, or pregnancy complications. A major fetal anomaly is one that may be described as lethal, life-threatening, life-shortening, requiring major surgery, or affecting in a significant way the quality of life, and includes chromosomal syndromes. Preexisting maternal disease included preexisting hypertension, diabetes, and heart, gastrointestinal, neurologic, and autoimmune diseases. Fetal growth restriction was defined as less than 10th percentile birth weight for gestational age. Pregnancy complications included gestational diabetes, any type of pregnancy-induced hypertension, and infectious disease. Ethical approval was obtained from the Research Ethics Board at the IWK Health Centre in Halifax, Nova Scotia and the Reproductive Care Program of Nova Scotia.

Maternal and infant summary characteristics included maternal age, maternal weight at delivery, the proportion of women who had prelabor rupture of membranes (spontaneous rupture of membranes before onset of contractions, regardless of gestation), the proportion of women who received regional analgesia, the proportion of women who received intrapartum antibiotics, gestational age at delivery, and birth weight. The use of cervical ripening agents was used as an indication of favorability of the cervix for induction of labor.

Maternal morbidity outcome variables included venous thromboembolism (pulmonary embolus or deep vein thrombosis), need for blood transfusion, wound infection (infected abdominal or episiotomy wound), peripartum hysterectomy, puerperal febrile morbidity (more than 38°C on 2 or more occasions in any 48 hour period, excluding the first 24 hours after delivery), evacuation of hematoma, early postpartum hemorrhage (physician-diagnosed postpartum hemorrhage or an estimated blood loss greater than 500 mL for vaginal delivery or greater than 1,000 mL for cesarean delivery within the first 24 hours postpartum), intraoperative trauma (including laceration of the uterine artery, laceration of the bladder, bowel or ureter, or severe extension of the uterine incision), maternal length of stay, need for postpartum readmission to hospital, near-miss maternal mortality (transfer to general hospital for intensive care), and maternal mortality. Outcomes in the cesarean delivery without labor group were compared with women who presented for induction of labor. Outcomes were also compared by method of delivery after induction of labor, including spontaneous vaginal delivery, assisted vaginal delivery, and cesarean delivery in labor. Additionally, outcomes in cesarean delivery without labor were compared with outcomes in women delivering having all types of labor (combined spontaneous onset of labor and induction of labor) to complete the evaluation of the comparison of cesarean delivery without labor with all labor (spontaneous onset of labor alone has been examined in previous work at our center).[8] Analyses using a composite outcome (composite morbidity) of any 1 of the maternal morbidities were also performed.

Continuous variables (maternal age, maternal weight at delivery, gestational age at delivery, and birth weight) between groups were compared using the Student *t* test. Categorical variables were analyzed with $\chi^2$ and Fisher exact tests where appropriate, and $\chi^2$ for trend analysis for rates of induction was performed. Adjusted analyses controlling for potential confounding factors were performed using logistic regression. All analyses were performed using SAS for Windows 8.0 (SAS Institute Inc., Cary, NC) and EpiInfo (Centers for Disease Control and Prevention, Atlanta, GA).

## RESULTS

In the potential study population (160,015 pregnancies), 44% were nulliparous, and the induction rate in

nulliparous women at term (37–42 weeks gestational age) with liveborn, singleton pregnancies and without major congenital abnormalities or maternal complications was 17%. A total of 5,779 pregnancies satisfied inclusion and exclusion criteria, 879 of which were cesarean deliveries without labor. Cesarean deliveries without labor were most commonly performed for breech presentation (84.0%), suspected cephalopelvic disproportion (5.2%), fetal distress (5.0%), and malpresentation (1.3%). There were no cesarean deliveries performed without a medical or obstetric reason. Induction of labor was most commonly performed for postmature pregnancies (greater than 41 weeks, 55.9%), prelabor rupture of membranes (27.2%), and elective indications (5.7%). The rate of induction in this population increased from 10.5% in 1988 to 27.9% in 2002 ($P<.001$), and this can largely be explained by the increase in induction for postmature pregnancies from 38.1% in 1988 to 68.27% in 2002 ($P<.001$). The rate of induction for elective reasons remained unchanged (7.0% in 1988 and 6.4% in 2002, $P=.66$).

Maternal and infant characteristics for women having a cesarean delivery with no labor and women undergoing induction of labor are summarized in Table 1. The proportion of women receiving intrapartum antibiotics and mean birth weight were not significantly different in the 2 groups. The differences in mean values for maternal age, maternal weight at delivery, and gestational age at delivery were statistically significant, but were not felt to be clinically relevant. Of those women who underwent induction of labor, 27.4% had prelabor rupture of membranes, and 33.5% required cervical ripening for an unfavorable cervix.

There were no maternal deaths or maternal readmissions in either the study group or the comparison group. No patients in the cesarean delivery without labor group were transferred to a general hospital for intensive care, whereas 3 patients in the induction of labor group were transferred (0.6/1,000). Women who underwent cesarean delivery without labor had a significantly longer length of hospital stay (4.2 days) compared with women having induction of labor (3.4 days, $P=.005$). The rates of venous thromboembolism (0.1% in the induction of labor group and 0% in the cesarean delivery without labor group), and peripartum hysterectomy (0.05% in the induction of labor group and 0% in the cesarean delivery without labor group) were low.

Crude and adjusted analyses for maternal morbidity outcomes comparing cesarean delivery without labor with induction of labor are shown in Table 2. Logistic regression controlled for the potential confounding factors of maternal age, type of anesthesia, use of antibiotics, gestational age at delivery, and birth weight. Because more than 10% of the values were missing for predelivery weight, and this would adversely affect the size of the population being analyzed, predelivery weight was excluded from the regression models. The rates of peripartum blood transfusion, wound infection, febrile morbidity, evacuation of hematoma, and intraoperative trauma rates were low (0.1–1.5%) in both groups, and there were no differences in these outcomes between the 2 groups. There was a decreased adjusted risk of early postpartum hemorrhage (relative risk [RR] 0.61, 95% confidence interval [CI] 0.42–0.88) in the cesarean delivery without labor group (number needed to treat 32, ie, 32 cesarean deliveries without labor needed to be performed instead of induction of labor to prevent 1 case of early postpartum hemorrhage). There was also a decreased risk of composite maternal morbidity (RR 0.71, 95% CI 0.52–0.95, number needed to treat 34) in the cesarean delivery without labor group compared with the labor induction group.

Adjusted analyses for maternal morbidity outcomes comparing cesarean delivery without labor with delivery after induction of labor by method of delivery are shown in Table 3. There were 2 women

**Table 1. Characteristics of Women Undergoing Cesarean Delivery Without Labor at Term Compared With Women Having Induction of Labor at Term in Nova Scotia, 1988-2002**

| | Cesarean Delivery Without Labor (n=879) | Induction of Labor (n=4,900) | *P* |
|---|---|---|---|
| Maternal age (y) | 27.5 (5.3) | 26.3 (5.2) | <.001 |
| Maternal weight at delivery (kg) | 81.5 (15.0) | 83.5 (15.3) | <.001 |
| Proportion with regional analgesia | 85.4 | 58.8 | <.001 |
| Proportion with antibiotic administration | 40.4 | 38.1 | .19 |
| Gestational age at delivery (wk) | 39.2 (1.2) | 40.2 (1.4) | <.001 |
| Birth weight (g) | 3,549 (431) | 3,676 (436) | .22 |

Values are mean (standard deviation) or %.

**Table 2. Crude and Adjusted Comparisons of Selected Maternal Morbidity Rates Among Women Undergoing Cesarean Delivery Without Labor at Term and Women Having Induction of Labor at Term in Nova Scotia, 1988–2002**

| Maternal Morbidity | CD Without Labor (n=879) | Referent Group—Induction of Labor (n=4,900) | | |
|---|---|---|---|---|
| | | | Crude | Adjusted |
| Blood transfusions | 3 (0.3) | 29 (0.6) | 0.58 (0.18–1.89) | 1.14 (0.30–4.33) |
| Wound infection | 12 (1.4) | 41 (0.8) | 1.64 (0.86–3.13) | 1.51 (0.74–3.11) |
| Puerperal febrile morbidity | 10 (1.1) | 41 (0.8) | 1.35 (0.69–2.70) | 0.86 (0.41–1.81) |
| Evacuation of hematoma | 1 (0.1) | 7 (0.1) | 0.79 (0.10–6.67) | 1.70 (0.17–17.1) |
| Early PPH | 36 (4.1) | 399 (8.1) | 0.50 (0.36–0.70) | 0.61 (0.42–0.88) |
| Intraoperative trauma | 1 (0.1) | 23 (0.3) | 0.24 (0.03–1.79) | 0.18 (0.02–1.37) |
| Composite morbidity | 57 (6.5) | 491 (10.2) | 0.65 (0.50–0.84) | 0.71 (0.52–0.95) |

CD, cesarean delivery; PPH, postpartum hemorrhage.
Values are n (%) or relative risk (95% confidence interval).

who underwent induction of labor where the method of delivery was unclassified. These cases were included in the comparison of cesarean delivery without labor with induction of labor, but not in subgroup analyses by method of delivery. There was an increase in wound infection (RR 5.90, 95% CI 2.02–17.3, number needed to treat 51) with cesarean delivery without labor compared with spontaneous vaginal delivery. In comparison with spontaneous vaginal delivery, the outcomes of febrile morbidity and early postpartum hemorrhage were significantly different in the crude analysis but not in the adjusted analysis. There was a decrease in early postpartum hemorrhage (RR 0.38, 95% CI 0.26–0.57, number needed to treat 13) with cesarean delivery without labor compared with assisted vaginal delivery. In comparison with assisted vaginal delivery, the need for blood transfusion was significantly different in the crude analysis but not in the adjusted analysis. There was a decrease in intraoperative trauma (RR 0.07, 95% CI 0.01–0.57, number needed to treat 67) with cesarean delivery without labor compared with cesarean delivery with labor. In comparison with cesarean delivery in labor, early postpartum hemorrhage was significantly different in the crude analysis but not in the adjusted analysis. No difference was observed in composite morbidity in the cesarean delivery without labor group compared with the spontaneous vaginal delivery group. There was a reduction in composite morbidity when cesarean delivery without labor was compared with assisted vaginal delivery (RR 0.47, 95% CI 0.33–0.65, number needed to treat 12) and cesarean in labor (RR 0.69, 95% CI 0.49–0.97, number needed to treat 30).

Adjusted analyses for maternal morbidity outcomes comparing cesarean delivery without labor with delivery after any type of labor (both spontaneous onset of labor and induction of labor) by method of delivery are shown in Table 4. All relationships that were significantly different with the crude analysis remained different after adjustment for potential confounding variables. The rate of wound infection was increased in cesarean delivery in labor compared with spontaneous vaginal delivery (RR 4.26, 95% CI 2.19–8.29, number needed to treat 77). Febrile morbidity was increased compared with spontaneous vaginal delivery (RR 4.87, 95% CI 2.29–10.4, number needed to treat 129) and assisted vaginal delivery (RR 2.18, 95% CI 1.03–4.59, number needed to treat 170), but decreased compared with cesarean delivery in labor (RR 0.38, 95% CI 0.20–0.74, number needed to treat 54). The rate of early postpartum hemorrhage was decreased compared with assisted vaginal delivery (RR 0.41, 95% CI 0.29–0.57, number needed to treat 16) and cesarean delivery in labor (RR 0.61, 95% CI 0.43–0.88, number needed to treat 36). Intraoperative trauma was decreased (RR 0.05, 95% CI 0.01–0.38, number needed to treat 50) compared with cesarean delivery with labor. Although no difference was observed in composite morbidity in the cesarean delivery without labor group compared with the spontaneous vaginal delivery group, a reduction in composite morbidity was seen when compared with assisted vaginal delivery (RR 0.51, 95% CI 0.38–0.67, number needed to treat 16) and cesarean in labor (RR 0.52, 95% CI 0.39–0.70, number needed to treat 16).

## DISCUSSION

There is increasing attention given to determining the risks associated with elective obstetric interventions. Small studies have considered the effect of elective induction of labor on the rate of cesarean delivery,[5–7] and data addressing the risks associated with elective cesarean delivery (cesarean on demand) are sparse. In






**Table 3.** Crude and Adjusted Comparisons of Selected Maternal Morbidity Rates Among Women Undergoing Cesarean Delivery Without Labor at Term Compared With Women Having Induction of Labor at Term by Method of Delivery in Nova Scotia, 1988-2002

| | | Referent Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Spontaneous Vaginal Delivery (n=2,606) | | | Assisted Vaginal Delivery (n=6,006) | | | Cesarean Delivery in Labor (n=1,202) | | |
| Maternal Morbidity | CD Without Labor (n=879) [n (%)] | n (%) | Crude RR (95% CI) | Adjusted RR (95% CI) | n (%) | Crude RR (95% CI) | Adjusted RR (95% CI) | n (%) | Crude RR (95% CI) | Adjusted RR (95% CI) |
| Blood transfusion | 3 (0.3) | 13 (0.5) | 0.69 (0.20–2.38) | 1.18 (0.23–5.97) | 13 (1.2) | 0.29 (0.08–1.00) | 0.41 (0.08–1.94) | 3 (0.3) | 1.37 (0.28–6.67) | 1.95 (0.37–10.2) |
| Wound infection | 12 (1.4) | 9 (0.4) | 4.00 (1.67–9.09) | 5.90 (2.02–17.3) | 13 (1.2) | 1.15 (0.53–2.50) | 1.50 (0.59–3.81) | 19 (1.6) | 0.86 (0.42–1.75) | 0.89 (0.41–1.95) |
| Puerperal febrile morbidity | 10 (1.1) | 7 (0.3) | 4.17 (1.61–11.1) | 2.76 (0.94–8.13) | 8 (0.7) | 1.54 (0.61–3.85) | 1.14 (0.42–3.09) | 26 (2.2) | 0.53 (0.25–1.09) | 0.48 (0.22–1.06) |
| Evacuation of hematoma | 1 (0.1) | 3 (0.1) | 0.99 (0.10–9.09) | 1.93 (0.15–24.7) | 3 (0.3) | 0.45 (0.04–3.97) | 0.88 (0.08–10.4) | 1 (0.1) | 1.37 (0.09–20.0) | 2.90 (0.16–53.6) |
| Early PPH | 36 (4.1) | 181 (7.0) | 0.59 (0.42–0.83) | 0.72 (0.48–1.07) | 140 (12.8) | 0.32 (0.22–0.45) | 0.38 (0.26–0.57) | 78 (6.5) | 0.63 (0.43–0.93) | 0.77 (0.51–1.18) |
| Intraoperative trauma | 1 (0.1) | 1 (0.04) | 2.94 (0.19–50.0) | 2.14 (0.12–37.9) | 3 (0.3) | 0.41 (0.04–3.97) | 0.33 (0.03–3.32) | 19 (1.6) | 0.07 (0.01–0.54) | 0.07 (0.01–0.57) |
| Composite morbidity | 57 (6.5) | 195 (7.5) | 0.87 (0.65–1.15) | 1.01 (0.72–1.41) | 166 (15.2) | 0.43 (0.32–0.57) | 0.47 (0.33-0.65) | 130 (10.8) | 0.60 (0.44–0.81) | 0.69 (0.49–0.97) |

CD, cesarean delivery; RR, relative risk; CI, confidence interval; PPH, postpartum hemorrhage.

**Table 4.** Crude and Adjusted Comparisons of Selected Maternal Morbidity Rates Among Women Undergoing Cesarean Delivery Without Labor at Term Compared With Women Having Any Labor (Induction of Labor or Spontaneous Onset of Labor) at Term by Method of Delivery in Nova Scotia, 1988-2002

| | | Referent Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Spontaneous Vaginal Delivery (n=18,603) | | | Assisted Vaginal Delivery (n=6,006) | | | Cesarean Delivery in Labor (n=3,988) | | |
| Maternal Morbidity | CD Without Labor (n=879) [n (%)] | n (%) | Crude RR | Adjusted RR | n (%) | Crude RR | Adjusted RR | n (%) | Crude RR | Adjusted RR |
| Blood transfusion | 3 (0.3) | 64 (0.3) | 0.99 (0.31–3.15) | 1.85 (0.51–6.66) | 57 (1.0) | 0.36 (0.11–1.14) | 0.54 (0.15–1.90) | 22 (0.6) | 0.62 (0.19–2.06) | 0.93 (0.27–3.15) |
| Wound infection | 12 (1.4) | 74 (0.4) | 3.43 (1.87–6.29) | 4.26 (2.19–8.29) | 114 (1.9) | 0.72 (0.40–1.30) | 0.80 (0.43–1.51) | 73 (1.8) | 0.74 (0.40–1.35) | 0.78 (0.42–1.46) |
| Puerperal febrile morbidity | 10 (1.1) | 38 (0.2) | 5.57 (2.78–11.1) | 4.87 (2.29–10.4) | 29 (0.5) | 2.36 (1.15–4.82) | 2.18 (1.03–4.59) | 120 (3.0) | 0.38 (0.20–0.72) | 0.38 (0.20–0.74) |
| Evacuation of hematoma | 1 (0.1) | 21 (0.1) | 1.01 (0.14–7.48) | 1.21 (0.14–10.2) | 7 (0.1) | 0.98 (0.12–7.92) | 1.15 (0.13–10.1) | 6 (0.2) | 0.76 (0.09–6.27) | 0.90 (0.11–7.65) |
| Early PPH | 36 (4.1) | 1,028 (5.5) | 0.74 (0.54–1.03) | 0.72 (0.51–1.03) | 622 (10.4) | 0.40 (0.28–0.55) | 0.41 (0.29–0.57) | 283 (7.1) | 0.58 (0.41–0.81) | 0.61 (0.43–0.88) |
| Intraoperative trauma | 1 (0.1) | 12 (0.1) | 1.76 (0.23–13.6) | 2.29 (0.27–19.1) | 9 (0.2) | 0.76 (0.10–5.99) | 0.89 (0.11–7.31) | 83 (2.1) | 0.05 (0.01–0.39) | 0.05 (0.01–0.38) |
| Composite morbidity | 57 (6.5) | 1,157 (6.2) | 0.98 (0.76–1.27) | 1.04 (0.78–1.38) | 762 (12.7) | 0.48 (0.37–0.63) | 0.51 (0.38–0.67) | 511 (12.8) | 0.48 (0.37–0.62) | 0.52 (0.39–0.70) |

CD, cesarean delivery; RR, relative risk; CI, confidence interval; PPH, postpartum hemorrhage.

an attempt to evaluate maternal risks associated with an option of elective delivery, this study evaluated maternal outcomes in a low-risk obstetric population at term in two groups that acted as surrogates for "patient request cesarean delivery" and "patient request induction of labor": healthy, nulliparous women who underwent a cesarean delivery with no labor were compared with healthy, nulliparous women who underwent induction of labor.

Increases in the rates of induction of labor in the United States (21% in 2003 compared with 10% in 1990)[16] are attributed to increases in elective inductions. In Canada, the rate of induction rose from 17% in 1991–1992 to 22% in 2000–2001,[17] with a similar increase in Nova Scotia.[18] In the select, low-risk population examined in this study, the change in rate of induction was more dramatic (11% in 1988 compared with 28% in 2002), explained in part by an increase in induction of labor in pregnancies greater than 41 weeks gestational age.

Risks of cesarean delivery with induction of labor for postmature pregnancy and other indications are well established.[1,2,13] However, concerns have been expressed in the literature regarding the appropriateness of comparison groups when evaluating the risks of morbidity associated with induction of labor, especially when compared with spontaneous onset of labor, primarily because the indication for induction may affect the rate of morbidity associated with method of delivery.[2,3,7,19] When there was no medical or obstetric indication for induction, Maslow et al[6] found a 2-fold increased risk for cesarean delivery in electively induced parous and nulliparous women compared with women with spontaneous onset of labor and also showed increased predelivery time and costs. Vahratian et al[5] evaluated electively induced nulliparous women and determined that an unfavorable cervix was associated with a 3.5-fold increased risk of cesarean delivery compared with those women with spontaneous onset of labor. Evidence for maternal and neonatal risks associated with elective cesarean delivery is mostly derived from evaluation of outcomes after elective repeat cesarean delivery compared with trial of labor[20,21] or planned cesarean delivery for breech presentation compared with planned vaginal breech delivery at term,[22] which have demonstrated no differences in serious maternal morbidity. Previous work using data from a low-risk population similar to the one in this study demonstrated a significant reduction in risk of maternal infectious, hemorrhagic, and traumatic morbidity when cesarean delivery without labor was compared with spontaneous onset of labor.[8] Further evaluation of morbidity by stage of labor using this similar population demonstrated increased maternal and perinatal morbidity in the second stage, regardless of duration of labor or failed operative vaginal delivery.[9]

The rates of adverse maternal outcomes identified in our study were low and were consistent with other studies examining outcomes after operative delivery.[8,22–30] Known risk factors for cesarean delivery after induction of labor include previous cesarean delivery, nulliparity, obesity, and an unfavorable cervix,[1,2,18] and although there were statistically significant differences in maternal age, predelivery weight, and gestational age at delivery in our study of healthy nulliparous women, there were no clinically significant differences in these factors or in infant birth weight. Adjusted analyses accounting for these summary characteristics, in comparisons of adverse maternal outcomes between cesarean delivery without labor and induction of labor, had minimal effect on crude relationships. Only a few outcomes became nonsignificant after regression analyses for induction of labor by method of delivery (need of blood transfusion, febrile morbidity, and early postpartum hemorrhage), and several of these were marginally nonsignificant (febrile morbidity and early postpartum hemorrhage).

A clinically relevant difference was observed in the 40% reduction in rate of early postpartum hemorrhage (95% CI 0.42–0.88) and a 30% reduction in rate of composite morbidity (95% CI 0.22–0.95) when cesarean delivery without labor was compared with induction of labor, after adjusting for potential confounders. Significant differences in maternal morbidity outcomes in our study were of the same magnitude as differences in risks with spontaneous onset of labor by method of delivery.[8] In particular, reductions in risks of composite maternal morbidity was again demonstrated for cesarean delivery without labor when compared with assisted vaginal delivery (50%) and cesarean delivery in labor (30%). Unlike the previous study, however, febrile morbidity was not different when compared with any method of delivery. When the group of any type of labor (induction of labor combined with spontaneous onset of labor) was considered, the effect of induction of labor alone on risks was sufficient to explain the effect of the combined labor group, except in the case of febrile morbidity with spontaneous vaginal delivery, assisted vaginal delivery, and cesarean delivery in labor, where the effect of spontaneous onset of labor seemed to be the major contributor to the increased risks, and in the case of intraoperative trauma with cesarean delivery in labor, where it seemed to be an additive

effect. The long-term complications associated with occurrence of these adverse outcomes and implications for future reproductivity warrants further study.

This study used data extracted from a large clinical, population-based database that, in addition to routine data checks and edits made at the time of data collection by qualified health records personnel, has been shown, through data abstraction and validation studies, to contain reliable information.[31,32] We are limited in this retrospective study to data collected in the Nova Scotia Atlee Perinatal Database, and thus there may be information on factors relevant to the groups in this study (such as Bishop's score and body mass index) that we were unable to include in the comparisons. In addition, Nova Scotia has a homogeneous population and these analyses may have limited generalizability in more ethnically or racially diverse populations. This study did not attempt to address fetal, neonatal, or infant morbidity and mortality, the effect of multiparity, the effect of previous cesarean delivery on morbidity, the costs of induction, or long-term maternal outcomes associated with induction of labor.

This study evaluated maternal morbidity and mortality in 2 groups of pregnant women at term, those undergoing either cesarean delivery without labor or induction of labor. No morbidity associated with cesarean delivery without labor was increased compared with induction of labor. Maternal morbidity with labor induction, including hemorrhagic and traumatic morbidities, was increased the most after assisted vaginal delivery and cesarean delivery in labor. This study highlights the magnitude of the increased risks of adverse maternal outcomes associated with induction of labor and, in fact, any type of labor compared with cesarean delivery without labor, especially when operative delivery in labor becomes necessary. The use of a healthy, low-risk population attempted to minimize the effect of comparing 2 diverse groups, and to approximate women undergoing elective obstetric interventions. This approach allowed the evaluation of these groups as representative of elective obstetric interventions to provide insight into the maternal risks associated with elective interventions, such as elective induction and elective cesarean delivery, and to aid in patient and physician decision-making to optimize pregnancy outcomes.

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