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Timing of Elective Repeat Cesarean Delivery at Term and Maternal Perioperative Outcomes

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Abstract

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For a list of other members of the NICHD MFMU, see the Appendix online at http://links.lww.com/xxx. *Dr. Spong, Associate Editor of* Obstetrics & Gynecology, *was not involved in the review or decision to publish this article.*

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Objective—Elective repeat cesarean delivery at 37 or 38 weeks compared to 39 completed weeks' gestation is associated with adverse neonatal outcomes. We assessed whether delivery prior to 39 weeks is justifiable on the basis of decreased adverse maternal outcomes.

Methods—We conducted a cohort study of women with live singleton pregnancies delivered by prelabor elective repeat cesarean from 1999 through 2002 at 19 U.S. academic centers. Gestational age was examined by completed weeks (e.g., 37 completed weeks = 37 0/7 to 37 6/7 weeks). Maternal outcomes included a primary composite of death, hysterectomy, uterine rupture or dehiscence, blood transfusion, uterine atony, thromboembolic complications, anesthetic complications, surgical injury or need for arterial ligation, intensive care unit admission, wound complications, or endometritis.

Results—Of 13,258 elective repeat cesareans performed at 37 weeks of gestation or later, 11,255 (84.9%) were between 37 0/7 and 39 6/7 weeks (6.3% at 37, 29.5% at 38, and 49.1% at 39 completed weeks), and 15.1% were at 40 0/7 weeks or more. The primary outcome occurred in 7.43% at 37 weeks, 7.47% at 38 weeks and 6.56% at 39 weeks (p-value for trend test = 0.09). Delivery prior to 39 weeks was not associated with a decrease in the primary outcome when compared with delivery at 39 weeks (adjusted OR 1.16; 95% CI 1.00-1.34). Early delivery was associated with increased maternal hospitalization of 5 days or more [1.96 (1.54, 2.49)] but not with a composite of death or hysterectomy or with individual maternal morbidities.

Conclusion—Elective repeat cesarean delivery at 37 or 38 weeks is not associated with decreased maternal morbidity.

Introduction

Neonatal morbidity associated with elective cesarean delivery at term increases as gestational age at delivery decreases from 39 to 37 weeks [1-2]. Therefore, elective delivery prior to 39 weeks is discouraged unless fetal lung maturity has been confirmed [3]. Despite these recommendations we reported delivery prior to 39 weeks in over a third of pre-labor elective repeat cesareans in a US multicenter cohort [4]. This figure has been reported to be as high as 50-80% in some European cohorts [5-7]. Concern that delivery at 39 weeks compared to earlier delivery may be associated with adverse maternal outcomes particularly among women with a prior cesarean has been suggested as one reason for elective delivery prior to 39 weeks [8]. To enhance ongoing initiatives to delay elective delivery until 39 weeks for neonatal benefit, it is important to verify that earlier delivery is not beneficial for the mother. Therefore, the objective of the current study was to test the hypothesis that delivery at term, but prior to 39 completed weeks of gestation (i.e. at 37 or 38 weeks), as compared to delivery at 39 completed weeks, is associated with a reduction in adverse maternal outcomes.

Materials and Methods

This cohort study is a secondary analysis of the Cesarean Section Registry of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal Fetal-Medicine Units (NICHD MFMU) Network. The registry contains detailed, prospectively collected information on consecutive repeat cesarean deliveries performed at 19 U.S. academic centers from 1999 to 2002 [9]. We have previously described the selection of our study cohort in detail [4]. Briefly, women who underwent cesarean delivery at each center were identified by research personnel. Maternal and neonatal information in medical records, including primary and secondary indications for the cesarean (selected from a list of up to 20 indications that included "elective"), were collected on standardized study forms by trained personnel. Using these indications as well as the recorded medical and obstetric history, we selected a group of women who underwent an elective cesarean delivery (i.e., in

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the absence of labor or other recognized obstetric or medical indications for delivery prior to 39 weeks' gestation) of a viable infant at or beyond 37 weeks' gestation. The long list of exclusion criteria included women who had a multiple gestation, a fetus with a major congenital anomaly and/or prior classical or unknown uterine scar [4].

The timing of delivery was determined in completed weeks of gestation such that 37 weeks (for example) included deliveries at 37 0/7 to 37 6/7 weeks. Gestational age was based on the best obstetric estimate determined by providers and used for clinical decision-making. In general, network providers used standard criteria that involved consideration of the clinical history and earliest ultrasound findings [10]: if last menstrual period (LMP) was certain and consistent with ultrasound, dating was based on the LMP; if the ultrasound estimate was not consistent with LMP or the LMP was not certain, ultrasound data were used.

We examined adverse maternal outcomes including death, uterine rupture or dehiscence, hysterectomy, intra-operative or postoperative blood transfusion, uterine atony, endometritis, wound infection, surgical injury of the bladder, ureter or bowel, broad ligament hematoma, need for uterine artery ligation, venous thromboembolism, ileus complications, anesthetic complications and intensive care unit (ICU) admission. The pre-specified primary outcome was a composite outcome including any of the above adverse outcomes. In addition, we examined an alternative composite severe outcome including only death, hysterectomy and uterine rupture. Although not included in the composite outcome, we also examined prolonged hospitalization, defined as a post-cesarean maternal hospital stay of greater than 4 days. Maternal outcomes were ascertained until hospital discharge and 6 weeks postpartum for readmissions.

Maternal death included only those resulting from complications related to childbirth. Uterine rupture was defined as a through and through disruption or tear of the uterine muscles and serosa, while dehiscence was defined as a disruption of the uterine muscle but with intact serosa. The diagnosis of uterine atony was based on the presence of excessive bleeding warranting treatment (not prophylaxis) with an uterotonic medication. Endometritis was defined based on a physician diagnosis (typically persistent postpartum fever with abnormal uterine tenderness in the absence of clinical or laboratory findings suggesting a non-uterine source of infection) or antibiotic treatment for endometritis. Wound infection was based on a diagnosis of superficial or deep infection involving the cesarean incision site. Anesthetic complications included failed intubation, spinal headache, chemical meningitis and epidural hematoma. Thromboembolic complications included either deep venous thrombosis of the lower extremities or pulmonary embolism.

Data were analyzed using SAS (SAS Institute, Cary, NC) and Cytel Studio (for exact statistical analysis). The incidence of adverse maternal outcome was calculated for each completed week of gestation at the time of cesarean delivery. The Exact Cochran-Armitage trend test was used to assess trends in outcome incidence from 37 to 39 weeks since several of the individual outcomes were rare. Adjusted odds ratios (OR) for the association between maternal outcomes and delivery prior to 39 weeks relative to delivery at 39 completed weeks (referent) were derived from logistic regression models adjusting for potential confounders including maternal age, race, payor, diet-controlled gestational diabetes (other classes of diabetes were excluded from the study population), smoking status during pregnancy and number of prior cesareans. Because of information on delivery BMI (based on last documented maternal weight prior to delivery) was missing for 584/13258 women, we excluded BMI from the primary model in order to enhance efficiency (since analyses including BMI did not materially change the results). A two-sided p-value less than 0.05 was considered statistically significant; no adjustments were made for multiple comparisons.

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The Institutional Review Board of each clinical center and the data-coordinating center had previously approved the initial study.

Results

Out of 24,077 women with repeat cesarean deliveries at or after 37 0/7 weeks' gestation in the Eunice Kennedy Shriver NICHD MFMU Network Cesarean Registry, 13,258 women were delivered by elective cesarean section, prior to labor, and in the absence of medical or obstetric indications for delivery prior to 39 weeks. The detailed distribution of the stringent exclusion criteria applied to select prelabor elective cesareans has been previously reported [4]. Pregnancy dating was confirmed by a 1st or 2nd trimester ultrasound in 77% of pregnancies; for the remaining 23% dating was based on a 3rd trimester ultrasound and/or LMP. Among all 13,258 women, 6.3% were delivered at 37 completed weeks, 29.5% at 38 weeks, 49.1% at 39 weeks and 15.1% at 40 weeks or later. We restricted the current analysis to the 11,255 (84.9%) delivered at 37 through 39 completed weeks.

Maternal characteristics of the study population according to gestational age group are presented in Table I. Statistically significant but modest differences in maternal age, delivery BMI, race/ethnicity, marital status, payor, smoking status and number of prior cesareans but not in diet-controlled gestational diabetes were observed among gestational age groups.

The incidence of individual and composite adverse maternal outcomes by gestational age at delivery is presented in Table 2. There were two maternal deaths (at 38 and 39 weeks) and no cases of uterine rupture. Need for blood transfusion and prolonged maternal hospitalization (≥5 days) decreased with increasing gestational age at cesarean delivery (p-values for trend <0.01). No other individual outcome showed significant trends. The incidence of the primary composite adverse maternal outcome and the composite of severe outcomes appeared to be higher at 37 and 38 weeks compared to 39 weeks but statistical tests for trend were not significant. The composite of severe outcomes was practically a reflection of hysterectomy, which was involved in all cases except one.

Unadjusted and adjusted relative risks for the association between delivery prior to 39 weeks (i.e. at 37 or 38 weeks compared to 39 weeks) and each of the composite maternal outcomes, and selected individual outcomes are presented in Table 3. In unadjusted analyses, delivery prior to 39 weeks was not associated with the composite primary outcome, the composite of severe outcomes or blood transfusion. Early delivery was associated with an increase in prolonged maternal hospitalization. After adjusting for potential confounders (maternal age, ethnicity, payor, class A1 diabetic status, smoking status during pregnancy and number of prior cesareans) by logistic regression, delivery prior to 39 weeks was not significantly associated with the composite primary outcome: adjusted OR 1.16, 95% CI 1.00-1.34; p-value = 0.05. Not shown, African American (adjusted OR 1.45; 1.18-1.80) and Hispanic ethnicities (1.51; 1.21-1.87) compared to non-Hispanic whites, and 2 prior (1.34; 1.14-1.58) or 3 prior cesareans (1.59; 1.26-2.02) compared to one prior cesarean, were significantly associated with composite adverse maternal outcome. Further analyses adjusting for the factors in the primary model as well as for study center and for maternal BMI gave results (not shown) similar to the primary findings; there was variation in the primary outcome by center. However, these models were limited by sparse data (given the high number of centers) and the high proportion without BMI information.

Multivariable analysis involving the composite of severe outcomes was limited by the low outcome frequency (Table 3). Risk of blood transfusion and prolonged maternal hospitalization were not significantly reduced by delivery prior to 39 weeks whereas

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delivery at 37 or 38 weeks was associated with almost a 2-fold increase in prolonged maternal hospitalization (Table 3). To further examine the association between early delivery and prolonged maternal hospitalization, prolonged neonatal hospitalization (>4 days) was added to the multivariable model for maternal hospitalization. Prolonged maternal hospitalization was strongly associated with prolonged neonatal hospitalization (p-value <0.001) and not with early delivery (p = 0.09).

In post hoc analyses, we examined the frequency of the primary composite adverse maternal outcome among women who underwent otherwise elective term cesarean prior to 39 weeks but after the onset of labor or spontaneous membrane rupture (i.e. without labor augmentation or induction). The frequency of adverse maternal outcome was 7.42% (31/418) with elective cesarean at 37 or 38 weeks after labor or spontaneous membrane rupture compared to the 7.47% at 37 or 38 weeks prior to labor/membrane rupture (p-value = 0.97) or to the 6.56% at 39 completed weeks (p value=0.49). Information on maximum cervical dilation was available only for 18.1% of patients delivered at 37 through 39 completed weeks (suggesting that few patients undergoing elective cesarean have a cervical examination). Mean dilation was 1.4±1.6 cm at 37 weeks, 0.8±1.3 cm at 38 weeks and 0.5±0.9 cm at 39 weeks (p <0.01). The result for the primary composite outcome was not changed by adding cervical dilation into the multivariable model; cervical dilation was not significantly associated with the primary composite outcome.

Discussion

The current findings suggest that elective cesarean delivery at 37 or 38 completed weeks as compared with delivery at 39 weeks (for neonatal benefit) is not associated with improved composite adverse maternal outcomes. A composite of severe outcomes only that included maternal death, uterine rupture or need for hysterectomy was also not decreased by earlier delivery compared with elective delivery at 39 weeks. Early elective delivery was associated with a 2-fold increased frequency of maternal hospitalization for 5 days or more, as compared to elective delivery at 39 weeks. Additional analyses suggested that this increase in prolonged maternal hospital stay may be more attributable to prolonged neonatal hospitalization (women remain longer in the hospital because of their babies) than to increased maternal morbidity. We previously reported an increase in a composite of several adverse neonatal outcomes associated with elective cesarean prior to 39 completed weeks [4].

In contrast to several studies examining neonatal outcomes [1-2,4-6,11], there is a dearth of information concerning maternal outcomes according to gestational age at delivery to compare to our results. Nevertheless, the incidence rates of adverse maternal outcomes overall in our cohort are consistent with findings reported in other studies of women who underwent pre-labor elective repeat and/or primary cesarean [7,12-15]. Also consistent with prior studies, individual adverse maternal outcomes were rare and most commonly represented uterine atony or postpartum hemorrhage and surgical site complications (endometritis or wound complications) [12--16].

Whilst not significantly increased, our adjusted estimates for maternal morbidities suggest that with a larger sample size, elective delivery prior to 39 weeks may modestly increase composite adverse maternal outcomes primarily due to an increased need for blood transfusion compared to elective delivery at 39 weeks. Bias is an alternative explanation, in that higher risk non-elective cesareans remained in the study sample and were overrepresented in the group delivered prior to 39 weeks. However, given the rigorous and detailed process used to identify elective cesareans, we believe such bias was minimized and unlikely to change the interpretation of our current results for maternal outcomes or those

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previously reported for neonatal outcomes [4]. Moreover, additional studies have since replicated our neonatal findings in different populations undergoing both elective and indicated deliveries [17-18], supporting the validity of the findings. Therefore, the possibility that pre-labor elective repeat (or even primary) cesarean is associated with increased need for blood transfusion when performed prior to 39 weeks compared to 39 completed weeks should be studied. Perhaps the development of the lower uterine segment (and its relation to adhesions due to prior surgery) is not optimal for avoiding blood loss prior to 39 weeks. The role of prolonged neonatal hospitalization as an explanation for the association between prolonged maternal hospitalization and early delivery deserves further study. If valid, costs associated with prolonged maternal hospitalization should be considered when evaluating costs associated with NICU admission or neonatal hospital stay.

The strengths of our study include the large sample size and our ability to adjust for multiple potential confounders. Among all women undergoing pre-labor elective repeat cesarean at term our findings apply directly to the majority who maintain this elective status at the actual time of delivery – approximately over 80% based on data from the MFMU Cesarean Registry [4]. Drawing from previous studies, about 10-16% of women labor prior to the target date, and typically undergo an otherwise non-urgent cesarean delivery early in labor [4,19-20]. Since these women typically have a prior lower uterine segment scar (as opposed to classical cesarean scars), and preceding labor is unlikely to significantly increase the rare severe adverse maternal outcomes but may improve neonatal outcomes, our results are not likely to be changed by including these otherwise elective cesareans performed after the onset of labor [5,8,21]. Indeed findings from relevant post-hoc analyses do not suggest an increase in adverse maternal outcomes when labor preceded elective repeat cesarean. Our data however do not account for the minority of women at term who develop complications such as preeclampsia or abruption while awaiting elective delivery at 39 weeks. This is a study limitation. Based on MFMU Cesarean Registry data, this group represents only an estimated 6% or less of the target population, who were excluded from our study population given the presence of routine indications for immediate delivery at term [4]. Given the small proportion and the impossibility of predicting who will subsequently develop these complications, studies of this sub-group will be unlikely to change practice. Of note, our study population of elective cesareans is smaller than previously reported from the MFMU Cesarean Section Registry because we used a more exclusive definition of “elective cesarean” [4,21]. Our study is also inherently limited by our inability to account for any unknown confounders. It is difficult to capture and describe all the nuances surrounding elective cesareans including “soft indications” such as maternal fatigue or anxiety. However, our results do apply to these deliveries since they are typically designated as “elective” and are therefore included in our study population.

Cumulatively, our studies of elective cesarean deliveries within the Cesarean Section Registry of the NICHD MFMU Network suggest that a high proportion of elective cesarean deliveries in the US were performed prior to 39 weeks. The practice is associated with an increase in adverse neonatal outcomes (and attendant health care costs), with no apparent maternal benefit compared to elective delivery in the 39th week [4]. These findings should provide impetus to clinical and public health initiatives to reduce elective cesarean delivery prior to 39 weeks in the absence of medical or obstetric indications. In the same vein, our findings should not deter delivery prior to 39 weeks when indicated for obstetric or medical reasons.

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Appendix

In addition to the authors, other members of the Eunice Kennedy Shriver National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network who contributed to the study are as follows:

University of Alabama at Birmingham — D. Rouse, J. Hauth, A. Northen, S. Tate

University of Texas Southwestern Medical Center — S. Bloom, J. Gold, D. Bradford

University of Utah — M. Belfort (Utah Valley Regional Medical Center), F. Porter (Intermountain Healthcare), B. Oshiro (McKay-Dee Hospital Center), K. Anderson (University of Utah Health Sciences Center), A. Guzman (McKay-Dee Hospital Center)

University of Pittsburgh — K. Lain, M. Cotroneo, D. Fischer, M. Luce

Wake Forest University Health Sciences — M. Harper, M. Swain, C. Moorefield, K. Lanier, L. Steele

The Ohio State University — J. Iams, F. Johnson, S. Meadows, H. Walker

Thomas Jefferson University — A. Sciscione, M. DiVito, M. Talucci, M. Pollock

Wayne State University — M. Dombrowski, G. Norman, A. Millinder, C. Sudz, B. Steffy

University of Cincinnati — M. Miodovnik, T. Siddiqi, H. How, N. Elder

Columbia University — M. Miodovnik, F. Malone, M. D'Alton, V. Pemberton, V. Carmona, H. Husami

Brown University — M. Carpenter, H. Silver, J. Tillinghast, D. Catlow, D. Allard

Northwestern University — M. Socol, D. Gradishar, G. Mallett

University of Miami — G. Burkett, J. Gilles, J. Potter, F. Doyle, S. Chandler

University of Tennessee — W. Mabie, R. Ramsey

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University of North Carolina — K. Moise, K. Dorman, S. Brody, J. Mitchell

The University of Texas Health Science Center at Houston — L. Gilstrap, M. Day, M. Kerr, E. Gildersleeve

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Case Western Reserve University — P. Catalano, C. Milluzzi, B. Slivers, C. Santori

The George Washington University Biostatistics Center — E. Thom, S. Gilbert, H. Juliussen-Stevenson, M. Fischer, L. Leuchtenburg

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Table I

Maternal characteristics by Gestational Age at Cesarean Delivery (n=11255)

Characteristics*	**37 weeks (n=834)**	**38 weeks (n=3909)**	**39 weeks (n=6512)**	**P-value****
Maternal age– yr	30.5 (17.0-47.0)	31.0 (16.0-46.0)	30.0 (15.0-48.0)	<0.001
< 18				0.036
18-34	1 (0.12)	13 (0.33)	29 (0.45)	
≥ 35	625 (74.9)	2972 (76.0)	5070 (77.9)	
	208 (24.9)	924 (23.6)	1412 (21.7)	
Delivery BMI – kg/m^2	31.4 (19.2-86.1)	31.7 (18.1-86.8)	32.2 (16.4-73.5)	<0.001
Race or Ethnicity				<0.001
Black	160 (19.2)	637 (16.3)	1292 (19.8)	
White	427 (51.2)	2194 (56.1)	2955 (45.4)	
Hispanic	201 (24.1)	896 (22.9)	1991 (30.6)	
Others	46 (5.5)	182 (4.7)	274 (4.2)	
Married	574 (68.8)	2930 (75.0)	4290 (65.9)	<0.001
Payor				<0.001
Medicaid or none	390 (46.8)	1453 (37.2)	3270 (50.2)	
Private	444 (53.2)	2454 (62.8)	3241 (49.8)	
Smoker	95 (11.4)	415 (10.6)	795 (12.2)	0.046
Prior cesareans				<0.001
1	444 (53.2)	2403 (61.5)	3940 (60.5)	
2	272 (32.6)	1135 (29.0)	2070 (31.8)	
3 or more	118 (14.2)	371 (9.5)	502 (7.7)	
Diet-controlled gestational diabetes	55 (6.6)	225 (5.8)	350 (5.4)	0.307

*Values represent numerator (%) except for maternal age (continuous) and delivery BMI where data are median (range)

**Chi-square test or Kruskal-Wallis test

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Table 2

Incidence of Adverse Maternal Outcomes by Gestational Age at Delivery (N=11255)

Maternal outcomes**	37 weeks (n=834)	38 weeks (n=3909)	39 weeks (n=6512)	p-value*
Primary composite adverse outcome	7.43 (62)	7.47 (292)	6.56 (427)	0.09
Composite severe outcomes**	0.48 (4)	0.23 (9)	0.15 (10)	0.07
Maternal Death	0 (0)	0.03 (1)	0.02 (1)	>0.99
Hysterectomy	0.48 (4)	0.20 (8)	0.15 (10)	0.09
Blood transfusion (intra- or postpartum)	2.04 (17)	0.77 (30)	0.74 (48)	<0.01
Uterine atony	2.64 (22)	2.71 (106)	2.18 (142)	0.12
Uterine dehiscence	0.60 (5)	0.61 (24)	0.46 (30)	0.35
Thromboembolism	0.12 (1)	0.13 (5)	0.03 (2)	0.10
Endometritis	0.96 (8)	1.28 (50)	1.61 (105)	0.07
Wound complication	0.84 (7)	1.31 (51)	1.04 (68)	0.72
Uterine artery ligation	0.48 (4)	0.44 (17)	0.34 (22)	0.40
Broad ligament hematoma	0.24 (2)	0.10 (4)	0.09 (6)	0.36
Cystotomy	0.12 (1)	0.15 (6)	0.15 (10)	>0.99
Ileus	0.36 (3)	0.28 (11)	0.32 (21)	>0.99
ICU admission	0.24 (2)	0.13 (5)	0.15 (10)	0.85
Maternal hospitalization ≥ 5 days	4.68 (39)	3.17 (124)	1.92 (125)	<0.01

* P-value for Exact Cochran-Armitage trend test from 37 to 39 weeks

** Composite of death, uterine rupture and hysterectomy only

Data presented as percent (number) – percentages reflect missing data for outcomes; ICU = Intensive care unit

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Table 3

Unadjusted and adjusted estimates of the relationship between selected maternal outcomes and gestational age (37-38 weeks vs. 39 weeks; N=11,255)

Maternal outcomes	Unadjusted Estimates		Adjusted Estimates**	
	RR	95% CI	OR	95% CI
Primary composite adverse outcome	1.14	(0.99, 1.30)	1.16	(1.00, 1.34)
Composite severe outcomes*	1.78	(0.78, 4.07)	n/a	n/a
Blood transfusion (intra- or postpartum)	1.34	(0.90, 2.01)	1.46	(0.97, 2.21)
Uterine atony	1.24	(0.98, 1.57)	1.23	(0.96, 1.57)
Uterine dehiscence	1.33	(0.80, 2.21)	1.19	(0.71, 2.00)
Endometritis	0.76	(0.55, 1.04)	0.90	(0.65,1.24)
Wound complication	1.17	(0.83, 1.66)	1.05	(0.73, 1.49)
Uterine artery ligation*	1.31	(0.72, 2.38)	n/a	n/a
Ileus	0.91	(0.47, 1.80)	n/a	n/a
Maternal hospitalization ≥ 5 days	1.79	(1.42, 2.25)	1.96	(1.54, 2.49)

*Composite of death, uterine rupture and hysterectomy only – there were too few events to conduct an adjusted analysis (n/a)

**Adjusted for maternal age, race, payor, class A1 diabetic status, smoking status during pregnancy and number of prior cesareans