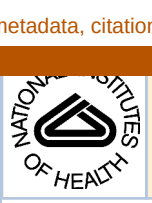

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Maternal and neonatal outcomes by labor onset type and gestational age

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Abstract

OBJECTIVE—We sought to determine maternal and neonatal outcomes by labor onset type and gestational age.

STUDY DESIGN—We used electronic medical records data from 10 US institutions in the Consortium on Safe Labor on 115,528 deliveries from 2002 through 2008. Deliveries were divided by labor onset type (spontaneous, elective induction, indicated induction, unlabored cesarean). Neonatal and maternal outcomes were calculated by labor onset type and gestational age.

RESULTS—Neonatal intensive care unit admissions and sepsis improved with each week of gestational age until 39 weeks ($P < .001$). After adjusting for complications, elective induction of labor was associated with a lower risk of ventilator use (odds ratio [OR], 0.38; 95% confidence interval [CI], 0.28 – 0.53), sepsis (OR, 0.36; 95% CI, 0.26 – 0.49), and neonatal intensive care unit admissions (OR, 0.52; 95% CI, 0.48 – 0.57) compared to spontaneous labor. The relative risk of hysterectomy at term was 3.21 (95% CI, 1.08 – 9.54) with elective induction, 1.16 (95% CI, 0.24 – 5.58) with indicated induction, and 6.57 (95% CI, 1.78 – 24.30) with cesarean without labor compared to spontaneous labor.

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CONCLUSION—Some neonatal outcomes improved until 39 weeks. Babies born with elective induction are associated with better neonatal outcomes compared to spontaneous labor. Elective induction may be associated with an increased hysterectomy risk.

Keywords

elective delivery; hysterectomy; maternal outcomes; neonatal outcomes

Fogyew issues in obstetrics and gynecology leave obstetricians more conflicted then elective induction of labor. Patients often ask for elective inductions due to logistics or discomforts. Physicians may be tempted to acquiesce for a variety of reasons. Scheduling logistics between the hospital and patient often result in deliveries occurring <39 weeks' gestation, counter to current American College of Obstetricians and Gynecologists (ACOG) recommendations. Data suggest that inductions are contributing to the shift toward shorter gestations nationally.[1]

Over the last few years, evidence for poorer neonatal outcomes at <39 weeks has been published.[2–5] In light of these data, clinicians should counsel patients on the increased risks to the neonate of a scheduled delivery <39 weeks. However, with few data available, it has been difficult to counsel patients about the maternal risks of elective induction in comparison to other labor onset types.

The studies on early term neonatal outcomes have been from single centers or used administrative data that lacked some clinical detail. Tita et al[4] published a nationally representative multicenter study based on abstracted medical records. That study showed neonatal outcomes were worse in babies delivered <39 weeks, but it only looked at repeat cesarean deliveries.

The Consortium on Safe Labor is a National Institutes of Health multicenter collaborative study designed to characterize labor and delivery in a contemporary group of women experiencing current obstetric clinical practices. By design, study hospitals had to have obstetric electronic medical records (EMR) that coded data into prespecified fields that would allow for data to be abstracted and combined into a uniform dataset for subsequent analysis of patient-specific risk factors and maternal and neonatal outcomes. Unlike electronic administrative data, EMRs are a direct clinical source and are rich in clinical and demographic details. These data offer the advantages of a large national sample size while maintaining the clinical detail of a single-center chart review.

The current study uses a convenient cohort from the Consortium on Safe Labor database. We sought to determine neonatal and maternal outcomes by gestational age and labor onset type. While previous studies have shown that babies born <39 weeks have poorer outcomes, it is unclear whether these poorer outcomes are secondary to the reasons for delivery. It is unclear whether elective inductions in healthy women carry the same neonatal risks as indicated inductions. Previous large studies have been unable to differentiate well between causes of delivery. Furthermore, because very few data are available on maternal outcomes of elective induction in comparison to other labor onset types, we sought to explore maternal outcomes by labor onset type.

Materials and Methods

The Consortium on Safe Labor retrospectively extracted data from EMRs from 12 institutions on 228,668 deliveries with 233,844 births from 2002 through 2008. Data included demographics, prenatal complications, labor and delivery information, and maternal and neonatal outcomes. We excluded deliveries from 2 centers that did not submit indications for

labor onset type (36,533), multiple gestations (8671), nonvertex deliveries (7069), gestational age <34 weeks or >42 weeks (6163), pregnancies complicated by placenta previa (205) or accreta (64), pregnancies with a prior uterine scar (cesarean or myomectomy 24,516), and fetal anomalies (8720). We removed deliveries with missing onset of labor data (25,503). There were 115,528 deliveries remaining in the dataset for analysis after exclusions.

Maternal demographics, clinical risk factors, and maternal and neonatal outcomes were categorized as discrete variables. Labor onset type was divided into 4 categories: spontaneous labor, elective induction of labor, indicated induction of labor, and unlabored cesarean delivery. These determinations were based on the listed reason for the induction or a cesarean delivery with no attempt to labor. Spontaneous labor was defined as having labored but no induction. Ultimate mode of delivery did not affect the labor onset type. If a woman had an elective induction that ended in a cesarean delivery, she was still considered an elective induction.

The neonatal outcomes that we examined were: ventilator use, asphyxia, sepsis, neonatal intensive care unit (NICU) length of stay, and NICU admissions. The maternal outcomes we examined were: chorioamnionitis, endometritis, maternal intensive care unit (ICU) admission, maternal length of stay, and hysterectomy.

We then evaluated the following demographics and risk factors: maternal age, race, ethnicity, parity, and mode of delivery for the entire sample and by labor onset type. Neonatal and maternal outcomes by labor onset type were examined. We stratified neonatal outcomes by gestational age (34 – 42 weeks) because of the likelihood that labor onset type might differ by gestational age and neonatal outcome is drastically different by gestational age. Differences between the groups were calculated by χ^2 and *t* tests where appropriate. Improvements in neonatal outcomes by week were tested with χ^2 for trend.

Multivariable logistic regression models for each of the neonatal outcomes adjusted for the following maternal complications were developed: age, parity, race/ethnicity, preeclampsia, chronic hypertension, diabetes, premature rupture of membranes, and group B streptococcus positivity (GBS+). Models for the maternal outcomes were performed adjusted for the following maternal conditions: age, parity, race/ethnicity, preeclampsia, chronic hypertension, diabetes, and GBS+.

Results

Maternal demographic characteristics are shown in Table 1. There are significant differences in all demographics by labor onset type. NICU admission and sepsis improved for each week of gestation until 39 weeks (Table 2) ($P < .01$ for trend, $P < .001$ for 38 vs 39 weeks). Ventilator use and asphyxia improved until 38 weeks ($P = .003$ for 37 vs 38 weeks). Ventilator use was different by labor onset type for all gestational ages except 41 and 42 weeks. Sepsis was statistically significantly different between labor onset types at 37–41 weeks. There were significant differences in asphyxia by labor onset types except at 37 and 40 weeks. NICU length of stay was significantly different by labor onset type at all gestational ages except 41 and 42 weeks. NICU length of stay was shortest with elective induction of labor and longest for unlabored cesarean deliveries at all gestational ages except 42 weeks, where indicated inductions had longer NICU stays than unlabored cesareans.

After adjusting for maternal characteristics and complications (maternal age, race/ethnicity, parity, preeclampsia, chronic hypertension, diabetes [class ≥ B], premature rupture of membranes, and GBS+), an unlabored cesarean was associated with 4.99-fold (95% confidence interval [CI], 4.00 – 6.21) increased risk of a neonate being on a ventilator compared to spontaneous labor (Table 3). Women with an elective induction of labor had a lower risk of neonatal ventilator use, sepsis, and NICU admission. Indicated inductions had neonatal

outcomes that were not significantly different from spontaneous labor. Unlabored cesarean deliveries were associated with an increased risk of poorer neonatal outcomes in all categories.

Unadjusted maternal outcomes varied by labor onset type (Table 4). Spontaneous labor had the lowest cesarean rates at each gestational age except 39 weeks, where elective induction was lower. Overall, for all gestational ages, spontaneous labor and elective induction had an 8% cesarean rate. Indicated inductions had a 24% cesarean rate. While individual gestational ages generally show higher rates of cesarean for elective induction than spontaneous labor, the overall cesarean rate for elective induction is weighted by the low cesarean rate and high volume at 39 weeks. Unlabored cesareans had higher rates of endometritis. Predictably, maternal length of stay varied significantly by labor onset type ($P < .0001$).

When maternal outcomes were adjusted for maternal age, race/ethnicity, parity, preeclampsia, chronic hypertension, diabetes, and GBS+, all induction types were associated with a higher risk of cesarean (Table 5). Spontaneous labor had the highest risk of chorioamnionitis, but indicated induction and unlabored cesarean had higher rates of endometritis. Unlabored cesarean had higher rates of maternal ICU admission. At term, elective induction was associated with an increased risk of hysterectomy (adjusted odds ratio [aOR], 3.21; 95% CI, 1.08 – 9.54) compared to spontaneous labor. Overall, unlabored cesarean was associated with an increased risk of hysterectomy (aOR, 9.06; 95% CI, 3.00 – 27.37) when compared to spontaneous labor. At term, the risks of hysterectomy were higher (aOR, 6.57; 95% CI, 1.78 – 24.30) with unlabored cesarean vs spontaneous labor. The rates of hysterectomy at 39 – 40 weeks were 0.24/10,000 with spontaneous labor, 3.9/10,000 with elective induction, 1.3/10,000 with indicated induction, and 17.4/10,000 with unlabored cesarean.

Comment

The incidence of induction has increased significantly over the past decade, prompting increased attention and criticism, especially as it relates to elective delivery for patient or physician convenience. Initially, concerns were raised over iatrogenic prematurity with inductions or cesareans <39 weeks. Our large multicenter cohort of medical records confirms other smaller, single-center studies showing that some neonatal outcomes improve until 39 weeks regardless of labor onset type. Our data suggest that neonatal outcomes are gestational age dependent regardless of labor onset type.

It is clear that an elective induction or unlabored cesarean not meeting ACOG gestational age criteria of at least 39 weeks of gestation is at increased risk of suboptimal neonatal outcome. However, given the increased utilization of elective induction, it is encouraging that within a given gestational age, elective induction of labor does not worsen neonatal outcomes. In fact, we found that infant ventilator use, sepsis, and NICU admissions were less likely with elective induction than spontaneous labor for a given gestational age.

Concerns over maternal outcomes in elective induction of labor have previously focused on length of labor and the increased risk of cesarean delivery. We chose to look at additional maternal morbidity that we believed represented more profound maternal morbidity. Elective induction was associated with a lower risk of maternal ICU admission, and unlabored cesarean was associated with an increased risk. The decreased risk of maternal ICU admission associated with elective induction is likely due to the fact that anyone with underlying comorbidity would likely be considered an indicated induction (not an elective induction). Elective inductions, by definition, occur among healthy women to start. Indicated induction, but not elective induction, was associated with an increased odds ratio for endometritis. As the induction process is similar in both populations, it is likely that some of the indicated inductions were for chorioamnionitis.

We also found that unlabored cesarean overall and elective induction at term were associated with increased risk of hysterectomy.

Our finding that hysterectomies are significantly increased in unlabored cesarean overall and term elective induction of labor is important in counseling patients about elective delivery. While much morbidity is recoverable and does not have a lasting impact on a woman's life, losing her uterus may have a profound impact on her family plans and may be weighed differently than a cesarean delivery, or a postpartum infection. The advantages of an elective delivery are the convenience of being able to plan delivery and perhaps more control over who is the delivering provider. These advantages pale in comparison to 3.21 times the risk of hysterectomy at term for an elective induction or 6.57 increased risk for unlabored cesarean at term. We recognize, however, that the association with increased hysterectomy risk is based on only 24 hysterectomies in our final dataset and that absolute rates of hysterectomy remain low. This highlights the need for large multicenter datasets such as ours to examine peripartum hysterectomies and other rare childbirth outcomes.

Our study population was designed to represent a low-risk obstetric population to represent the average-risk patient considering elective induction/cesarean delivery. Hence, we limited our dataset to vertex, singletons, without a prior uterine scar and without conditions that clearly increase risk of hemorrhage (previa and abruption). Furthermore, we tried to account for common morbidity in our model. While the percent of our population that is completely "elective" cesarean is unknown, we defined our unlabored cesarean population as those who had no induction, ≤ 2 vaginal examinations, and a cesarean for their delivery mode. Thus, it is possible we included some women in the unlabored cesarean group who in fact had cesareans after the onset of spontaneous labor or presented to labor and delivery with an immediate need for delivery such as nonreassuring fetal status. Some may have other underlying issues precluding labor predisposing them to hysterectomy, for example large obstructing fibroids. However, our multicenter dataset with predetermined data fields that contain clinical information such as reason for admission, examination on admission, number of examinations, type of medications, as well as specified maternal and neonatal outcomes is an improvement from previous single-center studies based on chart review, or multicenter studies where delivery method and patient outcomes are based on administrative data.

Although we did not report postpartum hemorrhage rates, or rates of transfusions, our findings add to the evidence that elective induction of labor increases hemorrhage risk as evidenced by increased hysterectomies. This is consistent with a recent publication from the Norway birth registry showing that hemorrhage from atony is increased with elective induction of labor.[6] The reasons for the observed increase in atony are not clear. We could speculate that inductions may have longer labors, and increase use of uterotonic agents all of which may predispose to postpartum hemorrhage.

Using EMRs for clinical research enhances efficiency in data collecting, but combining EMRs from different institutions can be difficult if data are not entered in a consistent way across sites. For example, if a clinician puts free text in a note stating the patient had a postpartum fever and endometritis, this may not be recognized as endometritis by the system if the discrete data fields "postpartum fever" or "endometritis" are not checked off or entered correctly. Similarly, our construction of the elective induction variable depends on the appropriate charting in the medical record. If a physician is inducing labor for a reason but fails to document that reason, it would be considered an unknown reason for induction and dropped from our study. It is difficult to estimate how often physicians are not documenting appropriately in the medical record in general and the EMRs in particular, as the medical record is generally considered to be the gold standard of what has happened. However, from clinical experience, it is clear that physicians do "underdocument" or do not explicitly specify all reasons for

induction. Our data suggest that this may be happening since we show a substantial number of elective deliveries <37 weeks–a time when early deliveries are more likely to be indicated. Thus, we suspect our elective induction variable likely contains some women who truly had indicated inductions of labor. This mixing of indicated and elective deliveries likely mutes the true differences between elective induction and indicated induction.

Conclusions

Some neonatal outcomes improve until 39 weeks and neonatal outcomes vary by labor onset type. Although elective delivery appears to be associated with a decreased risk of poor neonatal outcome, elective induction of labor should not be offered <39 weeks due to fetal concerns. Women should be informed that elective induction of labor may be associated with an increased risk of hysterectomy. Likewise, elective unlabored cesareans are associated with an increased risk of poor neonatal outcomes. Given that the advantages of elective delivery are primarily social or logistical and not medical, an argument could be made not to offer an elective delivery at all given the maternal risks. At minimum, patients should be well informed of the fetal and maternal risks of elective delivery.

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TABLE 1

Demographics for the whole sample by labor onset type

Variable	Spontaneous labor, n = 77,443	Elective induction of labor, n = 16,544	Indicated induction of labor, n = 17,582	Unlabored cesarean delivery, n = 3959	*P* value
Age, y[a]	26.8 (5.9)	27.7 (5.3)	27.4 (6.0)	30.1 (6.6)	< .0001
Race[b]					
White/non-Hispanic	40,799 (52.7)	12,514 (75.7)	10,099 (57.4)	2019 (51.0)	< .0001
Black/non-Hispanic	13,178 (17.0)	1825 (11.0)	3106 (17.7)	841 (21.2)	
Hispanic	15,174 (19.6)	1243 (7.5)	2970 (16.9)	660 (16.7)	
Asian/Pacific Islander	3770 (4.9)	397 (2.4)	716 (4.1)	188 (4.8)	
Other race	4522 (5.8)	565 (3.4)	691 (3.9)	251 (6.3)	
Parity[b]					
0	32,529 (42.0)	4665 (28.2)	9971 (56.7)	2530 (63.9)	< .0001
≥ 1	44,914 (58.0)	11,879 (71.8)	7611 (43.3)	1429 (36.1)	

[a] Continuous variables report means (SD);

[b] Categorical variables report frequency (percentage).

TABLE 2

Neonatal outcomes by gestational age and type of labor

		Use of ventilation			Asphyxia			Sepsis			NICU admission					
		Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Length of stay		
GA, wk	Type of onset	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	Mean	SD	*P* value
34	Spontaneous	788 (90.4)	84 (9.6)	.01	863 (99.3)	6 (0.7)	.94	759 (92.1)	65 (7.9)	.10	344 (39.4)	528 (60.6)	< .0001	6.5	8.5	< .0001
	Elective	43 (93.5)	3 (6.5)		43 (100)	0 (0.0)		42 (100)	0 (0.0)		37 (80.4)	9 (19.6)		2.5	5.5	
	Indicated	175 (88.8)	22 (11.2)		194 (99.5)	1 (0.5)		169 (91.4)	16 (8.6)		73 (37.1)	124 (62.9)		7.7	9.5	
	c/s w/o labor	97 (80.8)	23 (19.2)		119 (99.2)	1 (0.8)		103 (88.0)	14 (12.0)		28 (23.3)	92 (76.7)		13.8	18.6	
35	Spontaneous	1446 (94.4)	86 (5.6)	.0004	1518 (99.3)	11 (0.7)	.86	1426 (96.4)	53 (3.6)	.3	1035 (67.6)	497 (32.4)	< .0001	2.6	6.4	< .0001
	Elective	83 (97.6)	2 (2.4)		78 (100)	0 (0.0)		78 (100)	0 (0.0)		71 (83.5)	14 (16.5)		1.4	3.7	
	Indicated	311 (93.7)	21 (6.3)		329 (99.1)	3 (0.9)		299 (95.8)	13 (4.2)		213 (64.2)	119 (35.8)		2.7	5.2	
	c/s w/o labor	139 (86.3)	22 (13.7)		160 (99.4)	1 (0.6)		144 (95.4)	7 (4.6)		81 (50.3)	80 (49.7)		5.4	8.1	
36	Spontaneous	3115 (96.8)	102 (3.2)	.0007	3211 (99.8)	5 (0.2)	.29	3130 (98.1)	59 (1.9)	.46	2726 (84.7)	491 (15.3)	< .0001	1.1	4.4	< .0001
	Elective	172 (98.3)	3 (1.7)		172 (100)	0 (0.0)		169 (98.3)	3 (1.7)		159 (90.9)	16 (9.1)		0.7	3.0	
	Indicated	813 (96.7)	28 (3.3)		835 (99.5)	4 (0.5)		806 (98.4)	13 (1.6)		678 (80.6)	163 (19.4)		1.2	3.5	
	c/s w/o labor	238 (92.2)	20 (7.8)		257 (99.6)	1 (0.4)		247 (96.9)	8 (3.1)		168 (65.1)	90 (34.9)		2.9	6.9	
37	Spontaneous	7490 (99.2)	62 (0.8)	< .0001	7537 (99.8)	14 (0.2)	< .0001	7445 (99.0)	73 (1.0)	< .0001	7050 (93.4)	502 (6.6)	< .0001	0.3	2.2	< .0001
	Elective	581 (99.5)	3 (0.5)		578 (100)	0 (0.0)		572 (99.3)	4 (0.7)		548 (93.8)	36 (6.2)		0.2	2.6	
	Indicated	1817 (98.9)	20 (1.1)		1833 (99.9)	2 (0.1)		1814 (99.3)	12 (0.7)		1672 (91.0)	165 (9.0)		0.5	2.7	
	c/s w/o labor	459 (95.6)	21 (4.4)		471 (98.3)	8 (1.7)		453 (96.8)	15 (3.2)		381 (79.4)	99 (20.6)		2.0	7.8	
38	Spontaneous	16,661 (99.7)	42 (0.3)	.07	16,683 (99.9)	19 (0.1)	.29	16,532 (99.4)	107 (0.6)	.004	15,885 (95.1)	818 (4.9)	< .0001	0.2	1.4	< .0001
	Elective	2502 (99.8)	6 (0.2)		2502 (100)	1 (0.0)		2497 (99.9)	3 (0.1)		2433 (97.0)	75 (3.0)		0.1	1.3	
	Indicated	3212 (99.8)	8 (0.2)		3219 (100)	1 (0.0)		3188 (99.4)	18 (0.6)		3022 (93.9)	198 (6.1)		0.2	1.5	
	c/s w/o labor	1005 (99.3)	7 (0.7)		1010 (99.8)	2 (0.2)		1003 (99.8)	2 (0.2)		915 (90.4)	97 (9.6)		0.5	2.4	
39	Spontaneous	23,650 (99.8)	56 (0.2)	< .0001	23,679 (99.9)	23 (0.1)	.38	23,418 (99.4)	144 (0.6)	.0002	22,582 (95.3)	1124 (4.7)	< .0001	0.2	1.7	< .0001
	Elective	9740 (99.9)	14 (0.1)		9737 (99.9)	13 (0.1)		9723 (99.7)	27 (0.3)		9465 (97.0)	289 (3.0)		0.1	0.7	
	Indicated	3223 (99.6)	14 (0.4)		3231 (99.9)	4 (0.1)		3202 (99.8)	8 (0.2)		3040 (93.9)	197 (6.1)		0.2	2.0	
	c/s w/o labor	1153 (98.9)	13 (1.1)		1163 (99.7)	3 (0.3)		1150 (99.4)	7 (0.6)		1074 (92.1)	92 (7.9)		0.5	3.6	
40	Spontaneous	18,716 (99.8)	45 (0.2)	.0013	18,739 (99.9)	18 (0.1)	< .0001	18,514 (99.3)	127 (0.7)	.0007	17,780 (94.8)	981 (5.2)	< .0001	0.2	1.9	< .0001

		Use of ventilation			Asphyxia			Sepsis			NICU admission					
		Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Length of stay		
GA, wk	Type of onset	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	Mean	SD	*P* value
	Elective	3193 (99.7)	11 (0.3)		3198 (99.9)	3 (0.1)		3194 (99.8)	7 (0.2)		3101 (96.8)	103 (3.2)		0.1	0.9	
	Indicated	4279 (99.6)	18 (0.4)		4288 (99.8)	8 (0.2)		4246 (99.5)	21 (0.5)		4067 (94.6)	230 (5.4)		0.2	2.4	
	c/s w/o labor	555 (98.9)	6 (1.1)		556 (99.1)	5 (0.9)		548 (98.6)	8 (1.4)		505 (90.0)	56 (10.0)		0.6	3.4	
41	Spontaneous	4675 (99.6)	17 (0.4)	.69	4688 (99.9)	4 (0.1)	.89	4615 (99.3)	34 (0.7)	.007	4441 (94.7)	251 (5.3)	.0002	0.3	2.2	.02
	Elective	185 (100)	0 (0.0)		185 (100)	0 (0.0)		185 (100)	0 (0.0)		179 (96.8)	6 (3.2)		0.1	0.5	
	Indicated	3344 (99.7)	9 (0.3)		3349 (99.9)	4 (0.1)		3313 (99.3)	23 (0.7)		3157 (94.2)	196 (5.8)		0.3	2.3	
	c/s w/o labor	179 (99.4)	1 (0.6)		180 (100)	0 (0.0)		171 (97.2)	5 (2.8)		157 (87.2)	23 (12.8)		0.8	3.1	
42	Spontaneous	404 (99.0)	4 (1.0)	.79	408 (100)			401 (99.3)	3 (0.7)	.54	388 (95.1)	20 (4.9)	.09	0.2	1.1	.23
	Elective	3 (100)	0 (0.0)		3 (100)			3 (100)	0 (0.0)		3 (100)	0 (0.0)		0	0	
	Indicated	267 (99.6)	1 (0.4)		268 (100)			258 (98.1)	5 (1.9)		244 (91.0)	24 (9.0)		0.4	1.9	
	c/s w/o labor	21 (100)	0 (0.0)		21 (100)			21 (100)	0 (0.0)		18 (85.7)	3 (14.3)		0.3	1.1	

c/s, cesarean section; *NICU*, neonatal intensive care unit; *w/o*, without.

TABLE 3

Adjusted model for neonatal outcomes

Neonatal outcomes	Type of labor	Overall (34–42 wk) OR (95% CI)	Preterm (34–36 wk) OR (95% CI)	Term (37–42 wk) OR (95% CI)
Ventilation use	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.38 (0.28–0.53)	0.45 (0.22–0.92)	0.68 (0.47–0.98)
	Indicated	1.14 (0.94–1.39)	1.11 (0.83–1.48)	1.26 (0.96–1.67)
	c/s w/o labor	4.99 (4.00–6.21)	3.31 (2.43–4.51)	4.51 (3.24–6.28)
Asphyxia	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.78 (0.46–1.32)	NA	0.96 (0.56–1.64)
	Indicated	1.11 (0.71–1.73)	1.73 (0.72–4.20)	0.98 (0.58–1.66)
	c/s w/o labor	4.26 (2.59–7.01)	1.52 (0.43–5.35)	4.91 (2.85–8.44)
Sepsis	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.36 (0.26–0.49)	0.31 (0.10–0.98)	0.43 (0.31–0.60)
	Indicated	0.81 (0.67–0.99)	0.98 (0.68–1.42)	0.77 (0.61–0.98)
	c/s w/o labor	1.75 (1.34–2.29)	1.79 (1.16–2.74)	1.40 (0.98–1.99)
NICU admission	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.52 (0.48–0.57)	0.33 (0.23–0.46)	0.65 (0.59–0.71)
	Indicated	1.01 (0.94–1.07)	0.96 (0.84–1.11)	1.03 (0.96–1.11)
	c/s w/o labor	2.39 (2.18–2.63)	2.55 (2.11–3.09)	1.98 (1.76–2.23)

CI, confidence interval; *c/s*, cesarean section; *NA*, no observations in category; *NICU*, neonatal intensive care unit; *OR*, odds ratio; *w/o*, without.

Multivariable logistic model adjusted for race, maternal age, parity, preeclampsia, eclampsia, chronic hypertension, diabetes, premature rupture, and antepartum group B streptococcus.

TABLE 4

Maternal outcomes by gestational age and type of labor

		C/S			Chorioamnionitis			Endometritis			ICU admission			Hysterectomy					
		Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Length of stay		
GA, wk	Type of onset	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	Mean	SD	*P* value
34	Spontaneous	817 (93.7)	55 (6.3)	< .0001	388 (92.6)	31 (7.4)	.25	439 (99.8)	1 (0.2)	.02	676 (98.0)	14 (2.0)	.69	870 (99.8)	2 (0.2)	.05	3.3	3.7	< .0001
	Elective	38 (82.6)	8 (17.4)		7 (87.5)	1 (12.5)		2 (100)	0 (0.0)		45 (100)	0 (0.0)		46 (100)	0 (0.0)	–	5.2	7.1	–
	Indicated	144 (73.1)	53 (26.9)		121 (96.8)	4 (3.2)		97 (98.0)	2 (2.0)		173 (98.3)	3 (1.7)		197 (100)	0 (0.0)	–	6.1	6.1	–
	c/s w/o labor	0 (0.0)	120 (100)		71 (95.9)	3 (4.1)		44 (95.7)	2 (4.3)		99 (97.1)	3 (2.9)		118 (98.3)	2 (1.7)	–	6.3	4.9	–
35	Spontaneous	1451 (94.7)	81 (5.3)	< .0001	700 (97.0)	22 (3.0)	.61	726 (100)	0 (0.0)	.004	1243 (98.7)	17 (1.3)	.68	1532 (100)	–	–	2.5	2.6	< .0001
	Elective	71 (83.5)	14 (16.5)		16 (100)	0 (0.0)		6 (100)	0 (0.0)		85 (100)	0 (0.0)		85 (100)	–	–	2.8	1.5	–
	Indicated	242 (72.9)	90 (27.1)		198 (97.1)	6 (2.9)		157 (98.1)	3 (1.9)		287 (98.6)	4 (1.4)		332 (100)	–	–	4.1	2.8	–
	c/s w/o labor	0 (0.0)	161 (100)		99 (99.0)	1 (1.0)		66 (98.5)	1 (1.5)		135 (99.3)	1 (0.7)		161 (100)	–	–	5.2	4.6	–
36	Spontaneous	3003 (93.3)	214 (6.7)	< .0001	1391 (95.7)	62 (4.3)	.19	1493 (99.6)	6 (0.4)	.21	2598 (99.5)	14 (0.5)	.09	3217 (100)	–	–	2.3	2.5	< .0001
	Elective	141 (80.6)	34 (19.4)		57 (96.6)	2 (3.4)		29 (100)	0 (0.0)		175 (100)	0 (0.0)		175 (100)	–	–	2.7	1.1	–
	Indicated	621 (73.8)	220 (26.2)		460 (97.7)	11 (2.3)		376 (98.9)	4 (1.1)		741 (99.3)	5 (0.7)		841 (100)	–	–	3.4	2.5	–
	c/s w/o labor	0 (0.0)	258 (100)		168 (97.7)	4 (2.3)		126 (98.4)	2 (1.6)		217 (98.2)	4 (1.8)		258 (100)	–	–	5.0	5.9	–
37	Spontaneous	7160 (94.8)	392 (5.2)	< .0001	3085 (96.6)	108 (3.4)	.08	3300 (99.7)	10 (0.3)	< .0001	6139 (99.8)	11 (0.2)	< .0001	7550 (100)	2 (0.0)	.86	2.0	1.0	< .0001
	Elective	525 (89.9)	59 (10.1)		268 (99.3)	2 (0.7)		214 (100)	0 (0.0)		576 (99.8)	1 (0.2)		584 (100)	0 (0.0)	–	2.4	1.1	–
	Indicated	1498 (81.5)	339 (18.5)		883 (96.8)	29 (3.2)		674 (99.6)	3 (0.4)		1642 (99.2)	13 (0.8)		1836 (99.9)	1 (0.1)	–	2.8	1.7	–
	c/s w/o labor	0 (0.0)	480 (100)		311 (97.8)	7 (2.2)		235 (96.3)	9 (3.7)		403 (98.8)	5 (1.2)		480 (100)	0 (0.0)	–	3.8	2.4	–
38	Spontaneous	15,748 (94.3)	955 (5.7)	< .0001	6295 (96.3)	239 (3.7)	< .0001	7317 (99.6)	26 (0.4)	.04	12,786 (99.8)	32 (0.2)	.009	16,699 (100)	4 (0.0)	.37	2.0	1.0	< .0001
	Elective	2228 (88.8)	280 (11.2)		1272 (99.5)	7 (0.5)		1004 (99.8)	2 (0.2)		2468 (99.9)	3 (0.1)		2507 (100)	1 (0.0)	–	2.3	0.9	–
	Indicated	2624 (81.5)	596 (18.5)		1315 (97.1)	39 (2.9)		991 (99.3)	7 (0.7)		2818 (99.4)	16 (0.6)		3220 (100)	0 (0.0)	–	2.6	1.1	–
	c/s w/o labor	0 (0.0)	1012 (100)		666 (98.4)	11 (1.6)		484 (99.0)	5 (1.0)		825 (99.5)	4 (0.5)		1011 (99.9)	1 (0.1)	–	3.5	2.2	–
39	Spontaneous	22,067 (93.1)	1639 (6.9)	< .0001	9065 (95.6)	422 (4.4)	< .0001	11,691 (99.7)	37 (0.3)	< .0001	16,667 (99.7)	57 (0.3)	.009	23,706 (100)	0 (0.0)	.003	2.1	1.1	< .0001
	Elective	9181 (94.1)	573 (5.9)		1712 (97.9)	36 (2.1)		958 (99.5)	5 (0.5)		9698 (99.9)	13 (0.1)		9750 (100)	4 (0.0)	–	2	0.7	–
	Indicated	2542 (78.5)	695 (21.5)		1368 (95.0)	72 (5.0)		966 (98.9)	11 (1.1)		2775 (99.6)	11 (0.4)		3237 (100)	0 (0.0)	–	2.6	1.1	–
	c/s w/o labor	0 (0.0)	1166 (100)		749 (96.4)	28 (3.6)		408 (98.6)	6 (1.4)		967 (99.6)	4 (0.4)		1165 (99.9)	1 (0.1)	–	3.5	1.6	–
40	Spontaneous	16,924 (90.2)	1837 (9.8)	< .0001	7169 (94.4)	423 (5.6)	.83	10,110 (99.7)	32 (0.3)	< .0001	12,155 (99.7)	32 (0.3)	.04	18,760 (100)	1 (0.0)	< .0001	2.2	0.9	< .0001

		C/S			Chorioamnionitis			Endometritis			ICU admission			Hysterectomy					
		Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Frequency, n (%)			Length of stay		
GA, wk	Type of onset	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	No	Yes	*P* value	Mean	SD	*P* value
	Elective	2833 (88.4)	371 (11.6)		561 (93.7)	38 (6.3)		186 (99.5)	1 (0.5)		3185 (100)	1 (0.0)		3203 (100)	1 (0.0)	–	2.1	0.8	–
	Indicated	3168 (73.7)	1129 (26.3)		2041 (94.6)	117 (5.4)		1321 (99.8)	3 (0.2)		3613 (99.7)	11 (0.3)		4296 (100)	1 (0.0)	–	2.8	1.1	–
	c/s w/o labor	0 (0.0)	561 (100)		360 (94.0)	23 (6.0)		237 (96.0)	10 (4.0)		458 (100)	0 (0.0)		559 (99.6)	2 (0.4)	–	3.5	1.4	–
41	Spontaneous	4116 (87.7)	576 (12.3)	< .0001	1552 (93.8)	102 (6.2)	.42	3219 (99.6)	13 (0.4)	.004	2260 (99.5)	12 (0.5)	.41	4692 (100)	–	–	2.3	0.9	< .0001
	Elective	147 (79.5)	38 (20.5)		109 (94.8)	6 (5.2)		67 (100)	0 (0.0)		185 (100)	0 (0.0)		185 (100)	–	–	2.6	1.0	–
	Indicated	2401 (71.6)	952 (28.4)		1618 (93.5)	112 (6.5)		870 (99.1)	8 (0.9)		2887 (99.7)	9 (0.3)		3353 (100)	–	–	2.7	1.2	–
	c/s w/o labor	0 (0.0)	180 (100)		110 (90.2)	12 (9.8)		103 (97.2)	3 (2.8)		133 (100)	0 (0.0)		180 (100)	–	–	3.6	1.1	–
42	Spontaneous	347 (85.0)	61 (15.0)	< .0001	172 (96.1)	7 (3.9)	.77	287 (100)	0 (0.0)	.44	199 (100)	–		407 (99.8)	1 (0.2)	.87	2.3	0.9	< .0001
	Elective	3 (100)	0 (0.0)		3 (100)	0 (0.0)		3 (100)	0 (0.0)		3 (100)	–		3 (100)	0 (0.0)	–	1.3	0.6	–
	Indicated	188 (70.1)	80 (29.9)		154 (95.1)	8 (4.9)		110 (99.1)	1 (0.9)		180 (100)	–		268 (100)	0 (0.0)	–	3.1	1.3	–
	c/s w/o labor	0 (0.0)	21 (100)		17 (100)	0 (0.0)		6 (100)	0 (0.0)		19 (100)	–		21 (100)	0 (0.0)	–	3.1	0.5	–

c/s, cesarean section; *ICU*, intensive care unit; *w/o*, without.

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TABLE 5

Adjusted model for maternal outcomes

Maternal outcomes	Type of labor	Overall (34–42 wk) OR (95% CI)	Preterm (34–36 wk) OR (95% CI)	Term (37–42 wk) OR (95% CI)
c/s	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	1.62 (1.52–1.73)	3.72 (2.69–5.15)	1.58 (1.48–1.69)
	Indicated	2.92 (2.79–3.07)	4.00 (3.35–4.78)	2.86 (2.72–3.01)
	c/s w/o labor	NA	NA	NA
Chorioamnionitis	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.51 (0.41–0.64)	1.24 (0.37–4.12)	0.51 (0.41–0.63)
	Indicated	0.89 (0.79–1.00)	0.53 (0.32–0.88)	0.92 (0.81–1.05)
	c/s w/o labor	0.43 (0.34–0.53)	0.34 (0.16–0.74)	0.44 (0.35–0.56)
Endometritis	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.79 (0.38–1.62)	NA	0.77 (0.37–1.58)
	Indicated	1.99 (1.38–2.86)	7.12 (2.47–20.51)	1.71 (1.15–2.55)
	c/s w/o labor	6.16 (4.18–9.07)	14.20 (4.08–49.44)	5.90 (3.91–8.89)
ICU admission	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	0.45 (0.27–0.73)	NA	0.54 (0.33–0.89)
	Indicated	1.20 (0.89–1.61)	0.98 (0.49–1.96)	1.28 (0.92–1.78)
	c/s w/o labor	1.60 (1.00–2.56)	1.67 (0.74–3.77)	1.42 (0.79–2.56)
Hysterectomy	Spontaneous	1 (referent)	1 (referent)	1 (referent)
	Elective	2.47 (0.87–6.96)	NA	3.21 (1.08–9.54)
	Indicated	0.91 (0.19–4.26)	NA	1.16 (0.24–5.58)
	c/s w/o labor	9.06 (3.00–27.37)	15.76 (1.85–134.2)	6.57 (1.78–24.30)

CI, confidence interval; c/s, cesarean section; *ICU*, intensive care unit; *NA*, either 100% or 0% of observations in category; *OR*, odds ratio; *w/o*, without.

Multivariable logistic model adjusted for race, maternal age, parity, preeclampsia, eclampsia, chronic hypertension, diabetes, and antepartum group B streptococcus.