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Applying a physiologic partograph to Consortium on Safe Labor data to identify opportunities for safely decreasing cesarean births among nulliparous women

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Abstract

Background: The timing of hospital admission for women with spontaneous labor onset and the criteria used to assess active labor progress and diagnose labor dystocia may significantly influence women's risk for primary cesarean birth. Our aims were to assess associations of labor status at admission (i.e., preactive or active) and active labor progress (i.e., dystocic or physiologic) with oxytocin augmentation, cesarean birth, and adverse neonatal outcome rates.

Methods: A sample of low-risk, nulliparous women admitted to hospitals for spontaneous labor onset was extracted from the Consortium on Safe Labor ($n = 27\,077$). Binomial logistic regression was used to assess associations between labor classifications and outcomes.

Results: At admission, 68.0% of women were in preactive labor and 32.0% were in active labor. Cesarean rates for these groups were 18.0% and 7.2%, respectively (adjusted odds ratio [AOR] 2.69; 95% CI 2.45–2.96). Oxytocin augmentation and adverse neonatal outcomes were more likely for women admitted in preactive labor. Among women admitted in active labor, 9.3% experienced labor dystocia and 90.7% progressed physiologically. Cesarean rates for these groups were 20.4% and 5.9%, respectively (AOR 3.02; 95% CI 2.45–3.73). Nearly half of the cesareans performed for dystocia among women admitted in active labor occurred when cervical dilation was physiologic. Oxytocin augmentation and adverse neonatal outcomes were more likely when active labor was dystocic.

Conclusions: Adoption of evidence-based, standardized approaches for diagnosing active labor onset, assessing labor progress, and diagnosing dystocia may safely decrease oxytocin augmentation and cesarean birth rates in the United States.

Keywords

cesarean section; labor onset; nulliparity; oxytocin; parturition; term birth

1 | INTRODUCTION

Safely decreasing primary cesarean births is a national priority in the United States.^{1–4} Strategies to reduce cesareans are recommended by the American College of Obstetricians and Gynecologists (ACOG) and other maternal-child organizations.^{2,4,5} ACOG's recommendations include delaying labor admission for low-risk women with reassuring status until active labor begins,⁵ assessing labor progress using contemporary norms of cervical dilation, and eliminating slow but progressive progress in first stage of labor as an indication for cesarean delivery.² Establishing evidence-based definitions for labor dystocia (slow, abnormal progression of labor) is also recommended.² In contemporary practice, dystocia is the most common and subjective indication for primary cesareans, accounting for approximately half of primary cesarean births.^{6–8}

Neal and Lowe developed a physiologic partograph that packages the abovementioned ACOG recommendations into a clinical tool that provides a pictorial overview of cervical dilation during labor.^{9,10} This partograph gives clinicians a consistent, evidence-based approach to diagnosing active labor onset, assessing active labor progress, and diagnosing dystocia during the first stage of labor among nulliparous women with a term, single, vertex fetus and spontaneous labor onset. The World Health Organization recommends use of partographs to assess labor progress for women in both high- and low-income settings;¹¹ however, they are rarely used in the United States. The Neal and Lowe partograph, based on contemporary norms for cervical dilation,^{2,12} is designed for prospective use in clinical settings to safely reserve diagnoses of dystocia for nulliparous women in active labor with the slowest 10% of labor progress.⁹

Retrospectively applying ACOG recommendations for safely decreasing primary cesareans (i.e., delaying admission until active labor begins,⁵ assessing cervical dilation progress using contemporary norms,² and diagnosing labor dystocia using an evidence-based definition²) to robust data from hospitals in the United States allows for systematic evaluation of obstetrical practice patterns. Through this, we can estimate the effects of widespread implementation of ACOG recommendations. Our aims were to apply the physiologic partograph protocol to data from nulliparous women with a term, singleton, cephalic-presenting fetus from the Consortium on Safe Labor: (1) to assess associations of labor status at admission to the hospital (i.e., preactive or active labor) with oxytocin augmentation, cesarean birth, and adverse neonatal outcome rates, and (2) to assess associations of active labor progress (i.e., dystocic or physiologic progress) with oxytocin augmentation, cesarean birth, and adverse neonatal outcome rates.

2 | METHODS

A retrospective, cohort comparison design was used for this study. We used data from the Consortium on Safe Labor, a multi-site, observational cohort study conducted between 2002 and 2008 in 19 hospitals across the United States.¹³ The database includes data from women's health records including demographics, medical history, reproductive and prenatal history, labor interventions, birth outcomes, postpartum and discharge information, and newborn information. Repeated-measures, time-stamped data on labor progression (e.g., cervical dilation, cervical effacement, and fetal station) and oxytocin dosing were also included. Though Consortium on Safe Labor data were collected before current ACOG recommendations for safely decreasing primary cesareans, the overall increase in the United States cesarean rates since data collection suggests that factors affecting maternity care intervention rates from 2002–2008 likely remain relevant today. Institutional Review Board approval was obtained for secondary analyses of Consortium on Safe Labor data and all authors had data use agreements with The Eunice Kennedy Shriver National Institute of Child Health and Human Development.

Figure 1 depicts the sample selection process for this study. The sample included 27 077 nulliparous women admitted to hospitals for the indication of spontaneous labor onset with a trial of labor who gave birth to a single, cephalic-presenting fetus at or after 37.0 weeks' gestation. Women with a prior birth, preterm birth, multiple gestation, fetus in a noncephalic or unknown presentation, induction of labor, or cesarean birth without a trial of labor were excluded. Type of labor onset (i.e., spontaneous, induction, or prelabor cesarean) was identified using mutually exclusive, preexisting variables in the Consortium on Safe Labor dataset. Trial of labor was also predefined by the dataset creators as any vaginal birth or any cesarean with at least 2 sequential cervical examinations. Only women with a cervical examination performed within 1 hour of their hospital admission time were included in the final sample.

We first retrospectively determined if women were in active labor on admission to the hospital. Active labor diagnostic guidelines put forth by ACOG and the Society for Maternal-Fetal Medicine² and by the United Kingdom's National Institute for Health and Care Excellence¹⁴ were merged into a single, comprehensive active labor diagnostic guideline to overcome shortcomings of each individual guideline, described previously.¹⁵ Specifically, active labor was diagnosed when cervical dilation was (1) 4 or 5 cm at admission and immediately followed by adequate cervical change over time (i.e., 1 cm in 2 hours), or (2) 6 cm regardless of the rate of subsequent cervical change. Preactive labor was diagnosed when cervical dilation was (1) <4 cm at admission regardless of subsequent cervical change, or (2) 4 or 5 cm at admission but subsequent cervical change was <1 cm in 2 hours. Because cervical exams were rarely performed exactly 2 hours after the initial exam, slope calculations based on the exams immediately *prior to* and *after* the 2-hour time-point were used to approximate dilation at the 2-hour postadmission time point when admissions occurred at 4 or 5 cm. The average dilation slope (cm/hour) for the first 2 hours postadmission was then calculated, and women were categorized into the preactive or active labor group accordingly.

Cervical examination data for women admitted in active labor were electronically extracted and plotted on the physiologic partograph. Data for women admitted in preactive labor were not plotted on the partograph even if active labor was achieved later in labor because interventions received since admission (e.g., oxytocin augmentation) may have altered natural progression to active labor. The partograph is composed of a “Dystocia Line” and displays time (hours) on the *x*-axis and cervical dilation (cm) and fetal station on the *y*-axis (Figure 2). The first qualifying cervical dilation during active labor was plotted on the left-most point of the dystocia line at the corresponding dilation point with an “X,” fetal station was plotted with an “O,” and time of exam was entered on the time line. The initial exam time was deemed hour zero and subsequent examinations during active labor were plotted on the partograph, marking cervical change over time.

Cervical dilation progress during active labor was retrospectively categorized as either (1) *physiologic* (i.e., dilation remained left of or on the dystocia line without delay in dilation progress) or (2) *dystocic* (i.e., dilation crossed right of the dystocia line or remained left of or on the dystocia line but with >4 hour delay in cervical change from 5 cm dilation).

Frequencies and percentages were used to describe the number of women admitted before and in active labor and to categorize labor progress among women admitted in active labor (i.e., physiologic progress or dystocia). Labor interventions and birth outcomes between groups were compared using Mann-Whitney *U* tests for continuous-level data and likelihood ratio tests for categorical-level data comparisons. Binomial logistic regression was used to assess associations of labor status at admission (i.e., preactive labor relative to active labor) with oxytocin augmentation, cesarean birth, and a composite of adverse neonatal outcomes. Likewise, binomial logistic regression was used to assess associations of active labor progress categories (i.e., dystocia relative to physiologic progress) with the same outcomes. All models were adjusted for maternal age, race, maternal preexisting or antepartum health conditions (i.e., diabetes mellitus, hypertensive disorder, heart disease, renal disease, gastrointestinal disease, depression, seizure disorder, thyroid disorder, asthma, anemia, herpes, or human immunodeficiency virus), gestational age at labor admission, and epidural analgesia use. Models for cesarean birth and composite adverse neonatal outcomes were also adjusted for oxytocin augmentation and neonatal weight.

A composite of adverse neonatal outcomes was used with multivariate logistic regression modeling due to the large sample size needed to study each outcome separately. The composite variable included neonates with Apgar scores <7 at 5 minutes of life, admission to a neonatal intensive care unit, or with severe adverse outcomes (i.e., asphyxia, neonatal seizure, intracranial hemorrhage, necrotizing enterocolitis, hypoxic ischemic encephalopathy, or neonatal death). Statistical analyses were performed using IBM SPSS Statistics 24 (IBM Corporation, Armonk, NY, USA). A critical alpha of .05 was used for determining statistical significance.

3 | RESULTS

There were 27 077 nulliparous women who met inclusion criteria. The sample was predominantly white with a median age of 24 years (see Table 1). The overall cesarean rate

was 14.5% (3937/27 077). The most common indication for cesarean birth was labor dystocia, which accounted for 58.3% of cesareans (2296/3937). Two of every 3 cesareans for dystocia occurred in the first stage of labor. An abnormal or indeterminate fetal heart pattern was the cesarean indication for 28.2% of women. Less common or unspecified indications accounted for the remaining cesarean births.

Labor interventions and birth outcomes of women admitted in preactive and active labor are presented in Table 2. On admission to the hospital for the indication of spontaneous labor onset and with a subsequent trial of labor, 68.0% of women were not in active labor and 32.0% were in active labor. Women admitted to the hospital before active labor used epidural analgesia more often (66.3% vs 50.3%), had longer rupture of membrane durations (7.9 hours vs 4.0 hours), and had higher rates of intrapartum fever (9.7% vs 5.1%; Table 2). Oxytocin for augmentation of labor was more likely among women admitted to the hospital before versus in active labor (adjusted odds ratio [AOR] 2.42; 95% CI 2.29–2.57; Table 3).

Cesarean birth was 2.7-fold more likely among women admitted before active labor, relative to women admitted in active labor (18% vs 7.2%, respectively; AOR 2.69; 95% CI 2.45–2.96). Dystocia was the leading indication for cesarean in both the preactive and active labor admission groups. Postpartum blood transfusions were more common among women admitted in preactive labor and in-hospital labor duration for these women was more than 5 hours longer than for women in active labor at admission (Table 2). Adverse neonatal outcomes were also more likely among infants whose mothers were admitted before active labor (AOR 1.45; 95% CI 1.31–1.61; Table 3).

Labor interventions and birth outcomes of women with physiologic progress or dystocia after being admitted in active labor are shown in Table 2 (N = 8672). About 90.7% of women had labor progress that remained physiologic based on contemporary norms for cervical dilation and 9.3% of women experienced labor dystocia. Cesarean rates among these groups were 5.9% and 20.3%, respectively. Accordingly, the likelihood for cesarean delivery was 3- fold greater when labor progress was dystocic, as contrasted against women whose progress remained physiologic (AOR 3.02; 95% CI 2.45–3.73; Table 3). Oxytocin augmentation (AOR 2.78; 95% CI 2.37–3.25) and composite adverse neonatal outcomes (AOR 1.55; 95% CI 1.18–2.02) were also significantly more likely when active labor progress was dystocic (Table 3).

Among women admitted in active labor, there were 185 cesareans performed solely for first-stage dystocia; 48.1% (n = 89) of these occurred when cervical dilation was progressing normally according to current standards (Figure 3). Seventy-six of these 89 (85.4%) cesareans followed admissions at either 4 or 5 cm.

Body mass index values were not reported for 20.6% (5571) women in the dataset. Still, because of the association of obesity and cesarean birth,^{16–18} we reanalyzed all multivariate logistic regression models after adjusting for known body mass index values in addition to the other variables identified in Table 3. All findings and conclusions remained unchanged for all models, even with the reduced sample size.

4 | DISCUSSION

Two of every 3 low-risk nulliparous women in the Consortium on Safe Labor database who were admitted to hospitals after their labors had spontaneously begun were admitted before active labor. Women admitted before active labor onset had a significantly higher cesarean delivery rate, as compared with women admitted in active labor (18.0% vs 7.2%). These cesarean rates are remarkably similar to rates found in smaller observational studies of nulliparous women admitted before vs in active labor.^{19–21} Thus, our findings provide additional support to the ACOG recommendation to delay labor admission for low-risk women with reassuring status until active labor begins.⁵

In our retrospective, observational study, we cannot know how many women admitted in preactive labor who ultimately had a cesarean would have achieved a vaginal birth had they instead been admitted in active labor. However, among the 3311 women admitted before active labor began and who eventually delivered via cesarean, 43.9% (n = 1455) never reached 6 cm dilation. Dystocia in the first stage of labor was the documented indication for more than half of these cesareans among women never reaching 6 cm. This solidifies concern that many cesarean deliveries for slow progress among nulliparous women are performed before active labor onset.^{6–8,22} Accurate diagnosis of dystocia likely provides the best opportunity to prevent primary cesarean births and this diagnosis can only be appropriately made after a woman has entered active labor.²³ We are at a practice crossroads, wherein we know that many women with normal labor progression undergo potentially unnecessary cesarean birth simply because active labor onset and labor dystocia are diagnosed in some women whose labor progress does not meet recommended criteria.

We were unable to discern whether higher cesarean rates and more adverse neonatal outcomes occur to women admitted to hospitals before active labor because of increased exposure to the medical system²⁰ or because women who present early have a propensity for these outcomes. The possibility cannot be discounted that many women admitted to hospitals before active labor may have higher cesarean rates because physiologic changes important to successful labor are less mature.²⁴ However, our finding that 68.0% of women were not in active labor at the time of admission suggests that it is unlikely that early admission decisions are reserved only for women with inherent labor abnormalities. This supports the notion that systems factors that may affect patient outcomes should be examined, rather than exclusively examining patient factors.^{25,26}

Prospective research aimed at evaluating the effects of delaying hospital admission until active labor is needed to build on preliminary work in this area.²⁷ In the meantime, there appear to be advantages associated with waiting to admit women with reassuring status to the hospital until after active labor is diagnosed. Low-risk women in early labor with effective coping may be candidates for in-hospital early labor lounge observation or discharged home until labor becomes active.²⁸ Emerging evidence also suggests that low-risk women might be prepared antenatally to increase coping during latent labor, thus delaying hospital admission until active labor.²⁹ Finally, for women admitted before active labor for legitimate clinical rationale (e.g., maternal pain, fatigue, or anxiety), clinicians should await active labor onset before expecting progressive labor progress or diagnosing

labor dystocia. Women presenting to the hospital before active labor should be counseled on the risks of immediate admission, including more frequent oxytocin augmentation, cesarean birth, and adverse neonatal outcomes.

The timing of labor interventions for women admitted in active labor provide important and novel insights into modern obstetrical care patterns. For example, 1 in 4 nulliparous women with normal labor progress received oxytocin augmentation. It is likely that clinicians at Consortium on Safe Labor study sites used varying criteria to diagnose dystocia during data collection years (2002–2008), possibly contributing to oxytocin use as treatment for presumed slow labor progress when labor progress was physiologic based on contemporary knowledge about cervical dilation.¹² We cannot determine if women who received oxytocin during active labor and who subsequently maintained physiologic progress throughout active labor would have had abnormal labor progress had they not received oxytocin. Similarly, it cannot be known if the oxytocin received by women with physiologic progress contributed to cesareans performed for abnormal or indeterminate fetal heart tracings in this subgroup since augmentation is associated with higher risk of uterine tachysystole and subsequent fetal heart rate changes requiring intervention.³⁰

The prognosis for vaginal birth among low-risk, nulliparous women admitted in active labor in this Consortium on Safe Labor study was 92.8%. Although this vaginal birth rate is impressive, our findings suggest an opportunity for even more women to safely achieve vaginal birth. In our study, nearly half of the cesareans performed for first-stage dystocia among women admitted in active labor were performed when cervical dilation was progressing normally, and in many cases these cesareans occurred several hours before the dystocia line of the physiologic partograph could possibly be crossed (Figure 3). Allowing women evidence-based durations of time to dilate from one centimeter to the next before considering surgical intervention increases prospects for vaginal birth.

To our knowledge, our large retrospective study is the first to apply ACOG recommendations for safely decreasing primary cesareans to robust data from hospitals in the United States to systematically evaluate obstetrical practice patterns. However, there were limitations to our study. First, the Consortium on Safe Labor was an observational study from 19 hospitals across the United States with overrepresentation of urban, academic institutions. Thus, our findings may not be generalizable to nonacademic and rural hospital settings. Second, timing and frequency of cervical examinations, determinations for labor admission and interventions during labor (e.g., oxytocin augmentation), and definitions (e.g., “normal” labor progress and dystocia) were not standardized across participating institutions and perhaps not even within a single institution. Third, publications based on retrospective analyses of Consortium on Safe Labor data have significantly informed our understanding of cervical dilation patterns during labor.^{12,31–34} These data were not yet available to clinicians providing care to women during the Consortium on Safe Labor data collection period from 2002 to 2008. Finally, although we controlled our analyses for factors such as maternal age, race, preexisting and antepartum health conditions, gestational age, and others, it is possible that the groups we analyzed differed in unknown ways that may have influenced their birth outcomes.

In summary, most nulliparous women included in the Consortium on Safe Labor study were admitted to the labor unit before active labor onset according to new active labor diagnostic guidelines. These women had an increased likelihood for oxytocin augmentation, cesarean birth, and adverse neonatal outcomes. Moreover, women admitted in active labor remained at risk for cesareans for “slow progress,” even when progress was physiologic based on contemporary norms of cervical dilation represented by the physiologic partograph. Implementing evidence-based, standardized approaches for diagnosing active labor onset, assessing progress, and diagnosing dystocia may significantly and safely decrease the cesarean rate in the United States.

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FIGURE 1.
Diagram of patient selection

FIGURE 2.

Physiologic partograph with data. Data plotted on the partograph are from a 22-year-old woman at 39.6 gestational weeks with a body mass index of 23.6 at the time of her labor admission. She had no identified health conditions, did not receive oxytocin during labor, and had epidural analgesia. Labor progress remained physiologic based on contemporary norms for cervical dilatation. This woman achieved a spontaneous vaginal birth, male infant weighing 3.27 kg, Apgar scores of 9 at 1- and 5-min of life [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 3.

Time and dilation of last cervical examination among nulliparous women admitted to the hospital in active labor who had a cesarean for dystocia in the first stage of labor ($n = 185$). (●): Women admitted at 4 cm ($n = 84$); (○): Women admitted at 5 cm ($n = 27$); (◐): Women admitted at 6 cm ($n = 46$); (◑): Women admitted at 7 cm ($n = 14$); (◒): Women admitted at 8 cm ($n = 9$); (◓): Women admitted at 9 cm ($n = 5$). Cesareans among women admitted in active labor at 4 cm, the earliest active labor diagnostic point, were performed at 5 cm dilation or more because adequate cervical change over time (i.e., change to 5 cm or more in 2 h or less) was prerequisite for active labor classification in this retrospective study. Women dilated 4 cm at admission but without adequate cervical change were categorized into the preactive labor admission group [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1

Characteristics of nulliparous women from the Consortium on Safe Labor with a single, cephalic-presenting fetus at term gestation admitted to hospitals for spontaneous labor onset and with a subsequent trial of labor, United States, 2002–2008 (N = 27 077)

	No. (%) or median [5th, 95th percentile]
Demographics	
Maternal age (y)	24 [17, 35]
Race	
White, non-Hispanic	14 798 (54.7)
Black, non-Hispanic	4636 (17.1)
Hispanic	3896 (14.4)
Asian/Pacific Islander	1550 (5.7)
Other/Not reported	2197 (8.1)
Married	15 047 (55.6)
Birth admission information	
Gestational age	39.3 [37.4, 41.0]
Body mass index (kg/m ²) ^a	28.4 [22.8, 39.4]
Cervical dilation (cm)	3.0 [1.0, 7.0]
Cervical effacement (%)	90 [50, 100]
Fetal station	−1 [−3, 0]
Birth process and outcome information	
Oxytocin augmentation	11 229 (41.5)
Epidural analgesia	16 572 (61.2)
Mode of birth	
Vaginal—spontaneous	20 073 (74.1)
Vaginal—assisted	3067 (11.3)
Cesarean	3937 (14.5)
Indication for cesarean	
Dystocia—1st stage	1533 (38.9)
Dystocia—2nd stage	763 (19.4)
Abnormal/indeterminate fetal heart rate tracing	1111 (28.2)
Other ^b	530 (13.5)
Neonatal information	
Infant sex	
Female	13 208 (48.8)
Male	13 843 (51.1)
Not reported	26 (0.1)
Weight (infant) (kg)	3.29 [2.66, 4.03]

Percentages may not add to 100% due to rounding.

^aValues not reported for 20.6% (5571) of women.

^b Documented in the Consortium on Safe Labor dataset primarily as “other” although smaller proportions of these cesareans were also performed for more than one indication, chorioamnionitis, failed operative vaginal delivery, maternal hypertension, less common indications, or without a specified indication.

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Labor interventions and outcomes among nulliparous women from the Consortium on Safe Labor admitted to hospitals for spontaneous labor onset and with a subsequent trial of labor, United States, 2002–2008 (N = 27 077)

TABLE 2

	Women admitted for labor onset (N = 27 077)		Women admitted in active labor (N = 8672)	
	Admitted before active labor onset (n = 18 405) No. (%)	Admitted in active labor (n = 8672) No. (%)	Labor dystocia (n = 806) No. (%)	Physiologic labor progress (n = 7866) No. (%)
Oxytocin augmentation	8945 (48.6)	2284 (26.3)	387 (48.0)	1897 (24.1)
Epidural analgesia	12 211 (66.3)	4361 (50.3)	455 (56.5)	3906 (49.7)
Complete dilation reached	15 847 (86.1)	8312 (95.8)	688 (85.4)	7624 (96.9)
Rupture of membranes to birth duration (h)	7.9 [1.5, 21.5]	4.0 [0.4, 13.9]	6.3 [1.4, 23.6]	3.9 [0.4, 13.4]
Intrapartum fever	1779 (9.7)	446 (5.1)	87 (10.8)	359 (4.6)
Mode of birth				
Vaginal—spontaneous	12 889 (70.0)	7184 (82.8)	560 (69.5)	6624 (84.2)
Vaginal—assisted	2205 (12.0)	862 (9.9)	82 (10.2)	780 (9.9)
Cesarean	3311 (18.0)	626 (7.2)	164 (20.3)	462 (5.9)
Indication for cesarean				
Dystocia—1st stage	1348 (40.7)	185 (29.6)	96 (58.5)	89 (19.3)
Dystocia—2nd stage	565 (17.1)	198 (31.6)	35 (21.3)	163 (35.3)
Abnormal/indeterminate fetal heart rate tracing	932 (28.1)	179 (28.6)	17 (10.4)	162 (35.1)
Other ^a	466 (14.1)	64 (10.2)	16 (9.8)	48 (10.4)
Postpartum blood transfusion	631 (3.4)	170 (2.0)	20 (2.5)	150 (1.9)
Admission to birth duration (h)	10.2 [4.1, 20.8]	5.1 [0.8, 11.8]	8.9 [4.1, 16.6]	4.8 [0.7, 10.7]
Apgar score <7 at 5 min	192 (1.0)	60 (0.7)	11 (1.4)	49 (0.6)
Adverse neonatal health outcome ^b	93 (0.5)	24 (0.3)	2 (0.2)	22 (0.3)
Neonatal intensive care unit admission	1568 (8.5)	527 (6.1)	73 (9.1)	454 (5.8)

Percentages may not add to 100% due to rounding. Mann-Whitney *U* tests performed for continuous-level data comparisons due to non-normal distributions (Kolmogorov-Smirnov test for normality <.001). Likelihood ratio tests were performed for categorical-level data comparisons. NS = Not statistically significant.

^a Documented in the Consortium on Safe Labor dataset primarily as “other” although smaller proportions of these cesareans were also performed for more than one indication, chorioamnionitis, failed operative vaginal delivery, maternal hypertension, less common indications, or without a specified indication.

^b Defined as asphyxia, neonatal seizure, intracranial hemorrhage, paraventricular/intraventricular hemorrhage, necrotizing enterocolitis, hypoxic ischemic encephalopathy, or neonatal death.

Unadjusted and adjusted odds of oxytocin augmentation, cesarean birth, and composite adverse neonatal outcome among nulliparous women from the Consortium on Safe Labor admitted to hospitals for spontaneous labor, United States, 2002–2008 (N = 27 077)

TABLE 3

Group contrast	Oxytocin augmentation		Cesarean		Composite adverse neonatal outcome ^a	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^b	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^c	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^c
All women						
Preactive (n = 18 405) vs active labor (n = 8672) ^d	2.65 (2.50, 2.80)	2.42 (2.29, 2.57)	2.82 (2.58, 3.08)	2.69 (2.45, 2.96)	1.45 (1.31, 1.60)	1.45 (1.31, 1.61)
Women admitted in active labor						
Dystocia (n = 806) vs physiologic progress (n = 7866) ^e	2.91 (2.51, 3.37)	2.78 (2.37, 3.25)	4.09 (3.37, 4.98)	3.02 (2.45, 3.73)	1.62 (1.25, 2.08)	1.55 (1.18, 2.02)

^a Defined as Apgar score <7 at 5 min, admission to a neonatal intensive care unit, or adverse neonatal health outcome (i.e., asphyxia, neonatal seizure, intracranial hemorrhage, paraventricular/intraventricular hemorrhage, necrotizing enterocolitis, hypoxic ischemic encephalopathy, or neonatal death).

^b Adjusted for maternal age, race, maternal preexisting or antepartum health conditions (i.e., diabetes mellitus, hypertensive disorder, heart disease, renal disease, gastrointestinal disease, seizure disorder, thyroid disorder, asthma, anemia, herpes, or human immunodeficiency virus), gestational age at labor admission, and epidural analgesia use.

^c Adjusted for all variables listed above and oxytocin augmentation and neonatal weight.

^d Active labor at admission is the reference group.

^e Physiologic progress during active labor is the reference group.