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Can Contraction Patterns Predict Neonatal Outcomes?

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Abstract

Objective—To estimate the association between contraction patterns in labor and neonatal outcomes.

Methods—A nested case-control study within a consecutive term birth cohort included women in labor with intrauterine pressure catheters (IUPCs) who reached the second stage. Cases were women delivering neonates with composite morbidity: special care or intensive care unit admission, umbilical artery pH ≤7.1, or 5-minute Apgar <7. The control group delivered without any components of the composite morbidity. Contraction frequency, duration, relaxation time, Montevideo units (MVUs), and baseline tone in the last 30 minutes prior to delivery were compared. We used logistic regression to adjust for potential confounders and receiver operating characteristic curves to evaluate the ability of contraction parameters to predict adverse neonatal outcomes.

Results—There were 183 cases of adverse neonatal outcomes and 2,172 controls without the composite outcome. Contraction duration, relaxation time, MVUs, and baseline tone did not significantly differ between the groups. Tachysystole was more common in women with the adverse neonatal outcome (21% vs. 15%, p=0.01). A model including tachysystole, oxytocin use, and nulliparity did not adequately predict the adverse outcome (AUC=0.61).

Conclusions—Although tachysystole is associated with adverse neonatal outcomes, uterine activity cannot be used to predict neonatal outcome.

Keywords

Uterine activity; tachysystole; acidosis; umbilical artery pH; Apgar

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Introduction

As the use of continuous fetal monitoring during labor has become widespread throughout most industrialized countries over the last three decades, attention has focused on the relationship between fetal heart rate patterns and neonatal outcomes. Unfortunately, the current standards for the interpretation of intrapartum fetal monitoring have not significantly improved neonatal outcomes, and instead have led to higher rates of operative deliveries [1]. More recently, interest in the effect of uterine activity, the second component of cardiotocography, on clinical outcomes has increased.

In guidelines published by the American College of Obstetricians and Gynecologists (ACOG) on the interpretation and management of fetal monitoring, recommendations about contraction interpretation have focused on frequency. *Tachysystole*, defined as more than five contractions in a 10-minute period, averaged over a 30-minute window, is described as abnormal [2]. Interventions to reduce contraction frequency are advised, especially in cases of concurrent abnormal fetal heart rate patterns [3]. Although it is acknowledged by ACOG that “contraction frequency alone is a partial assessment of uterine activity,” recommendations regarding the role of other contraction parameters, such as duration, amplitude, Montevideo units, and relaxation time are omitted [2]. This is likely because of the extremely limited data on the relationship of these other measurements to neonatal and labor outcomes.

The purpose of this study was to examine the relationship between contraction characteristics thirty minutes prior to delivery and neonatal outcomes in women in labor at term.

Methods

This was a nested case-control study performed within a consecutive term birth cohort of women admitted in labor who reached the second stage from 2004–2008. Within the term birth cohort, only women with an intrauterine pressure catheter (IUPC) in place during the last 30 minutes of labor were included in the case-control study. Exclusion criteria included multiple gestations, non-vertex presentation, major fetal anomalies, gestational age <37 0/7 weeks, and cases of intrauterine fetal demise. Cases were defined as women delivering neonates that met the criteria for the composite neonatal morbidity outcome, defined as special care nursery or neonatal intensive care unit (NICU) admission, umbilical artery pH ≤7.1, or five-minute Apgar score <7. The components of the composite were chosen as markers of neonatal morbidity based on prior studies [4,5,6,7]. Women in the control group delivered infants without any of the components of the neonatal morbidity outcome. If data was missing regarding any of the elements of the composite outcome, then the woman was excluded from analysis (n=2). Because this was a retrospective study of minimal risk, informed consent was waived. Approval for the study was granted by the Human Research Protection Office at Washington University in St. Louis.

Detailed data regarding maternal history and demographics was obtained from the medical record and stored in a study database. Gestational age at the time of delivery was determined by reported last menstrual period, if available, and confirmed by earliest ultrasound evaluation [8]. Diabetes was defined as either pregestational or gestational diabetes, diagnosed using the National Diabetes Data group definitions [9]. Similarly, women were recorded as having hypertension if they met standard criteria for the diagnosis of chronic hypertension, gestational hypertension or preeclampsia [10,11]. Temporal information about labor management and progress was also recorded. Outcome data was obtained from the medical record including mode of delivery, indication for operative delivery, infant birth weight, and all elements of the neonatal composite morbidity including arterial cord pH, five-minute Apgar score, and special care nursery or NICU admission. Umbilical cord arterial gases are routinely sent following all deliveries at our institution. Our higher acuity nurseries consist of a NICU, which is a level IV nursery, and the special care nursery, which is a level II nursery.

Formally trained obstetric research nurses prospectively reviewed electronic fetal monitoring thirty minutes prior to delivery in all women included in this study, blind to clinical data and pregnancy outcomes. Fetal heart rate data was evaluated using ACOG endorsed definitions [2]. Contraction parameters including contraction frequency, duration, Montevideo units, baseline uterine tone, and relaxation time were recorded during the three 10-minute epochs prior to delivery using standard definitions (Table 1). The amplitude of the contractions used to calculate Montevideo units (MVUs) was determined based on the peak of the contraction, excluding the increase in recorded intrauterine pressure during maternal pushing effort. Only data obtained using an IUPC was analyzed in this study, thus if an IUPC was present for only the first two epochs and no monitor was utilized in the last 10 minutes prior to delivery, then only information from the first two epochs was considered. Contraction parameters were averaged over the total time in which data was considered for each patient, which for most participants was 30 minutes (86.1%). Electronic sensor-tip intrauterine pressure catheters (Koala Intrauterine Pressure Catheters, Clinical Innovations Inc., Murray, Utah) were placed at the discretion of the individual obstetric provider during labor. Cardiotocography data was recorded real-time using Hewlett-Packard (Models M1350B and M50XM) monitors and the generated paper fetal tracings were later reviewed by the research nurses.

Baseline maternal and labor characteristics were compared among women who had an infant with the adverse neonatal outcome and controls. Median values for continuous variables were compared using the Wilcoxon rank-sum test as the data was not normally distributed. Categorical data was compared using the Chi-square test. Contraction parameters were evaluated in bivariate analysis using the Student's *t* test to compare contraction frequency, duration, MVUs, relaxation time and baseline uterine tone in cases and controls. Rates of tachysystole and elevated baseline uterine tone (defined as average tone greater than 20 mmHg) within the groups were compared using the Chi-square test. To test the current definition of tachysystole, we performed sensitivity analyses utilizing definitions of ≥5 contractions and ≥4 contractions in 10 minutes to define excessive uterine activity. The percentage of women with average MVUs ≤200 mmHg, a cut-off used to define inadequate contractile activity during labor [12,13], was compared in the group of women with infants with the adverse neonatal outcome and controls. Similarly, rates of average MVUs >300 were compared in the groups. We used logistic regression models to adjust for relevant confounders and created prediction models which were tested using receiver operating characteristic curves. We considered an area under the curve <0.8 poorly predictive and ≥0.95 highly predictive [14]. Tests with a p-value <0.05 were considered statistically significant. Final models were developed using backwards step-wise elimination. Only significant covariates remained in the final models, which were tested for fit using the Hosmer-Lemeshow goodness-of-fit test. Finally, we explored the relationship between contraction parameters and fetal acidemia as an independent outcome. We compared contraction parameters among women who had arterial umbilical cord pH ≤7.1 and women who had an arterial cord pH >7.1. All statistical analyses were performed using STATA 10.0 (special edition, Stata-Corp, College Station, TX).

Results

Of the 5,388 women enrolled in the term birth cohort, 2,355 met inclusion criteria for this study. The primary reason for exclusion was the lack of IUPC use during the last 30 minutes of labor (n=3,022). One hundred eighty three women (7.8%) had an infant with the composite adverse morbidity including special care nursery (n=144) or NICU admission (n=9), umbilical artery pH ≤7.1 (n=34), or five minute Apgar score <7 (n=30), while in 2,172 (92.2%) women the components of the composite adverse outcome were absent in their infants. Although all women included in the study reached the second stage of labor, some women (54.3%) delivered in less than 30 minutes from the time of the cervical examination diagnosing complete dilation and therefore a portion of the analyzed data was obtained from the end of the first stage.

Maternal age, body mass index (kg/m^2), and ethnicity, were similar in cases and controls. History of prior cesarean delivery, rates of maternal complications median birth weights of the infants, also, did not significantly differ among the groups. Women with infants with the adverse neonatal outcome were as likely as women in the control group to have regional anesthesia and receive oxytocin. Women who gave birth to infants with the adverse neonatal outcome, however, were significantly more likely to have been nulliparous and have had an operative delivery. The presence of decelerations, categorized as early, variable, late and prolonged, recorded during the last 30 minutes of labor did not significantly differ among cases and controls (Table 2).

When the contraction parameters were evaluated as continuous variables, none were associated with the composite adverse neonatal outcome. However, tachysystole was more commonly found in the 30 minutes prior to delivery in women who gave birth to infants with the adverse outcome, even after adjusting for oxytocin use, nulliparity, and mode of delivery using logistic regression (aOR 1.62, 95% CI 1.11–2.37, p=0.01). The alternative definition of excessive uterine activity of ≥5 contractions in 10 minutes also was associated with the adverse outcome (aOR 1.64, 95% CI 1.18–2.27, p<0.01), while rates of contraction frequency ≥4 contractions in 10 minutes were similar in the groups (Table 3).

Multivariable logistic regression and receiver operating characteristic curves were used to evaluate the interaction of multiple contraction parameters and assess the predictive ability of the models. A model composed of tachysystole, oxytocin use and nulliparity was poorly predictive of the composite neonatal outcome, regardless of the definition of tachysystole that was utilized (AUC =0.61).

We also examined acidemia, defined as arterial umbilical cord pH ≤7.1, independently as an outcome. While tachysystole (>5 contractions/10 minutes) was common in cases of fetal acidemia, the rates of tachysystole were not significantly different than in women with normal umbilical artery pH (20.6 % compared to 15.6%, p=0.43). A predictive model that included tachysystole, oxytocin use, and nulliparity performed just as poorly as the model for the composite adverse neonatal outcome (AUC=0.62). Other contraction parameters did not significantly differ between women with umbilical artery cord pH ≤7.1 and women without evidence of fetal acidemia, except that the total relaxation time in 10 minutes was greater in cases of fetal acidemia (310 +/− 119 seconds compared to 272 +/− 89 seconds, p=0.02).

It is currently recommended that practitioners incorporate information about the fetal heart rate tracing during periods of tachysystole to guide intervention [3]. Fetal heart rate patterns were similar between the groups, with the exception of rates of tachycardia, defined as fetal heart rate >160 beats/minute (Table 4). Tachycardia was more commonly found in women with tachysystole and the adverse neonatal outcome, even after adjusting for maternal fever (≥38°C) during labor (57.6% vs. 17.3%, aOR 10.9, 95% CI 4.3–27.8).

Because operative delivery was more commonly found in the adverse outcome category, we evaluated the relationship between tachysystole and operative delivery. Tachysystole was less commonly found among those with an operative vaginal delivery (11.5% vs. 16.5%, p=0.01).

Discussion

In this case-control study, we found that uterine tachysystole, defined as >5 contractions in 10 minutes, within the 30 minutes prior to delivery was significantly associated with the composite adverse neonatal outcome at term. An alternative definition of tachysystole as ≥5 contractions in 10 minutes was also associated with the outcome. Among women with tachysystole, fetal tachycardia was the only fetal heart rate characteristic that was more common in those with the adverse neonatal outcome. Other measures of uterine activity including contraction duration, relaxation time, MVUs, and baseline uterine tone were not significantly different in cases and controls. Overall, a model incorporating uterine activity 30 minutes prior to delivery was not predictive of adverse neonatal outcomes.

Our findings show that frequency is the contraction parameter demonstrating the greatest association with neonatal outcomes in women who reach complete cervical dilation. Simpson and James previously reported that increasing contraction frequency (<5 contraction/10 minutes, vs. ≥5 contractions/10 minutes, vs. ≥6 contractions/10 minutes) was associated with decreasing mean fetal oxygen saturation during the period of assessed uterine activity [15]. Stewart et al. studied uterine activity within the first four hours of induction of labor with misoprostol. They found that while increasing contraction frequency was associated with more frequent decelerations, it was also associated with decreased cesarean delivery rate and had no effect on neonatal outcomes. However, a major limitation of the study was that the time period that was analyzed was remote from the time of delivery making the clinical interpretation of their results challenging [16].

In our study, measures of uterine activity other than tachysystole were not significantly associated with the adverse neonatal outcome. In a similar study performed by Bakker and colleagues which evaluated uterine activity in the last hour of the first stage of labor as well as the second stage, umbilical artery pH <7.11 was associated with increased contraction duration, amplitude, contraction surface, MVUs, active planimeter units, and frequency, as well as decreased relaxation time. They reported that using logistic regression contraction amplitude, surface, and high contraction frequency predicted low arterial pH [17]. Possible causes for the differences seen in our studies include the use of cumulative as well as averaged data in the Bakker study, and our use of a composite outcome to define cases and controls.

We also found that an alternative definition of tachysystole which utilized a lower threshold of uterine contraction frequency was associated with the composite adverse neonatal outcome. This finding is consistent with reports that increased contraction frequency is associated with lower fetal oxygen saturation and fetal heart rate decelerations [15,16]. However, a potential limitation of our study is that we only evaluated contractions and outcomes in women who reached the second stage of labor and that our time period of analysis was restricted to the last thirty minutes of labor. Although the evaluation of uterine activity most proximal in time to delivery likely has the greatest effect on neonatal outcomes, data regarding uterine activity in the first stage of labor and its effects on outcomes such as mode of delivery, rate of cervical change, and neonatal morbidity should be investigated prior to changing current definitions of abnormal uterine activity.

The evaluation of uterine activity in the second stage is also impacted by maternal pushing effort. While pushing has been found to have no effect on contraction duration or baseline uterine tone, it does result in increased amplitude and Montevideo units [18]. We are unsure of how other investigators of uterine activity in the second stage have addressed this issue, but we calculated Montevideo units by utilizing amplitude determined by the peak of the expected contraction shape and ignoring the sharp increases in intrauterine pressure correlating with maternal pushing effort. In our labor and delivery unit, nurses instruct women to utilize a closed-glottis technique and to voluntarily push for three 10-second periods during each contraction with a short period of rest between each of the 3 separate efforts. This technique results in a decrease of the recorded intrauterine pressure to a value that corresponds with uterine contractile force alone during the short durations of rest. It is presently unknown how changes in intrauterine pressure during maternal pushing specifically affect neonatal outcomes.. An additional limitation of our study is that we only evaluated women who had data collected with an IUPC. Although this is a source of bias, most of the contraction parameters that we assessed can only be measured with an IUPC not an external contraction monitor.

In our study, we used a composite adverse neonatal outcome because each of the components was thought to provide critical information about neonatal wellbeing. In addition, it increased our power to detect small differences in contraction parameters among cases with the adverse outcome and controls. In a post-hoc analysis, we calculated that with our given sample size, mean values of the contraction parameters observed in the control group, and assuming an alpha of 0.05 that we had over 86% power to detect a 20 mmHg difference in mean MVUs, a 0.2 contraction difference in average frequency, a 2 mmHg difference in mean baseline uterine tone, 25-second difference in mean relaxation time, and a 3-second difference in average contraction duration.

We found that tachysystole in the 30 minutes prior to delivery was significantly associated with adverse neonatal outcomes. However, we demonstrated that uterine activity is a poor predictor of neonatal outcome. We also found that a threshold of ≥5 contractions in 10 minutes was as closely associated with the composite adverse outcome as the current definition of tachysystole, which is >5 contractions in 10 minutes. Importantly, despite the association with either definition, the absolute risk of adverse outcome was low. Despite the current focus on fetal heart rate as an indicator of fetal wellbeing, uterine activity may also have an important impact on clinical outcomes. Ultimately, further investigation of the relationship between contraction parameters, fetal heart rate changes and neonatal outcomes throughout the labor process is needed to inform optimal clinical management.

References

1. Alfirevic Z, Devane D, Gyte GM. Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. Cochrane Database Syst Rev. 2006; (3):CD006066. [PubMed: 16856111]
2. ACOG Practice Bulletin No. 106: Intrapartum fetal heart rate monitoring: nomenclature, interpretation, and general management principles. Obstet Gynecol. 2009 Jul; 114(1):192–202. [PubMed: 19546798]
3. Practice bulletin no. 116: Management of intrapartum fetal heart rate tracings. Obstet Gynecol. 2010 Nov; 116(5):1232–40. [PubMed: 20966730]
4. Moster D, Lie RT, Irgens LM, Bjerkedal T, Markestad T. The association of Apgar score with subsequent death and cerebral palsy: a population-based study of term infants. J Pediatr. 2001 Jun; 138(6):798–803. [PubMed: 11391319]
5. Thorngren-Jerneck K, Herbst A. Low 5-minute Apgar score: a population-based register of 1 million term births. Obstet Gynecol. 2001 Jul; 98(1):65–70. [PubMed: 11430958]
6. Victory R, Penava D, da Silva O, Natale R, Richardson B. Umbilical cord pH and base excess values in relation to adverse outcome events for infants delivery at term. Am J Obstet Gyencol. 2004 Dec.191:2021–8.
7. Malin GL, Morris RK, Khan KS. Strength of association between umbilical cord pH and perinatal and long term outcomes: systematic review and meta-analysis. BMJ. 2010 May.340:c1471. [PubMed: 20466789]
8. ACOG Practice Bulletin No. 101: Ultrasonography in pregnancy. Obstet Gynecol. 2009 Feb; 113(2 Pt 1):451–61. [PubMed: 19155920]
9. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003 Jan; 26(Suppl 1):S5–20. [PubMed: 12502614]
10. ACOG Practice Bulletin No. 125: Chronic hypertension in pregnancy. Obstet Gynecol. 2012 Feb; 119(2 Pt 1):396–407. [PubMed: 22270315]
11. ACOG practice bulletin. Diagnosis and management of preeclampsia and eclampsia Number 33, January 2002. Obstet Gynecol. 2002 Jan; 99(1):159–67. [PubMed: 16175681]

12. Hauth JC, Hankins GD, Gilstrap LC 3rd, Strickland DM, Vance P. Uterine contraction pressures with oxytocin induction/augmentation. Obstet Gynecol. 1986 Sep; 68(3):305–9. [PubMed: 3737050]
13. ACOG Practice Bulletin Number 49, December 2003: Dystocia and augmentation of labor. Obstet Gynecol. 2003 Dec; 102(6):1445–54. [PubMed: 14662243]
14. Lasko TA, Bhagwat JG, Zou KH, Ohno-Machado L. The use of receiver operating characteristic curves in biomedical informatics. J Biomed Inform. 2005 Oct; 38(5):404–15. [PubMed: 16198999]
15. Simpson KR, James DC. Effects of oxytocin-induced uterine hyperstimulation during labor on fetal oxygen status and fetal heart rate patterns. Am J Obstet Gynecol. 2008 Jul; 199(1):34 e1–5. [PubMed: 18342288]
16. Stewart RD, Bleich AT, Lo JY, Alexander JM, McIntire DD, Leveno KJ. Defining uterine tachysystole: how much is too much? Am J Obstet Gynecol. 2012 Oct; 207(4):290 e1–6. [PubMed: 22901710]
17. Bakker PC, Kurver PH, Kuik DJ, Van Geijn HP. Elevated uterine activity increases the risk of fetal acidosis at birth. Am J Obstet Gynecol. 2007 Apr; 196(4):313 e1–6. [PubMed: 17403401]
18. Buhimschi CS, Buhimschi IA, Malinow AM, Kopelman JN, Weiner CP. Pushing in labor: performance and not endurance. Am J Obstet Gynecol. 2002 Jun; 186(6):1339–44. [PubMed: 12066119]

Table 1

Definitions of contraction parameters

Parameter	**Definition***
Frequency	Number of contractions in 10-minute period
Duration	Average time in seconds between the onset of a contraction and return to baseline uterine tone
Relaxation time	Time in seconds between the end of a contraction and the onset of the next contraction summed over a 10-minute period
Montevideo units	Average contraction amplitude in a 10-minute period multiplied by the number of contractions in that period
Baseline uterine tone	Average intrauterine pressure in mmHg between contractions

*All values averaged over 30 minutes, or amount of time an IUPC was used to measure contractions in the last 30 minutes in labor.

Table 2

Comparison of baseline characteristics of cases and controls

	Adverse neonatal outcome* **n= 183**	**Absence of adverse neonatal outcome*** **n= 2172**	**p**
Median maternal age	4.3 +/− 1.1	4.2 +/− 1.0	0.06
Nulliparous	103 (56.3)	877 (40.4)	<0.01
Median gestational age at delivery	39 (38–40)	39 (38–40)	0.44
BMI			0.37
BMI <25.0	14 (7.9)	241 (11.4)	
BMI 25.1–29.9	44 (24.7)	574 (27.0)	
BMI 30–39.9	93 (52.2)	993 (46.7)	
BMI ≥40	27 (15.2)	317 (14.9)	
Race			0.73
White	33 (18.0)	344 (15.8)	
Black	136 (74.3)	1650 (76.0)	
Other	14 (7.7)	178 (8.2)	
Regional anesthesia	178 (97.3)	2050 (94.4)	0.10
History of prior cesarean	21 (11.5)	177 (8.2)	0.12
Oxytocin use	153 (83.6)	1691 (77.9)	0.07
Median birth weight	3285 (2995–3600)	3242.5 (2950–3545)	0.13
Diabetes	4 (2.2)	89 (4.2)	0.24
Hypertension (any)	29 (15.9)	310 (14.3)	0.56
Type of operative delivery			<0.01
SVD	137 (74.9)	1837 (84.6)	
Vacuum	29 (15.8)	242 (11.1)	
Forceps	6 (3.3)	70 (3.2)	
Cesarean	11 (6.0)	23 (1.1)	
Indication for operative delivery			0.38
Non-reassuring fetal status	28 (60.9)	232 (69.3)	
Arrest	5 (10.9)	37 (11.0)	
Other	13 (28.2)	65 (19.4)	
Not documented	0 (0)	1 (0.3)	
Presence of decelerations during last 30 minutes of labor			
Any	179 (97.8)	2121 (97.7)	0.89

	Adverse neonatal outcome* **n= 183**	**Absence of adverse neonatal outcome*** **n= 2172**	**p**
Early	6 (3.3)	63 (2.9)	0.77
Variable	165 (90.2)	2011 (92.6)	0.23
Late	132 (72.1)	1436 (66.1)	0.10
Prolonged	102 (55.7)	1111 (51.2)	0.23

*Data presented as n (%) except continuous variables which are presented as median (interquartile range)

Table 3

Comparison of contraction parameters in cases and controls

	Adverse neonatal outcome* n= 183	Absence of adverse neonatal outcome* n= 2172	OR (95% CI)	p	aOR (95% CI)	p
Frequency						
Average contraction frequency	4.3 +/− 1.1	4.2 +/− 1.0	-	0.26	-	-
% of women with >5 contractions/10 minutes†	39 (21.3)	331 (15.2)	1.51 (1.01–2.21)	0.03	1.62 (1.11–2.37)	0.01
% of women with ≥5 contractions/10 minutes†	63 (34.4)	553 (25.5)	1.54 (1.10–2.14)	0.01	1.64 (1.18–2.27)	<0.01
% of women with ≥4 contractions/10 minutes†	118 (64.5)	1469 (68.9)	0.82 (0.59–1.14)	0.22	0.90 (0.65–1.24)	0.51
Duration						
Average duration of contractions (sec)	81 +/− 13	83 +/− 13	-	0.16	-	-
Relaxation time						
Average relaxation time (total sec in 10 min)	283 +/− 102	271 +/− 88	-	0.08	-	-
Montevideo units (mmHg)						
Average Montevideo units	200 +/− 89	208 +/− 87	-	0.22	-	-
% of women with average Montevideo units ≤200†	95 (41.9)	997 (45.9)	1.27 (0.93–1.73)	0.12	1.21 (0.89–1.65)	0.22
% of women with average Montevideo units >300‡	27 (14.8)	306 (14.1)	1.06 (0.66–1.63)	0.80	1.02 (0.66–1.57)	0.92
Baseline tone (mmHg)						
Average baseline uterine tone +/− SD	24.7 +/− 8.4	23.6 +/− 8.1	-	0.08	-	-
% of women with average baseline tone > 20 mmHg†	130 (71.0)	1431 (65.9)	1.27 (0.90–1.81)	0.16	1.23 (0.88–1.72)	0.23

*Data presented as n (%) except continuous variables which are presented as mean +/− standard deviation

†Adjusted for oxytocin use, nulliparity, and mode of delivery

‡Adjusted for nulliparity, and mode of delivery

Table 4

Comparison of fetal heart rate (FHR) characteristics in women with tachysystole with and without the adverse neonatal outcome*

FHR characteristic	Tachysystole + Adverse Neonatal Outcome† n=39	Tachysystole + *Absent* Adverse Neonatal Outcome† n=331	OR	p
NICHD Category I	0 (0)	4 (1.2)	-	-
NICHD Category II	39 (100)	325 (98.2)	-	-
NICHD Category III	0 (0)	2 (0.6)	-	-
Moderate variability	17 (43.6)	160 (48.3)	0.83 (0.40–1.70)	0.57
Median variable decelerations	5 (3–7)	5 (2–7)	-	0.95
Median late decelerations	2 (0–3)	1 (0–2)	-	0.19
Median prolonged decelerations	1 (0–2)	1 (0–1)	-	0.12
Baseline tachycardia	19 (57.6)	48 (17.3)	6.50 (2.85–14.97)	<0.01
Baseline bradycardia	0 (0)	6 (1.8)	-	-

*All definitions based on guidelines from the 2008 workshop sponsored by the National Institute of Child Health and Human Development (NICHD), the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine.[5]

† Data presented as n (%) except continuous variables which are presented as median (interquartile range)