OBSTETRICS

Recognition and response to electronic fetal heart rate patterns: impact on newborn outcomes and primary cesarean delivery rate in women undergoing induction of labor

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OBJECTIVE: The objective of the study was to examine the clinical impact of specific fetal monitoring-related practices during induced labor.

STUDY DESIGN: This was a prospective, nonrandomized study.

RESULTS: We studied 14,398 women undergoing oxytocin induction of labor. A decrease in the infusion rate of oxytocin in the face of specified category II fetal heart rate tracings was associated with a significantly reduced rate of neonatal intensive care unit admission (3.8% vs 5.2%, $P = .01$) and Apgar score less than 7 at 1 and 5 minutes (4.9% vs 6.4%, $P = .01$, 0.6% vs 1.1%, $P = .04$). Compliance with an in-use checklist was associated with both a reduction in the rate of neonatal intensive care unit admission (2.9 vs 4.4, $P = .00$) and a reduction in the cesarean delivery rate (15.8% vs 18.8%, $P = .00$).

CONCLUSION: Electronic fetal heart rate monitoring improves neonatal outcomes when unambiguous definitions of abnormal fetal heart rate and tachysystole are coupled with specific interventions. Utilization of a checklist for oxytocin monitoring is associated with improved neonatal outcomes and a reduction in the cesarean delivery rate.

Key words: fetal heart rate monitoring, oxytocin, patient safety

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Perhaps no subject in obstetrics has been associated with as much confusion and controversy as the value of electronic fetal heart rate monitoring (EFHRM). Despite well-designed basic science investigations into the physiology underlying standard fetal heart rate (FHR) patterns (variability, accelerations, and decelerations), these observations have not translated into measureable positive impacts on newborn outcomes but have contributed significantly to the cesarean delivery rate.[1-4] Although agreement with this assessment is nearly universal, the origins of this disconnect remain obscure.

If there is a subject that rivals EFHRM in controversy, it may be the use of oxytocin to stimulate labor. Although few would question the benefit of oxytocin to carefully selected patients when this drug is appropriately administered and monitored, ideal rates of infusion, definitions of hyperstimulation or tachysystole, and proper clinical endpoints for a reduction or discontinuation of oxytocin infusion based on fetal response to induced uterine contractions remain uncertain.[5-9]

We sought to investigate the impact of several areas of clinical assessment and practice related to oxytocin infusion and FHR monitoring on neonatal outcomes and the cesarean delivery rate.[9] Our principal focus involved the impact of the identification and reaction to select category II FHR patterns and the uterine tachysystole in women undergoing the oxytocin induction of labor.

Materials and Methods

The Hospital Corporation of America is the nation's largest provider of inpatient health care, including deliveries. The 110 affiliated hospitals with obstetric and newborn services in 21 states have an annual delivery volume of approximately 207,000, representing 5-6% of all deliveries in the United States. Demographic representation (both ethnic and payer mix) has been shown to mirror that of the US population as a whole.[10-12]

The study population was singleton, term fetuses (gestation of $\geq$37 weeks) undergoing an induction of labor with oxytocin. Based on the annual delivery volume of each facility, we determined a sample size that would represent a statistically representative proportion of the entire population, using the Cochran's sample size formula set for a 5% maximum error.[13,14] All patient charts meeting the previously mentioned inclusion criteria were examined sequentially in a prospective manner beginning April 1, 2013, until the requisite sample

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size was reached. All chart reviews were completed by Sept. 30, 2013.

Each chart was individually reviewed by a regional nurse who was certified as an FHRM instructor by the Association of Women's Health, Obstetric, and Neonatal Nurses. For each 30 minute segment of fetal heart rate tracing (FHRT) in which oxytocin was being infused, the FHR tracing was examined and data concerning the practices specified in Table 1 were collected. A chart was considered compliant if practices 1-3 (Table 1) were documented for the labor in question prior to oxytocin infusion. Demonstration of practices 4-6 (Table 1) was required in each applicable 30 minute segment to qualify as compliant.

Each of these practices has been recognized in the existing literature as a potentially important contributor to safe peripartum care, although the quality of supporting evidence varies.[2,5,6,7,9,15-21] Details of the checklists referred to in Tables 1 and 2 have been previously published.[9] Of note, for items 5 and 6 (Table 1), it is suggested that unless each checklist element is present, the oxytocin dose should be reduced.

In addition, the outcomes data specified in Table 3 were collected for each patient. We then compared clinical outcomes among patients in whom each practice was followed with those among patients in whom these practices were not followed.

All data were submitted directly from the local site chart reviewer to an independent entity not affiliated with the Hospital Corporation of America (The Sullivan Group, Oakbrook Terrance, IL) for data compilation and statistical analysis. Composite system data and associated statistical evaluation were then made available to the authors and are presented here. Individual facility performance data were made available to local clinical and administrative leaders at these hospitals for quality improvement purposes.

Two-way contingency analysis was performed using a Fisher exact test, with a value of $P < .05$ considered significant. Number-needed-to-treat (NNT) calculations were performed using the standard formula of $NNT = 1/f_a - f_b$ where f_a and f_b represent the frequency of adverse outcome with or without a reduction in the dose of oxytocin.[22]

Because this project involved only examination of deidentified aggregate data for quality improvement purposes, it was exempt from institutional review board approval based on 45CFR46.101(b)(2) and 46.102(f) as well as 45CFR164.514(a)-(c) of the Health Insurance Portability and Accountability Act.

Results

During this study period, 14,398 charts were prospectively examined as outlined in the previous text. Data regarding each of the specific practices described in Table 1 and associated clinical outcomes described in Table 3 are presented in Table 2 and Figures 1 and 2. There was a significant correlation between a reduction in the dose of oxytocin based on the identification of specified abnormal FHR patterns (Table 1) and all indicators of improved newborn outcome (Table 2).

There was a similar significant reduction in neonatal intensive care unit (NICU) admissions when the oxytocin infusion rate was reduced in the face of uterine tachysystole. There was an inconsistent relationship between compliance with other individual practices and clinical outcomes (Table 2). Notably, however, compliance with all practices described in the in-use checklist was cumulatively associated with both a significant reduction in NICU admission and a reduction in the cesarean delivery rate in this population (Table 2).

Comment

Our data demonstrate several important points.

1. Patients in whom the specified abnormal fetal heart rate and/or uterine contraction patterns were identified and acted upon with a reduction in oxytocin dose experienced fewer low 1 and 5 minute Apgar scores and fewer newborn intensive care unit admissions than the control group. This represents the first presentation of data demonstrating improvement in neonatal outcomes with the use of EFHRM. These findings stand in contrast to several previous reports comparing EFHRM with intermittent auscultation.[3,4,23-27] A consideration of the differences in study design clarifies the reason for these different findings.

   Most studies comparing EFHRM to intermittent auscultation were designed with the assumption that those clinicians interpreting and acting upon the information gleaned from EFHRM were interpreting and acting correctly. Yet no attempt was made to validate these assumptions; in fact, no unambiguous definition

TABLE 1
Clinical practices examined and current level of evidence[a]

1. Estimated fetal weight prior to induction (level III).
2. Clinical assessment of pelvic adequacy prior to induction (level III).
3. Completion of a safety checklist prior to induction[9] (level III).
4. Completion of a safety checkist every 30 minutes during induction[9] (level III).
5. Number of 30 minute intervals in which specified FHRT elements were not present and oxytocin infusion rate was decreased (level III).[a]
6. Number of 30 minute intervals in which specified uterine contraction elements were not present and oxytocin infusion rate was decreased (level II-2).[b]

FHRT, fetal heart rate tracing.

[a] At least 1 acceleration of 15 bpm × 15 seconds in 30 minutes is observed, or adequate variability is present for 10 of the previous 30 minutes; no more than 1 late deceleration occurred in the previous 30 minutes; no more than 2 variable decelerations exceeding 60 seconds in duration and decreasing greater than 60 bpm from the baseline occurred within the previous 30 minutes[9]; [b] no more than 5 uterine contractions in 10 minutes for any 20 minute interval; no 2 contractions greater than 120 seconds; duration; uterus palpates were soft between contractions[9]; if intrauterine pressure catheter is in place, Montevideo units must calculate less than 300 mm Hg and the baseline resting tone must be less than 25 mm Hg.

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