JAMA Network Open

Invited Commentary | Obstetrics and Gynecology

Electronic Fetal Monitoring—Imperfect but Opportunities for Improvement

Aaron B. Caughey, MD, PhD

+ Related article

Author affiliations and article information are listed at the end of this article.

Being born is one of the riskiest endeavors that most of us have undertaken. For example, the risk of dying or developing cerebral palsy ranges from 1 in 500 to 1 in 1000 associated with events around the time of birth. Electronic fetal monitoring was specifically developed to reduce the risk of cerebral palsy. While an initial study of electronic fetal monitoring reported a reduction in neonatal seizures,[1] a follow-up study did not find similar reductions in cerebral palsy.[2] Furthermore, because it appears that only approximately 25% to 35% of cases of cerebral palsy are associated with intrapartum events,[3] a modified goal would be to reduce the risk of neonatal encephalopathy or metabolic acidemia, 2 relatively common precursors of cerebral palsy associated with birth asphyxia.

Over the past 2 decades there have been efforts to refine how electronic fetal monitoring may reduce perinatal asphyxia. The Fetal Pulse-Oximetry Trial randomized approximately 1000 laboring women to a fetal oxygen saturation assessment vs standard fetal monitoring and found no differences in neonatal acidemia.[4] The STAN fetal heart monitor (Neoventa Medical) trial randomized more than 11 000 women to a new tool that analyzed the fetal electrocardiogram ST wave form vs standard fetal monitoring and again found no differences.[5] Another recent study[6] randomized more than 45 000 laboring women to receive care that was augmented by a computer algorithm and support tool designed to both identify abnormal fetal heart rate tracings and provide standardized care plans to the clinicians. This study found no difference in worse neonatal outcomes (0.7% in each group) between the computer-supported care group or the usual care group. Of note, while there was no difference in outcomes between the groups, clinicians were not blinded regarding the study, and the overall rates of both perinatal mortality and neonatal encephalopathy were lower than had been estimated by prestudy institutional data. Because the clinicians in the study were trained in the use of the algorithm, these data suggest that outcomes were associated with improved training and algorithmic approaches, even if not demonstrated by the comparative portion of the study. Additionally, in both groups of the study, 38% of the time when the computer identified abnormal fetal heart rate readings that would have resulted in changes from a care algorithm, the clinicians did not engage in the change in care.

Thus, there are multiple opportunities to use electronic fetal monitoring in the context of neonatal encephalopathy: (1) there must be identifiable events that can be detected by continuous electronic fetal monitoring; (2) the events must be interpretable by clinicians; (3) there need to be practice changes that clinicians can engage in that prevent the progression to fetal acidemia; and (4) the consequences must be substantial enough to prevent the fetal or neonatal injury. There appear to be limitations for each of these steps.

Farquhar and colleagues[8] designed a case-control study to examine whether abnormal readings can be identified on the continuous fetal heart rate monitoring strip, also known as a cardiotocograph (CTG).[8] The cases were all of neonatal encephalopathy in which there was at least 1 hour of CTG available in the penultimate hour before delivery. The authors excluded cases that included an acute peripartum event immediately prior to delivery as well as cases with a likely source of the neonatal encephalopathy that preceded the labor and delivery. The controls were selected at random from a cohort of infants born in 2010 to 2011 at 1 tertiary hospital in New Zealand for an unrelated study of cord lactate. The CTGs accompanied by a modest amount of clinical data were evaluated by 10 clinicians (5 obstetricians and 5 midwives) in New Zealand. Clinician assessors were blinded to outcomes and were informed that in the study was a quality improvement project. They were

instructed to identify abnormal or suspicious tracings that were clearly defined and to identify cases in which they believed immediate action was called for.

Ultimately, 75% of the cases of neonatal encephalopathy were identified as having abnormal CTG readings by the assessors, with the specificity for the controls being 67%. However, when the assessors were asked to identify cases that required immediate action, only 41% of cases were identified, although the specificity was higher at 87%. These numbers are not that different from those from a similarly designed study that found that 46% of neonates with metabolic acidemia would have been delivered via operative delivery if a fetal heart rate monitoring algorithm was applied.[7]

One response to a study like this is to point out the limitations of fetal heart rate monitoring – it is an imperfect tool. However, if fetal heart rate monitoring is used judiciously, there appears to be opportunity to improve outcomes. While not all of the neonatal encephalopathy cases could be identified, most could, and there are a number of opportunities in clinical care outcomes associated with repetitive or prolonged fetal heart rate decelerations. Reviewing the large trials mentioned previously that found no difference, one wonders whether the biggest issues is not the imperfect identification of fetal hypoxia and acidemia but, rather, how clinicians react when faced with abnormal fetal heart rate tracings. In both studies that attempted to identify features of the abnormal fetal heart rate tracing, there were significant opportunities for improvement. It is notable, however, in the study of computer algorithms, that approximately 40% of the time, clinicians chose to ignore the proposed clinical plan from the algorithm.

Ultimately, while we need to improve our ability to identify and anticipate fetal hypoxia and acidemia, as clinicians, we likely have many tools already at our disposal to decrease fetal heart rate decelerations, manage the throughput on labor and delivery, reduce barriers to a rapid delivery when indicated, and ensure that rapid anesthesia care and neonatal resuscitation are available. All of these approaches could be standardized to protocol and studied to ascertain which of them will be associated with reduced neonatal encephalopathy. Such studies will be challenging to design and expensive to fund. But don't we owe this work to reduce the risks associated with being born to millions of babies born each year in the United States and around the world?

ARTICLE INFORMATION

Published: February 19, 2020. doi:10.1001/jamanetworkopen.2019.21352

Corresponding Author: Aaron B. Caughey, MD, PhD, Department of Obstetrics and Gynecology, Oregon Health & Science University, 3181 SW Sam Jackson Park Rd, Portland, OR 97219 (caughey@ohsu.edu).

Author Affiliation: Department of Obstetrics and Gynecology, Oregon Health & Science University, Portland.

Conflict of Interest Disclosures: None reported.

REFERENCES

1. MacDonald D, Grant A, Sheridan-Pereira M, Boylan P, Chalmers I. The Dublin randomized controlled trial of intrapartum fetal heart rate monitoring. *Am J Obstet Gynecol*. 1985;152(5):524-539. doi:10.1016/0002-9378(85)90619-2

2. Grant A, O'Brien N, Joy MT, Hennessy E, MacDonald D. Cerebral palsy among children born during the Dublin randomised trial of intrapartum monitoring. *Lancet*. 1989;2(8674):1233-1236. doi:10.1016/S0140-6736(89)91848-5

3. Gilbert WM, Jacoby BN, Xing G, Danielsen B, Smith LH. Adverse obstetric events are associated with significant risk of cerebral palsy. *Am J Obstet Gynecol*. 2010;203(4):328.e1-328.e5. doi:10.1016/j.ajog.2010.05.013

4. Garite TJ, Dildy GA, McNamara H, et al. A multicenter controlled trial of fetal pulse oximetry in the intrapartum management of nonreassuring fetal heart rate patterns. *Am J Obstet Gynecol*. 2000;183(5):1049-1058. doi:10.1067/mob.2000.110632

5. Belfort MA, Saade GR, Thom E, et al; Eunice Kennedy Shriver National Institute of Child Health and Human Development Maternal–Fetal Medicine Units Network. A randomized trial of intrapartum fetal ECG ST-segment analysis. *N Engl J Med*. 2015;373(7):632-641. doi:10.1056/NEJMoa1500600

6. INFANT Collaborative Group. Computerised interpretation of fetal heart rate during labour (INFANT): a randomised controlled trial. *Lancet*. 2017;389(10080):1719-1729. doi:10.1016/S0140-6736(17)30568-8

7. Clark SL, Hamilton EF, Garite TJ, Timmins A, Warrick PA, Smith S. The limits of electronic fetal heart rate monitoring in the prevention of neonatal metabolic acidemia. *Am J Obstet Gynecol*. 2017;216(2):163.e1-163.e6. doi:10.1016/j.ajog.2016.10.009

8. Farquhar CM, Armstrong S, Masson V, Thompson JMD, Sadler L. Clinician identification of birth asphyxia using intrapartum cardiotocography among neonates with and without encephalopathy in New Zealand. *JAMA Netw Open*. 2020;3(2):e1921363. doi:10.1001/jamanetworkopen.2019.21363