Electronic fetal heart rate monitoring and its relationship to neonatal and infant mortality in the United States

Han-Yang Chen, MS; Suneet P. Chauhan, MD; Cande V. Ananth, PhD, MPH; Anthony M. Vintzileos, MD; Alfred Z. Abuhamad, MD

OBJECTIVE: To examine the association between electronic fetal heart rate monitoring and neonatal and infant mortality, as well as neonatal morbidity.

STUDY DESIGN: We used the United States 2004 linked birth and infant death data. Multivariable log-binomial regression models were fitted to estimate risk ratio for association between electronic fetal heart rate monitoring and mortality, while adjusting for potential confounders.

RESULTS: In 2004, 89% of singleton pregnancies had electronic fetal heart rate monitoring. Electronic fetal heart rate monitoring was associated with significantly lower infant mortality (adjusted relative risk, 0.75); this was mainly driven by the lower risk of early neonatal mortality (adjusted relative risk, 0.50). In low-risk pregnancies, electronic fetal heart rate monitoring was associated with decreased risk for Apgar scores <4 at 5 minutes (relative risk, 0.54); in high-risk pregnancies, with decreased risk of neonatal seizures (relative risk, 0.65).

CONCLUSION: In the United States, the use of electronic fetal heart rate monitoring was associated with a substantial decrease in early neonatal mortality and morbidity that lowered infant mortality.

Key words: Apgar score, electronic fetal heart rate monitoring, infant mortality, neonatal mortality, neonatal seizure

Cite this article as: Chen H-Y, Chauhan SP, Ananth CV, et al. Electronic fetal heart rate monitoring and its relationship to neonatal and infant mortality in the United States. Am J Obstet Gynecol 2011;204:491.e1-10.

During labor electronic fetal monitoring (EFM) is used to assure well-being because the inexplicable interplay of antenatal complications, inadequate placental perfusion, and intrapartum events can lead to adverse outcomes.[1] Even uncomplicated pregnancies are monitored for asphyxial injury and intrapartum death.[2,3] Indeed, EFM during labor is the most common obstetric procedure in the United States.[1] From 1997 to 2003 in the United States, EFM was used in 84% of the over 27 million births.[4-10]

★ EDITORS' CHOICE ★

Despite the ubiquitous use, there are concerns about the efficacy of EFM. As noted by the American College of Obstetricians and Gynecologists (ACOG) practice bulletin,[1] the efficacy of monitoring is adjudicated by comparing the neonatal morbidity, including seizure and cerebral palsy, or mortality averted vs the unnecessary interventions (operative vaginal or cesarean delivery) undertaken. Because all the randomized clinical trials (RCTs) with EFM compare it with intermittent auscultation (IA), the efficacy is determined by calculating the relative risk (RR) of interventions, neonatal seizure, cerebral palsy, or death. Compared with IA, EFM is associated with a significantly increased likelihood of operative vaginal delivery, overall cesarean delivery, as well as with nonreassuring fetal heart rate tracing or fetal acidosis. Though the use of EFM and intrapartum interventions significantly decreases the rate of neonatal seizures, its use is not associated with a significantly lower rate of cerebral palsy or of neonatal death.[1] A recent Cochrane review by Alfirevic et al[11] reported that EFM was associated with 1 additional cesarean - delivery for every 58 women monitored continuously and 661 women would have to have EFM during labor to prevent 1 neonatal seizure.

Although the efficacy of EFM is debatable, it is noteworthy that there are some concerns[11] regarding the 12 RCTs, which sampled 37,000 women. Only 2 of these trials are of high quality,[12,13] and only 3 trials reported data in low-risk women.[12-14] The risk of cerebral palsy was ascertained in one trial,[15] which randomized newborn infants at <32 weeks and risk of hypoxic ischemic encephalopathy by another.[16] The combined sample size of 12 RCTs is insufficient to determine

From the Center for Urban Population Health, Milwaukee, and the School of Medicine and Public Health (Mr Chen), University of Wisconsin–Madison, Madison, WI; the Department of Obstetrics and Gynecology (Drs Chauhan and Abuhamad), Eastern Virginia Medical School, Norfolk, VA; the Department of Obstetrics and Gynecology (Dr Ananth), College of Physicians and Surgeons, Columbia University, New York, NY; and the Department of Obstetrics and Gynecology (Dr Vintzileos), Winthrop University Hospital, Mineola, NY.

Presented, in part, during the oral session at the 31st Annual Meeting of the Society for Maternal-Fetal Medicine, San Francisco, CA, Feb. 7-12, 2011.

Received Jan. 18, 2011; revised March 22, 2011; accepted April 13, 2011.

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TABLE 1
Sample characteristics

Characteristics	Total live births (n = 1,732,211)	Mortality			
		Early neonatal (n = 1568)	Late neonatal (n = 919)	Post-neonatal (n = 2927)	Infant (n = 5414)
Mother's age, y					
<20	11% (196,225)	17% (266)	20% (186)	21% (624)	20% (1076)
20–34	76% (1,322,142)	71% (1120)	70% (644)	72% (2097)	71% (3861)
≥35	12% (213,844)	12% (182)	10% (89)	7% (206)	9% (477)
Mother's race/ethnicity					
White/non-Hispanic	63% (1,090,445)	49% (755)	50% (457)	53% (1551)	51% (2763)
Black/non-Hispanic	16% (281,740)	34% (523)	33% (303)	31% (915)	32% (1741)
Hispanic	14% (247,710)	13% (195)	13% (121)	10% (298)	11% (614)
Other/non-Hispanic	6% (99,235)	5% (80)	4% (33)	5% (146)	5% (259)
Mother's marital status					
Nonmarried	37% (635,672)	53% (836)	58% (532)	63% (1832)	59% (3200)
Married	63% (1,096,539)	47% (732)	42% (387)	37% (1095)	41% (2214)
Mother's education					
Less than high school	19% (332,758)	26% (392)	29% (255)	35% (1022)	32% (1669)
High school completed	30% (515,557)	36% (545)	37% (326)	36% (1051)	36% (1922)
Above high school	50% (863,027)	37% (561)	35% (309)	28% (821)	32% (1691)
Use of tobacco					
No	89% (1,528,545)	85% (1313)	76% (696)	72% (2089)	77% (4098)
Yes	11% (194,339)	15% (233)	24% (218)	28% (806)	23% (1257)
Use of alcohol					
No	99% (1,710,120)	98% (1519)	98% (897)	98% (2855)	98% (5721)
Yes	1% (12,457)	2% (25)	2% (18)	2% (46)	2% (89)
Infant sex					
Female	49% (847,007)	41% (636)	40% (371)	41% (1188)	41% (2195)
Male	51% (885,204)	59% (932)	60% (548)	59% (1739)	59% (3219)
Electronic fetal monitoring					
No	11% (195,940)	21% (324)	12% (112)	12% (349)	14% (785)
Yes	89% (1,536,271)	79% (1244)	88% (807)	88% (2578)	86% (4629)

Data presented as % (n).

Chen. Electronic fetal monitoring and mortality. Am J Obstet Gynecol 2011.

whether EFM can significantly lower neonatal mortality. Alfirevic et al[11] noted that to test the hypothesis that continuous monitoring can prevent 1 death in 1000 births, more than 50,000 women need randomization. In addition, there are concerns that a metaanalysis that combines results of RCTs published before the introduction of the CONSORT (Consolidated Standards of Reporting Trials) guidelines[17] or with inadequate study sample size may not reflect the outcomes in actual practice.[18] Thus, we sought to determine the efficacy of EFM by comparing the outcomes among women who were vs were not monitored electronically during labor.

The primary objective of this study was to examine the association between EFM during labor and corrected neonatal and infant mortality in the United States. The secondary objectives were to assess the relative risk of operative vaginal delivery or primary cesarean delivery as well as neonatal morbidity (Apgar score <4 at 5 minutes or neonatal seizures) by EFM status.

Materials and Methods

We used the US 2004 birth cohort linked birth/infant death dataset assembled by the National Center for Health Statistics.