



**Electronic fetal monitoring, cerebral palsy, and our epidemic  
of cesarean births**

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3 Letter  
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6 To the Editor:  
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8 We offer herewith an article, "Electronic fetal monitoring, cerebral palsy, and  
9 cesarean births," for consideration for the BMJ **Analysis** section.  
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11 The rate of cesarean births in the US and UK exceeds the optimal for the health  
12 of mothers and infants. EFM as used increases the cesarean section rate without  
13 producing better outcomes for mothers or babies, but increasing risks and costs.  
14 Evidence of good medical quality, available for a quarter century, indicates that EFM is  
15 irrelevant to risk of CP. That evidence is widely ignored in expert testimony in "birth  
16 injury" lawsuits alleging failure of proper use of EFM as the cause of cerebral palsy.  
17 Such litigation has become common and costly, and provokes defensive obstetrics that  
18 contributes further to the high rate of surgical deliveries.  
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Obstetrical professional societies have made only low-key, hard-to-find  
pronouncements about the irrelevance of EFM to CP risk, and have not spoken in a  
single clear voice about the evidence nor found effective means to discipline  
professionals who offer specious expert testimony on the subject in courtrooms.

The contributions to our high rate of cesarean sections of EFM and of junk  
science in related litigation have been markedly under-addressed. This important public  
health issue warrants open discussion in a multidiscipline journal that reaches health  
economists and ethicists, and scholars of the relationship of law and medicine, as well as  
a range of medical specialists.

All authors have contributed to this article, and have seen and approve this  
submission.

There was no funding for the writing of this article. Dr. Nelson has no conflicts of  
interest. Mr. Sartwelle is a defense attorney who has tried cases involving fetal  
monitoring and cerebral palsh, and Dr. Rouse has been an expert witness in such cases.

As a preferred reviewer we suggest Dr. Alan Peaceman of Northwestern  
University.

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3 The article is very slightly above the word limit. The topic is complex, with a  
4 number of moving parts. Aiming for clarity for a general readership, we hope that this  
5 number of words will be acceptable.  
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11 Sincerely yours,  
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14 Karin B. Nelson  
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## Electronic fetal monitoring, cerebral palsy, and our epidemic of cesarean births

*Electronic fetal monitoring does not enable prevention of cerebral palsy, but EFM and expert testimony that contradicts evidence of good medical quality in “birth injury” litigation contribute to our high rate of cesarean deliveries.*

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6 **Electronic fetal monitoring, cerebral palsy, and our epidemic of**  
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8 **cesarean births**  
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11 *Electronic fetal monitoring does not enable prevention of cerebral palsy, but*  
12 *EFM and expert testimony that contradicts evidence of good medical quality in*  
13 *“birth injury” litigation contribute to our high rate of cesarean deliveries.*  
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## Electronic fetal monitoring, cerebral palsy, and our epidemic of cesarean births.

One in three babies born in the United States, [1] one in four in England, [2] is delivered by cesarean section, rates too high for optimal health of mothers and infants.[3,4] Electronic fetal monitoring in labor (EFM) is an important driver of operative deliveries as its exceedingly high rate of false positive identification of the fetus in danger [5] too often suggests a need for rapid intervention to prevent fetal death or brain injury.

Cerebral palsy (CP) was once thought to be due chiefly to birth asphyxia. Early advocates of electronic fetal monitoring expected that it would enable birth caregivers to recognize and rescue fetuses undergoing asphyxia in labor and thereby largely eliminate CP and markedly reduce intellectual deficits. Studies using surrogate endpoints such as low neonatal pH and low Apgar scores encouraged that expectation. Clinical trials were not conducted before the introduction of electronic monitoring because it was considered unethical to deny controls its anticipated benefit.[6] EFM became widely disseminated and became the most frequently performed procedure in obstetrics. Now, with half a century of experience, it is possible to assess the results.

### EFM and CP

Randomized clinical trials are the most reliable method for examining the effect of an intervention, and are especially important for evaluating EFM because in a country in which electronic monitoring is virtually ubiquitous, reasons for its non-use-- birth outside a medical facility, delivery for medical indication in mother or fetus, etc. -- might themselves be related to risk.

CP cannot be diagnosed at birth, so investigating its association with fetal monitoring requires that infants be followed for several years, until a diagnosis can reliably be made. To date only two randomized trials have compared CP rates with and

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3 without EFM. In the large Dublin trial, the rate of CP in children whose births were  
4 monitored electronically was not lower than in those monitored by intermittent  
5 auscultation.[7] In preterm births, the CP rate was significantly *higher* in the  
6 electronically monitored group.[8] Thus, data from randomized trials do not support the  
7 hypothesis that EFM protects against CP. Results of both these trials were published  
8 more than 25 years ago.

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14 As a predictor of CP, abnormalities on EFM have a false positive rate of 99.8%,  
15 [5] so almost all positives are false positives. Using additional observations including  
16 depression of the ST-segment of the fetal electrocardiogram has not improved reliability  
17 or prediction of neonatal outcome. [9]

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21 Over the years in which EFM became widely adopted, rates of cesarean section  
22 rose about five-fold but the CP rate was unchanged.[10,11] Nor were rates of perinatal  
23 death, intrapartum stillbirth, neonatal death, low or very low Apgar scores, need for  
24 special neonatal care, or neonatal death less frequent with electronic monitoring.[12]

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28 Aberrant fetal heart rate patterns are neither sensitive nor specific indicators of  
29 current or future brain status. The obstetrical societies of the United States, Canada,  
30 Australia and New Zealand acknowledge that electronic monitoring provides no long-  
31 term benefit for children. [13]

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35 The number of children with CP in the relevant randomized trials was small,  
36 interpretation of monitoring traces has changed somewhat over the period of its use, and  
37 procedures for delivery have undergone changes. The evidence that EFM does not aid in  
38 prevention of CP is imperfect, but we know of no evidence of good medical quality [14]  
39 that contradicts it. New trials of EFM for prevention of CP could be contemplated, but it  
40 is doubtful that such studies warrant priority for limited research funding.  
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### 50 **Why doesn't it work?**

51 Use of EFM in the hope of preventing CP was based on several erroneous  
52 assumptions. First, the basic physiology of fetal heart rate decelerations may have been  
53 misinterpreted.[15] Second, most CP in births at or near term is not caused by birth  
54 asphyxia, according to consistent evidence from studies of human infants in  
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3 representative populations.[12,16,17] Third, a test that identifies abnormalities in a high  
4 percentage of births will inevitably produce a high false positive rate if used in an effort  
5 to identify an uncommon outcome such as CP, guaranteeing an “arithmetic of failure.”  
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7 [18] Tightening criteria in order to reduce false positives would further lower the test’s  
8 already-low sensitivity.[5]  
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11 Reliability of interpretation of fetal heart rate tracings is low. Experienced  
12 obstetricians had only mediocre agreement with one another in reading monitoring  
13 tracings, and when shown the same tracing months later agreed with their *own* earlier  
14 interpretations even *less* well.[19]. The United States Preventive Services Task Force  
15 gave electronic fetal monitoring a grade of D, the lowest grade possible. [20]  
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### 26 **Why does EFM remain in use?**

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29 Whether EFM contributes to lowering the risk of intrapartum death remains  
30 somewhat uncertain because rates of perinatal death rates were already falling at the time  
31 EFM was introduced, and randomized trials showed no decrease in perinatal deaths with  
32 EFM. However, most observational studies are compatible with the conclusion that use of  
33 electronic monitoring does reduce risk of intrapartum or neonatal death. [21] Although  
34 electronic monitoring has no demonstrated value for preventing CP, it may thus have  
35 other applications and is less expensive than one-on-one auscultation.  
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43 Only obstetricians can decide whether and how to use electronic monitoring.  
44 Informed decisions will require clinical trials to establish whether specific monitoring  
45 patterns in specific clinical situations aid in improving clinical management.  
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### 53 **EFM and cesarean sections**

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55 All relevant randomized clinical trials have shown that use of electronic  
56 monitoring is associated with more interventions in labor, more surgical vaginal  
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3 deliveries and more cesarean sections.[12] Electronic monitoring is not the only factor  
4 contributing to the excess of surgical deliveries, but it is clearly a significant factor.  
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7 A high proportion of cesarean deliveries are undertaken partly or wholly in  
8 response to abnormal monitoring tracings.[22,23} For medical caregivers, not performing  
9 a cesarean delivery can be a basis for lawsuit but they are seldom sued for doing a  
10 section. “[T]he only cesarean section you will regret is the one you didn’t perform.” [24]  
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### 15 16 17 18 **Why is high cesarean section rate a problem?** 19

20 Surgical delivery increases risks to mothers, immediate and long-term.[25,26]  
21 Maternal death (adjusted for confounders) was 3.6 times more frequent after cesarean  
22 than vaginal delivery, [27] Operative deliveries increase risks of maternal hemorrhage,  
23 infection, and thromboembolism, and respiratory depression in the neonate.  
24 Complications in subsequent pregnancies include a high rate of repeat cesarean delivery,  
25 abnormally invasive placentation with potential for catastrophic hemorrhage, and uterine  
26 rupture.  
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28 It seems intuitively likely that electronic monitoring occasionally enables rescue  
29 of a threatened fetus, even if such events are too rare to register in randomized trials or  
30 cerebral palsy rates. But do the unproven benefits exceed the known harms? Even a few  
31 uterine ruptures – with their high risk of death or disability-- in subsequent pregnancies of  
32 women who had an unnecessary surgical delivery because of electronic monitoring  
33 would have to be weighed against the hypothetical benefit. “The evidence is  
34 overwhelming that continuous EFM... has overall caused more harm than good.” [20]  
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46 Cesarean sections are among the most frequently performed surgical procedures  
47 in the United States. Higher medical care costs accompany a high section rate: an  
48 uncomplicated vaginal delivery typically costs \$9000 to \$17,000, while for an  
49 uncomplicated cesarean section cost ranges from about \$14,000 to \$25,000 or  
50 more.[28] Even a modest reduction in surgical deliveries would contribute to lowering  
51 health costs.  
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3 Ethical problems arise when doctors use ready recourse to surgical intervention  
4 to protect themselves against litigation, thereby placing their own interests above those  
5 of their patients in whom risks are increased without established benefit. And there is  
6 the injustice to medical caregivers of using bad science in courtrooms to charge them  
7 with harms they did not cause.  
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### 14 **EFM and litigation**

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17 Failure to prevent CP due to alleged birth asphyxia by proper use of EFM is a  
18 frequent allegation in malpractice cases in the United States and elsewhere,[29,30]  
19 despite the evidence that such monitoring is irrelevant to prevention of CP. Responding  
20 to the threat of litigation, medical caregivers move more quickly to surgery.[31,32]  
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22 “There is overwhelming evidence that part of the recent rise in the cesarean section rate  
23 in this country is the result of the medical-legal environment.” [21]  
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29 EFM is the cudgel in most CP claims.[33] Plaintiffs’ experts can usually find  
30 something worrisome to point to in any monitoring strip. According to a plaintiff’s  
31 attorney, he “can take any fetal monitor strip and make a malpractice case out of it.” [34]  
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35 Importantly, knowledge of neurologic abnormality in a child with alleged  
36 birth injury influences interpretations of monitoring tracings and judgments about  
37 the appropriateness of the clinical care provided.[19,35,36] In a “birth injury” trial,  
38 it can safely be assumed that neurologic outcome was unfavorable. That prior  
39 knowledge builds a high level of bias into interpretation of fetal monitoring as  
40 employed in courts.  
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46 “Birth injury” lawsuits are among the most expensive of claims: the verdict for  
47 one plaintiff was \$212 million. “Birth injury” cases accounted for half of British  
48 National Health Service litigation costs in 2013, almost 20% of the total budget for  
49 maternity services.[37] Judgments in the tens of millions of dollars or pounds sterling are  
50 not rare, most of the money from settlements going to lawyers, experts, and court  
51 costs.[38] The current medicolegal approach is expensive, irrational and highly  
52 inefficient, and benefit to disabled children and their families is minimal.  
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Obstetricians and surgeons are the specialty groups most often sued. [39] Three of four American obstetricians surveyed had had at least one professional liability claim, and most had had more than one. [40] The most frequent claims related to neurologically impaired infants. Many of the obstetricians polled had altered their practice in response, increasing the number of cesarean deliveries, decreasing their availability to high-risk patients, or decreasing the number of deliveries performed.

The same few individuals do much of the testifying for plaintiffs in “birth injury” cases.[41] Professional societies can censure members for spurious testimony, but have no power beyond withdrawing membership. Most are slow to do even that, fearing counter-litigation.

Plaintiff expert witnesses often testify that cesarean section, or cesarean section earlier, would have prevented CP in a child whose case is before the court. Such testimony is gross speculation because actions based upon electronic monitoring patterns have never been shown in evidence of good medical quality to prevent CP.

Litigation and fear of litigation have contributed to a high rate of cesarean deliveries often performed in the hope of preventing CP.[42] The consequence is that around the world each year hundreds of thousands of cesarean deliveries are performed needlessly, a baneful effect of bad science on health care decisions.

In summary [Figure], although EFM was introduced with the expectation that it would enable prevention of CP, decades of experience have shown that hope to be unfounded. Electronic monitoring *is*, however, linked with more cesarean sections, increasing risks and costs. Since the introduction of electronic monitoring, litigation related to CP has become common and costly, and such litigation is associated with further increase in the cesarean section rate.

**Is there a way forward?**

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Consistent evidence of good medical quality [14] establishing that use of EFM does not reduce risk of CP is often not acknowledged in the testimony of expert witnesses in courtrooms. Indeed, unwarranted assumptions to the contrary are the major fault-finding tool in “birth injury” lawsuits.[30,33]

A potential remedy is the ruling of the United States Supreme Court that expert witness testimony of poor scientific quality should be excluded from evidence. The Daubert standard is applied in federal courts, in various forms in most state courts, and in many other countries. Daubert requires the dual standard of reliability and relevance to make expert testimony admissible.

It is the responsibility of trial judges, often scientifically unschooled, to assess whether the experts’ reasoning and methodology are compatible with good science and applicable to the facts at issue. Complicating that task in birth injury cases is the fact that the current literature, the internet, and plaintiff expert testimony contain a great deal that is erroneous and unscientific, and there are few clear and forceful statements from relevant professional societies that EFM does not enable prevention of CP.

One major step toward increasing the use of Daubert challenges would be a review by an impartial expert task force with focus on a narrow question: does use of EFM in labor reduce risk of CP? Such a task force would include evidence brought forward by all concerned parties and might be participated in and supported by the National Institutes of Health and by birth-related professional organizations, the trial bar, and consumer groups. A consensus document would provide judges with contemporary evidence by which to decide Daubert challenges. Such challenges would occur one at a time, but once one plaintiff expert was excluded that precedent would beget another and another. Birth-related professionals who do not favor development of an expert task force to address these issues should consider offering an alternative solution.

It is past time for medical professionals to acknowledge clearly the ineffectiveness of electronic monitoring in prevention of cerebral palsy and teach the evidence to medical trainees, lawyers, and the public. It is past time for wide application

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3 of the Daubert junk science doctrine, to exclude as irrelevant testimony about EFM in CP  
4 lawsuits.  
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8 Our current high rate of cesarean births exceeds levels that benefit mothers or  
9 babies, increases costs, involves serious ethical issues, and fosters injustice. This is an  
10 important problem in current health care and a significant women's health issue. Any  
11 serious discussion of reducing our high rate of surgical deliveries should include  
12 consideration of the role of electronic fetal monitoring and related litigation in  
13 maintaining the high rate of cesarean births.  
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FIGURE LEGEND

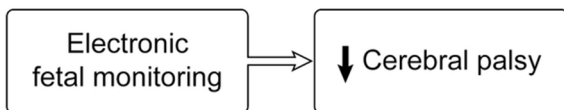
Expected vs. observed: relationship of electronic fetal monitoring in labor with increase, decrease, or no change in rate of cerebral palsy, cesarean section, risks to mothers, medical care costs and litigation related to cerebral palsy. Heavy connecting lines indicate evidence based on randomized clinical trials, lighter connecting lines indicate other sources of information (See text.)

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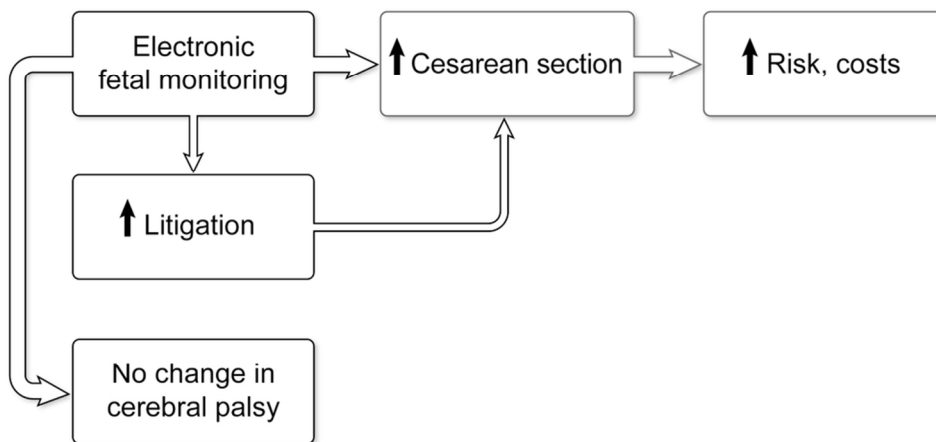


FIGURE LEGEND

Expected vs. observed: relationship of electronic fetal monitoring in labor with increase, decrease, or no change in rate of cerebral palsy, cesarean section, risks to mothers, medical care costs and litigation related to cerebral palsy. Heavy connecting lines indicate evidence based on randomized clinical trials, lighter connecting lines indicate other sources of information (See text.)

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3 Letter

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6 To the Editor:

7 We offer herewith an article, "Electronic fetal monitoring, cerebral palsy, and  
8 cesarean births," for consideration for the BMJ **Analysis** section.  
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11 The rate of cesarean births in the US and UK exceeds the optimal for the  
12 health of mothers and infants. EFM as used increases the cesarean section rate  
13 without producing better outcomes for mothers or babies, but increasing risks and  
14 costs. Evidence of good medical quality, available for a quarter century, indicates  
15 that EFM is irrelevant to risk of CP. That evidence is widely ignored in expert  
16 testimony in "birth injury" lawsuits alleging failure of proper use of EFM as the  
17 cause of cerebral palsy. Such litigation has become common and costly, and  
18 provokes defensive obstetrics that contributes further to the high rate of surgical  
19 deliveries.  
20

21  
22 Obstetrical professional societies have made only low-key, hard-to-find  
23 pronouncements about the irrelevance of EFM to CP risk, and have not spoken in a  
24 single clear voice about the evidence nor found effective means to discipline  
25 professionals who offer specious expert testimony on the subject in courtrooms.  
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28 The contributions to our high rate of cesarean sections of EFM and of junk  
29 science in related litigation have been markedly under-addressed. This important  
30 public health issue warrants open discussion in a multidiscipline journal that  
31 reaches health economists and ethicists, and scholars of the relationship of law and  
32 medicine, as well as a range of medical specialists.  
33

34  
35 All authors have contributed to this article, and have seen and approve this  
36 submission.  
37

38  
39 There was no funding for the writing of this article. Dr. Nelson has no  
40 conflicts of interest. Mr. Sartwelle is a defense attorney who has tried cases  
41 involving fetal monitoring and cerebral palsh, and Dr. Rouse has been an expert  
42 witness in such cases.  
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45 As a preferred reviewer we suggest Dr. Alan Peaceman of Northwestern  
46 University.  
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3 The article is very slightly above the word limit. The topic is complex, with a  
4 number of moving parts. Aiming for clarity for a general readership, we hope that  
5 this number of words will be acceptable.  
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11 Sincerely yours,

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