Infant and Neonatal Mortality for Primary Cesarean and Vaginal Births to Women with "No Indicated Risk," United States, 1998–2001 Birth Cohorts

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ABSTRACT: Background: *The percentage of United States' births delivered by cesarean section has increased rapidly in recent years, even for women considered to be at low risk for a cesarean section. The purpose of this paper is to examine infant and neonatal mortality risks associated with primary cesarean section compared with vaginal delivery for singleton full-term (37–41 weeks' gestation) women with no indicated medical risks or complications.* **Methods:** *National linked birth and infant death data for the 1998–2001 birth cohorts (5,762,037 live births and 11,897 infant deaths) were analyzed to assess the risk of infant and neonatal mortality for women with no indicated risk by method of delivery and cause of death. Multivariable logistic regression was used to model neonatal survival probabilities as a function of delivery method, and sociodemographic and medical risk factors.* **Results:** *Neonatal mortality rates were higher among infants delivered by cesarean section (1.77 per 1,000 live births) than for those delivered vaginally (0.62). The magnitude of this difference was reduced only moderately on statistical adjustment for demographic and medical factors, and when deaths due to congenital malformations and events with Apgar scores less than 4 were excluded. The cesarean/vaginal mortality differential was widespread, and not confined to a few causes of death.* **Conclusions:** *Understanding the causes of these differentials is important, given the rapid growth in the number of primary cesareans without a reported medical indication. (BIRTH 33:3 September 2006)*

Key words: *birth certificate*, *neonatal mortality*, *cesarean delivery*, *vaginal delivery*, *low-risk women*

The percentage of United States' births delivered by cesarean section has increased substantially in recent years, from 20.7 percent in 1996 to 29.1 percent in 2004 (1,2). The cesarean delivery rate has increased rapidly even among women considered to be at low risk based on the Healthy People 2010 criteria (i.e., women with a full-term, singleton infant in vertex presentation) (3,4). Much of the overall increase is due to a substantial rise in primary cesarean section rates, from 14.6 percent in 1996 to 20.6 percent in 2004 (1,2). The growth in primary cesareans is of particular concern because, due to a precipitous drop in the rate of vaginal birth after previous cesarean (VBAC), now at the all-time low of 9.2 percent, a woman who has a primary cesarean section has a greater than 90 percent chance of having a subsequent cesarean delivery, thus elevating the overall cesarean rate even further (1,5).

Since vital statistics data on cesarean sections began to be collected (1989), the infant mortality rate in the United

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States for total cesarean deliveries has consistently been approximately 1.5 times that for vaginal deliveries (6). It was assumed that this mortality differential was due to a higher risk profile for cesarean births, since the indication for cesarean section would likely constitute a risk factor for mortality. A variety of studies have examined neonatal mortality for cesarean and vaginal births for special populations, such as low-birthweight or preterm births (7–10), breech births (8,11), and multiple births (12–14). However, no study known to us has attempted to examine this relationship for term births with no known risk factors or indications.

The examination of the relationship between method of delivery and infant mortality for low-risk women has assumed greater urgency, given the recent controversy over elective primary cesarean deliveries and the rapid increase in those deliveries (15,16). This paper uses a previously developed methodology to identify births with "no indicated risk" (17). These are births that, in addition to meeting the Healthy People 2010 criteria for low risk, have no reported medical risk factors or complications of labor and/or delivery identified on the birth certificate. These no indicated risk women experienced a 49 percent increase in the odds of cesarean delivery from 1996 to 2001, after statistical adjustment for maternal age, race, education, birthweight, and parity (17). This study extends the previous analysis of the group with no indicated risk to examine birth outcomes in the form of infant and neonatal mortality in the United States by method of delivery (i.e., vaginal or primary cesarean).

Methods

The 1998–2001 birth cohort national linked birth/infant death data sets were analyzed to examine infant and neonatal mortality for women with no indicated risk. These data sets link the birth record to the infant death record for each infant who dies in the United States. The purpose of the linkage is to use the many additional variables available from the birth certificate for infant mortality analysis. Information on all of the approximately 4 million live births in the United States each year is also included. For the 1998–2001 birth cohorts, over 98 percent of all infant death records were linked to their corresponding birth certificates (6,18). Since this data set contains information on infant, but not maternal, outcomes, it was not possible to examine maternal outcomes in this study.

For the purposes of this analysis, women with no indicated risk were defined as those with singleton, term (37–41 weeks' gestation), infants in vertex presentation who were not reported to have any medical risk factors, and for whom no complications of labor or delivery were reported on the birth certificate (17). Medical risk factors that were excluded from the study were anemia, cardiac disease, acute or chronic lung disease, diabetes, genital herpes, hydramnios/oligohydramnios, hemoglobinopathy, chronic hypertension, pregnancy-associated hypertension, eclampsia, incompetent cervix, previous infant 4000+ g, previous preterm or small-for-gestational-age infant, renal disease, Rh sensitization, uterine bleeding, and other. Complications of labor and delivery that were excluded were febrile, meconium moderate/heavy, premature rupture of membrane, abruptio placentae, placenta previa, other excessive bleeding, seizures during labor, precipitous labor, prolonged labor, dysfunctional labor, breech/malpresentation, cephalopelvic disproportion, cord prolapse, anesthetic complication, fetal distress, and other. The study was further restricted to women who had never had a previous cesarean, because having had a previous cesarean could strongly influence the choice of method of delivery in the current pregnancy. Slightly more than one-fourth of mothers in the United States met these criteria in the years studied.

Infant (< 1 year) mortality rates are shown by age at death and method of delivery. Neonatal (< 28 days) mortality rates are shown by maternal race/ethnicity, age, education, and tobacco use; by infant birthweight and gestational age; and for leading causes of death. Rates were computed per 100,000 live births for cause of death, and per 1,000 live births for all other variables. Rates for categories with fewer than 20 infant deaths are considered statistically unreliable and are not shown. All variables were reported by all states, except for maternal smoking and 5-minute Apgar score. Maternal smoking was not reported by California, Indiana, South Dakota, and New York State (New York City did report) in 1998, California and South Dakota in 1999, and California in 2000 and 2001. Apgar score was not reported by California and Texas from 1998 to 2001. Tabulations of maternal smoking and Apgar score presented in Table 2 excluded the nonreporting states for each year.

Cause-of-death data for the 1999–2001 birth cohorts were classified according to the Tenth Revision of the *International Classification of Diseases and Related Health Problems* (ICD-10) (19). Leading causes of death for infants of women with no indicated risk were ranked using the conventions outlined for cause-of-death rankings by the National Center for Health Statistics (20). Data for the 1998 and prior birth cohorts were classified according to the Ninth Revision of the ICD (21). Comparability in classification between ICD-9 and ICD-10 for the leading causes of death in the study was evaluated and found to be less than ideal for several of the causes of death

under study (22); therefore, 1998 data were excluded from the cause-specific analysis.

Logistic regression was used to assess the adjusted risk of neonatal mortality for vaginal and cesarean deliveries. Three models were run. For Model 1 total neonatal mortality is the dependent variable, with covariates for birthweight (< 2,500 g, 2,500–3,999 g, 4,000+ g); gestational age (37–39, 40, 41 weeks); and maternal characteristics: age (< 20, 20–34, 35+ years); race/ethnicity (non-Hispanic white, black, Asian and Pacific Islander, American Indian, Hispanic); parity (primipara, multipara); education (0–11, 12, 13+ years); and smoking (yes or no). For Model 2 neonatal mortality excluding congenital malformations is the dependent variable (since if congenital malformations were identified prenatally, this factor might affect the choice of delivery method) with the same covariates. Model 3 is identical to Model 2, but infants with Apgar scores less than 4 or not stated were also excluded because intrapartum hypoxia might also be both a reason for performing a cesarean and a contributor to infant death.

Records with not stated responses for birthweight, maternal education, and parity were excluded from the models. The effect of these exclusions was small, since each of these variables had less than 1 percent of records not stated. A separate covariate was constructed to represent missing smoking data. Models that were run both including and excluding missing data on maternal smoking yielded similar results. The parameters in the logistic model were estimated by the maximum likelihood method using the LOGISTIC procedure of SAS, version 8.2 (23).

Results

Table 1 presents infant mortality rates for births to no indicated risk women by age at infant death, method of delivery, and parity, for the 1998–2001 birth cohorts. Not surprisingly, infant mortality rates were very low for this group of low-risk women, with a total infant mortality rate of 2.14 infant deaths per 1,000 live births, less than one-third the rate of 6.99 for the United States population as a whole for this time period. However, substantial differentials in mortality by method of delivery and parity still exist. For example, for primaparous mothers, infant mortality rates for no indicated risk mothers were 56 percent higher for cesarean deliveries (2.85 per 1,000 live births) than for those delivered vaginally (1.83). For multiparous mothers, infant mortality rates for primary cesarean deliveries (4.51) were more than twice those for vaginal deliveries (2.18).

The overall neonatal mortality rate for cesarean births was 1.77 deaths per 1,000 live births, 2.9 times the rate of 0.62 for vaginal births. For primiparous mothers, the neonatal mortality rate for cesarean births was 2.2 times the rate for vaginal deliveries; for multiparous mothers, the neonatal mortality rate for cesarean births was 3.7 times that for vaginal births. Mortality differentials by method of delivery were much smaller during the postneonatal period (28 days–1 year). This is not surprising, since the choice of method of delivery would be expected to be more strongly related to infant health in the period immediately following the delivery. For this reason, the subsequent analysis in this paper will focus on neonatal mortality.

Table 1. Infant Mortality Rates (per 1,000 Live Births) for No Indicated Risk[a] Births by Parity, Method of Delivery, and Age at Death, United States: 1998-2001 Birth Cohorts

	Total[b]		*Primiparous Women*		*Multiparous Women*	
Age at Death	*Vaginal*	*Cesarean*	*Vaginal*	*Cesarean*	*Vaginal*	*Cesarean*
Rates						
Infant	2.06	3.56	1.83	2.85	2.18	4.51
Total neonatal	0.62	1.77	0.62	1.36	0.62	2.30
Early neonatal	0.33	1.07	0.33	0.78	0.32	1.44
Late neonatal	0.29	0.69	0.29	0.58	0.29	0.86
Postneonatal	1.44	1.80	1.21	1.49	1.56	2.21
Number of deaths						
Infant	11,897	1,112	3,530	510	8,265	585
Total neonatal	3,586	551	1,199	243	2,343	298
Early neonatal	1,897	335	641	139	1,223	187
Late neonatal	1,688	216	558	104	1,120	111
Postneonatal	8,311	561	2,331	267	5,922	287
Births	5,762,037	311,927	1,931,054	179,082	3,798,869	129,640

[a]*Births to women with singleton, full-term (37-41 weeks' gestation), vertex presentation infants, with no risk factors or complications of labor and/or delivery reported on the birth certificate, who have not had a previous cesarean delivery.*
[b]*Not stated parity included in total but not shown separately.*

Neonatal mortality rates for no indicated risk vaginal and cesarean births were examined by selected maternal and infant characteristics (Table 2). Also computed was the ratio of neonatal mortality rates for women delivered by primary cesarean section, compared with those delivered vaginally (hereafter referred to as the mortality rate ratio). Neonatal mortality rates were considerably higher for cesarean deliveries, compared with vaginal deliveries, for all of the characteristics studied, with mortality rate ratios ranging from 1.7 to 3.7. In general, mortality rate ratios were highest (i.e., over 3) for multiparous mothers (3.7), those with a high school education only (3.2), those with a gestational age of 37–39 weeks (3.2), non-Hispanic white mothers (3.1), nonsmokers (3.0), and those 35 years or older (3.0) (Table 2).

Leading causes of neonatal mortality for no indicated risk births in the 1999–2001 birth cohorts by method of delivery are examined in Table 3. Among this group of low-risk women, the leading cause of neonatal mortality was congenital malformations, deformations, and chromosomal abnormalities (congenital malformations), which accounted for over one-half (54%) of all neonatal deaths. This cause was followed

Table 2. Neonatal Mortality Rates[a] for No Indicated Risk[b] Births by Mother's Characteristics and Method of Delivery: United States, 1998-2001 Birth Cohorts

	Neonatal Mortality Rates			*Neonatal Deaths*		*Live Births*	
Characteristic	*Vaginal*	*Cesarean*	*Ratio of Cesarean/Vaginal Neonatal Mortality Rates*	*Vaginal*	*Cesarean*	*Vaginal*	*Cesarean*
Total	0.62	1.77	2.84	3,586	551	5,762,037	311,927
Race/ethnicity							
Non-Hispanic white	0.60	1.85	3.10	2,035	309	3,404,518	166,814
Non-Hispanic black	0.84	2.01	2.38	632	101	748,068	50,320
Hispanic	0.57	1.50	2.66	717	113	1,268,248	75,130
Asian or Pacific Islander	0.56	1.29	2.28	166	23	294,723	17,880
American Indian	0.77	[c]		36	5	46,480	1,783
Maternal age (yr)							
<20	0.79	2.18	2.74	579	76	728,670	34,927
20-34	0.59	1.65	2.81	2,576	374	4,395,254	227,281
35+	0.67	2.05	3.04	430	102	638,113	49,719
Maternal education (yr)[d]							
<12	0.79	2.08	2.64	996	119	1,262,290	57,202
12	0.65	2.04	3.16	1,156	191	1,792,096	93,838
13 or more	0.50	1.42	2.83	1,322	222	2,627,285	155,868
Birthweight (g)[d]							
<2,500	6.34	15.55	2.45	702	159	110,781	10,222
2,500-3,999	0.53	1.44	2.72	2,705	360	5,119,896	250,726
4,000 or more	0.33	0.65	1.93	178	33	531,360	50,979
Gestational age (wk)							
37-39	0.69	2.18	3.16	2,318	384	3,364,752	176,458
40	0.52	1.32	2.53	843	111	1,617,686	84,064
41	0.54	1.09	2.00	424	56	779,559	51,405
Parity[d]							
Primiparous	0.62	1.36	2.19	1,199	243	1,931,054	179,082
Multiparous	0.62	2.30	3.73	2,343	298	3,798,869	129,640
Maternal smoking[d,e]							
Smoker	0.87	1.87	2.16	429	35	495,414	18,679
Nonsmoker	0.59	1.73	2.96	2,454	380	4,192,857	219,117
5-minute Apgar score[d,f]							
0-3	134.78	229.05	1.70	386	82	2,864	358
4-10	0.52	1.42	2.70	2,231	289	4,255,815	204,185

[a] *per 1,000 live births.*
[b] *Births to women with singleton, full-term (37-41 weeks' gestation), vertex presentation infants, with no risk factors or complications of labor and/or delivery reported on the birth certificate, who have not had a previous cesarean delivery.*
[c] *Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.*
[d] *Not stated responses included in totals, but not shown separately.*
[e] *Excludes data from states that did not report maternal smoking: New York State (New York City did report) and Indiana in 1998; South Dakota, 1998-99; and California, 1998-2001.*
[f] *Excludes data from California and Texas, which did not report Apgar score from 1998-2001.*

by sudden infant death syndrome (SIDS), accounting for 5 percent of deaths. The relatively small percentage of neonatal SIDS is not surprising, since most SIDS events occur during the postneonatal period (20). The third and fourth leading causes were intrauterine hypoxia and birth asphyxia and diseases of the circulatory system, each with 4 percent of deaths. Bacterial sepsis of newborn was fifth, with 3 percent of deaths. Taken together, the five leading causes of deaths accounted for 71 percent of all neonatal deaths for this population of low-risk women.

Large differences in neonatal mortality rates by method of delivery were found for all leading causes of death for which reliable neonatal mortality rates could be computed, as well as for the residual category of all other causes combined. For example, the neonatal mortality rate (per 100,000 live births) for congenital malformations was 95.4 for primary cesarean deliveries, about 2.9 times the rate of 32.8 for vaginal deliveries. For intrauterine hypoxia and birth asphyxia, the neonatal mortality rate was 14.7 for cesarean deliveries, 6.7 times the rate of 2.2 for vaginal deliveries. Statistically reliable neonatal mortality rates could not be computed for the other three leading causes of death for the cesarean group due to relatively small numbers (< 20) of deaths in those categories. The combined congenital malformations and intrauterine hypoxia/birth asphyxia neonatal mortality rate difference between vaginal and cesarean deliveries (75.1 deaths/100,000 live births) accounted for 67 percent of the total rate difference in neonatal mortality (110.9 deaths/100,000 live births) between vaginal and cesarean deliveries.

Logistic regression was used to assess the adjusted risk of neonatal mortality for vaginal and cesarean deliveries (Table 4). In Model 1 the dependent variable is total neonatal mortality. After controlling for demographic and medical covariates, the adjusted

Table 3. Neonatal Mortality Rates[a] for No Indicated Risk Births[b] by Leading Causes of Death and Method of Delivery: United States, 1999-2001 Birth Cohorts

		Neonatal Mortality Rates			*Neonatal Deaths*		
Rank	*Cause of Death (ICD-10)*	*Total*	*Vaginal*	*Cesarean*	*Total*	*Vaginal*	*Cesarean*
	All causes combined	66.7	60.8	171.7	3,047	2,625	421
1	Congenital malformations, deformations and chromosomal anomalies (Q00-Q99)	36.2	32.8	95.4	1,652	1,417	234
2	Sudden infant death syndrome (R95)	3.5	3.7	[c]	162	158	4
3	Intrauterine hypoxia and birth asphyxia (P20-21)	2.9	2.2	14.7	133	97	36
4	Diseases of the circulatory system (I00-I99)	2.5	2.3	[c]	113	98	15
5	Bacterial sepsis of newborn (P36)	2.1	2.0	[c]	95	85	10
	All other causes (residual)	19.5	17.8	49.7	892	770	122

[a]*per 100,000 live births.*
[b]*Births to women with singleton, full-term (37-41 weeks' gestation), vertex presentation infants, with no risk factors or complications of labor and/or delivery reported on the birth certificate, who have not had a previous cesarean delivery.*
[c]*Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.*

Table 4. Adjusted Odds Ratios and 95% Confidence Intervals for Neonatal Mortality for No Indicated Risk[a] Births: United States, 1999-2001 Birth Cohorts

Logistic Regression Model	*Method of Delivery*	*Adjusted Odds Ratio[b]*	*95% CI*
Model 1 - Dependent variable = total neonatal mortality	Vaginal	1.00	
	Cesarean	2.71	(2.43-3.02)
Model 2 - Dependent variable = neonatal mortality excluding congenital anomalies	Vaginal	1.00	
	Cesarean	2.63	(2.23-3.10)
Model 3 - Dependent variable = neonatal mortality excluding congenital anomalies and events with Apgar score <4	Vaginal	1.00	
	Cesarean	2.02	(1.60-2.55)

[a]*Births to women with singleton, full-term (37-41 weeks' gestation), vertex presentation infants, with no risk factors or complications of labor and/or delivery reported on the birth certificate, who have not had a previous cesarean.*
[b]*All models are adjusted for maternal age, race/ethnicity, parity, education, smoking, period of gestation and infant birthweight.*

odds ratio for neonatal mortality associated with cesarean delivery is 2.71 (95% CI = 2.43–3.02). In Model 2, the dependent variable is neonatal mortality excluding congenital malformations (since if a congenital malformation was diagnosed prenatally, this might affect the choice of delivery method). After controlling for the same covariates as in Model 1, the adjusted odds ratio for cesarean was 2.63 (2.23–3.10). Model 3 is identical to Model 2, but infants with Apgar scores less than 4 were also excluded because intrapartum hypoxia might also be both a reason for performing a cesarean and a contributor to infant death. The adjusted odds ratio for cesarean in Model 3 was 2.02 (1.60–2.55).

Discussion and Conclusions

This analysis demonstrated a higher neonatal mortality rate among infants of low intrapartum risk women delivered by cesarean section when compared with similar low- risk women delivered vaginally. The neonatal mortality rate for cesarean births was 1.77 deaths per 1,000 live births, 2.9 times the rate of 0.62 for vaginal births. This difference in neonatal mortality rates between cesarean and vaginal deliveries was reduced only moderately by statistical adjustment for a variety of demographic and medical covariates during multivariate analyses.

Congenital malformations were clearly the leading cause of neonatal mortality regardless of method of delivery. For infants with some types of prenatally diagnosed congenital malformations, clinicians might decide on a scheduled cesarean section so that the appropriate specialists could be present to provide immediate postpartum care. Unfortunately, the birth certificate data do not contain information on whether the congenital malformation was diagnosed prenatally. To examine this issue further, we examined the 11 major subcategories of congenital malformations (e.g., heart, digestive system, respiratory system, chromosomal, etc.) with 20 or more neonatal deaths, and computed the percent delivered by cesarean. For each subcategory, the majority of births were delivered vaginally, with a minority (ranging from 7–28%) delivered by cesarean (data not shown). In addition, when deaths due to congenital malformations were excluded from the multivariate models, the adjusted odds of neonatal mortality for cesarean, compared with vaginal, deliveries declined only slightly (from 2.71 to 2.63).

In cases where the cause of death was intrauterine hypoxia and birth asphyxia, the neonatal mortality rate for cesarean deliveries was 6.7 times that for vaginal deliveries. This finding may be due to clinicians performing cesareans to attempt to expedite the delivery of infants with suspected intrauterine hypoxia. In such cases, the intrauterine hypoxia might be both the reason for performing the cesarean and the cause of death. Eliminating births with Apgar scores less than 4 as a proxy for asphyxia resulted in the largest drop in the odds ratio for the risk of neonatal mortality. For the residual category of all other causes of death, the neonatal mortality rate for cesarean delivery was 2.9 times that for vaginal delivery.

Studies have documented several possible effects of cesarean delivery on infant health (24–30). Morrison et al, in a prospective 9-year study of 33,289 deliveries at or beyond 37 weeks' gestation, reported that the incidence of respiratory morbidity (respiratory distress syndrome or transient tachypnea of the newborn) was 35.5 per 1,000 live births for infants delivered by cesarean section without labor, compared with 12.2 for infants delivered by cesarean with labor, and 5.3 for vaginal deliveries (24,29). Levine et al also found nearly a fivefold greater risk of persistent pulmonary hypertension for elective cesarean than for vaginal deliveries (27). Labor induces the release of fetal catecholamines and prostaglandins that promote lung surfactant secretion. In addition, epinephrine release during labor, as well as the physical compression of the infant, helps to remove fetal lung fluid and facilitates postnatal lung adaptation (24,27,29). Other risks of cesarean delivery include delayed neurologic adaptation (30), possible laceration of the infant during the performance of the cesarean surgery, and delayed establishment of breastfeeding (24,25). Although most of these risks are manageable with appropriate neonatal care, some increased risk of mortality may result from these factors.

The strengths of this study include the comprehensive population-based nature of the data set, which includes all births and over 98 percent of infant deaths in the United States over a recent 4-year period, together with the large number of sociodemographic and medical variables available for analysis. The neonatal mortality rate for both vaginal and primary cesarean deliveries for this low-risk population is extremely low, with a mortality differential between the cesarean (1.77 per 1,000 births) and vaginal (0.62) groups of approximately 1.15 infant death per 1,000 live births (or about 358 excess deaths for the cesarean group from 1998–2001). This magnitude of difference could only be detected in a very large data set. Most clinic- or hospital-based studies would have insufficient power, in terms of sample size, to detect a statistically significant difference in mortality of 1 infant death per 1,000 live births.

Limitations of the study include concerns about the accuracy of reporting of specific data items on

birth certificates. Reporting of birth certificate data is generally considered to be excellent for most demographic items, and for some medical items, such as method of delivery and birthweight (31,32). However, underreporting of individual medical risk factors and complications of labor and delivery on birth certificates has been documented (31–33). Our measure of "no indicated risk" notably did not focus on any single item but, rather, included only those births where none of the more than 30 items on risks or complications was reported. It would seem reasonable to expect any bias in the reporting of these items by method of delivery would favor overreporting of risks among cesarean deliveries, thereby excluding mothers from this study population. In addition, an increase in elective cesarean sections during the study period using alternative measures has been documented (15). Nonetheless, it is possible, based on either poor reporting or because the risks involved items not recorded on the birth certificate, that the cesarean group was still an inherently higher risk group and those risks accounted for both the decision to perform a cesarean and the neonatal death.

Understanding the causes of the observed differences is important given the rapid growth in the cesarean delivery rate. Timely cesareans in response to medical conditions have proved to be life-saving interventions for countless mothers and babies. At present we are witnessing a different phenomenon—a growing number of primary cesareans without a reported medical indication (5,15,17,34). Although the neonatal mortality rate for this group of low-risk women remains low regardless of the method of delivery, the resulting increase in the cesarean section rate may inadvertently be putting a larger population of neonates at risk for neonatal mortality for reasons that remain uncertain.

The increased risk of neonatal mortality associated with cesarean section in this low intrapartum-risk group of women cannot be explained by a simple review of the causes of death of their infants. Further research into biologically plausible mechanisms that may put an infant at higher risk for neonatal mortality when delivered by cesarean section, better documentation of the indications for a cesarean section, or both will be necessary to explain the increased risk of neonatal mortality among low-risk women delivered by cesarean section.

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