



Maternal and Neonatal Morbidity Associated with Lowering of the Cesarean Delivery Rate

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Objective: To learn whether there was an increase in maternal or neonatal morbidity associated with a decrease in the cesarean delivery rate in a group-model health maintenance organization.

Study Design: We studied hospital discharge data from St. Joseph Hospital, Denver, Colorado, from July 1, 1986 through December 31, 1989. We matched 8,387 mother and infant pairs and identified maternal and neonatal morbidity by ICD-9 codes for each of four modes of delivery: cesarean, spontaneous vaginal, forceps, and vacuum extraction. For the analysis, we compared 1986 (the year of the highest cesarean delivery rate) with 1989 (the year of the lowest rate).

Results: A statistically significant decrease in cesarean births had occurred from 1986 through 1989, from 15.9% to 11.4% (OR, 1.47, 95% CI 1.21-1.80). Although maternal morbidity was not significantly different in high and low years, overall neonatal morbidity was significantly lower in 1989 for all modes of delivery. We observed a significantly elevated rate of "birth trauma" in 1989 ($P < .0001$). This increase was due to injuries to the scalp (caput succedaneum and cephalohematoma), conditions associated with vaginal births which usually resolve without clinical sequelae. Mean maternal postpartum and neonatal lengths of hospital stay were significantly higher for all deliveries in 1986 ($P < .0001$ and $P = 0.0078$, respectively).

Conclusion: In this population, the lowered cesarean delivery rate was not accompanied by an increase in clinically significant maternal and neonatal morbidity or in length of hospital stay.

Between 1965 and 1991, cesarean deliveries in the United States increased from 4.5% to 23.5% of all births.¹ There is general agreement among health care professionals and consumers that current cesarean rates have been too high. The American College of Obstetricians and Gynecologists (ACOG) has offered no guideline regarding the "appropriateness" of any cesarean delivery rate. The only opinion on this subject issued by ACOG has referred to vaginal birth after a cesarean delivery.² Although authors have suggested that rates varying from 8 to 15% are appropriate targets,^{3,4} there has been little evidence on which to base the choices of target rates for defined populations that would result in acceptable rates of maternal and neonatal morbidity. Strategies such as performing a trial of labor after cesarean delivery, managing labor actively, ob-

taining second opinions, providing labor support personnel (e.g., doulas) or using narcotic analgesia (instead of epidural anesthesia) have resulted in lower cesarean delivery rates.⁵⁻¹³ Further, using gross measures of perinatal outcome (e.g., Apgar scores, acidemia at birth, and mortality), these investigators found that lowered cesarean delivery rates did not increase the rates of adverse outcomes.

There is a serious need for reports that compare varying cesarean delivery rates to maternal and infant morbidity. Cesarean deliveries are still being performed in some settings for more than 25% of births while being held to less than 10% in others. Replicated studies of safety and risk will be required if the performance of cesarean deliveries is to be based on sound evidence of benefit rather than on personal or institutional practice styles.

From 1986 through 1989, the cesarean delivery rate in the Colorado Region* of Kaiser Permanente decreased from 16.2 to 12.6%. This downward trend in cesarean delivery provided an opportunity to study modes of delivery, associated maternal and neonatal morbidity, and length of hospital stay among patients in a group-model health maintenance organization.

Methods

In this retrospective study, we wished to learn whether a lowered cesarean delivery rate was accompanied by increased maternal and neonatal morbidity and length of hospital stay. The study population was composed of mothers (and their liveborn neonates) who delivered in the Colorado Region of Kaiser Permanente from July 1, 1986, through December 31, 1989. All deliveries occurred at a large, urban, nonprofit hospital (Saint Joseph Hospital, Denver, Colorado). There was a standard physician staffing pattern during the study, in which at least two obstetricians were present in the hospital 24 hours per day on a rotating basis.

*Now part of the Rocky Mountain Division.

Figure 1: Maternal Morbidity - ICD-9 Diagnostic Codes

Morbidity Associated with Vaginal Delivery	ICD-9 Code
Third-degree perineal laceration	664.2
Fourth-degree perineal laceration	664.3
Other specified trauma to perineum and vulva	664.8
Laceration of cervix	665.3
High vaginal laceration	665.4
Other injury to pelvic organs	665.5
Pelvic hematoma	665.7
Other specific obstetrical trauma	665.8
Morbidity Associated with Cesarean Delivery	
Other complications of obstetrical surgical wounds	674.3
Morbidity Associated with Both Vaginal and Cesarean Delivery	
Rupture of uterus during and after labor	665.1
Postpartum Hemorrhage	
Other immediate postpartum hemorrhage	666.1
Delayed and secondary postpartum hemorrhage	666.2
Major Puerperal Infection	670.0

*The following maternal conditions and their ICD-9 codes did not occur in women delivering from July 1, 1986, through December 31, 1989:
 Vulval and perineal hematoma (664.5); rupture of the uterus before onset of labor (665.0); damage to pelvic joints and ligaments (665.6); unspecified obstetrical trauma (665.9); postpartum coagulation defects (666.3); deep phlebotrombosis (671.4); disruption of cesarean wound (674.1); disruption of perineal wound (674.2).

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“Cesarean deliveries are still being performed in some settings for more than 25% of births while being held to less than 10% in others.”

Obstetric practice guidelines did not undergo formal change during this time, nor is there evidence that the demographic composition of the population changed. Generally, the population base included employed women and wives and daughters of employed men.

Discharge data were provided by the hospital for July 1, 1986 through December 31, 1989. Maternal and neonatal records of more than 8,000 births were linked manually. Because mothers' and neonates' discharge records were maintained separately and because some mothers' names differed from those of their offspring, it was often necessary to search neonatal charts in order to find mothers' names. The proportion of mothers who could not be matched to neonates ranged from 8.4 to 9.7% per year. Our outcome data refer only to matched pairs of mothers and neonates. We classified maternal and neonatal morbidity, maternal postpartum length of stay, and neonatal length of hospital stay by mode of delivery. Two single breech vaginal births in 1988 and 1989 were omitted from analysis; no morbidity was associated with these births.

Maternal morbid conditions (Figure 1) were identified by ICD-9 codes. We selected codes that were most likely to be associated with events of delivery

rather than with underlying health problems. We differentiated vaginal births by whether they were spontaneous, forceps, or vacuum deliveries. Neonatal morbidity was identified using selected ICD-9 diagnostic codes. In Figure 2, three general categories are shown: 1) birth trauma, 2) intrauterine hypoxia and birth asphyxia, and 3) other conditions of the fetus and newborn. Data were first analyzed by the chi-squared method. Odds ratios and 95% confidence intervals were calculated. Years with the highest (1986) and lowest (1989) rates of cesarean delivery were compared, with 1989 as the reference year. Continuous data (lengths of stay) were analyzed with t-tests, comparing 1986 with 1989 (SAS version 6.10, Statistical Analysis Systems, Cary, NC). We considered a P value of < 0.05 significant.

Results

Mode of Delivery

In Table 1, births are reported by mode of delivery for each year of the study. The rate of cesarean delivery was lower among our study participants in 1989 (11.4%) than in 1986 (15.9%). This decline was significant (P < .001). Rates of spontaneous and vacuum deliveries did not differ in these two years. The rate of forceps delivery in 1989 was higher than in 1986 (P = .047). We also noted that the rate of cesarean

Figure 2. Infant Morbidity and Procedures and ICD-9 Diagnostic Codes

Birth Trauma	ICD-9 Code
Subdural and cerebral hemorrhage	767.0
Subdural hematoma	
Tentorial tear	
Injuries to scalp	767.1
Caput succedaneum	
Cephalohematoma	
Chignon (from vacuum extraction)	
Massive epicranial subaponeurotic hemorrhage	
Fracture of clavicle	767.2
Other injuries to skeleton	767.3
Fracture of long bones, skull	
Injuries to spine and spinal cord: dislocation, fracture, laceration, rupture	767.4
Facial palsy	767.5
Erb's palsy	767.6
Intrauterine Hypoxia and Birth Asphyxia	
Fetal death from asphyxia or anoxia before onset of labor	768.0
Severe birth asphyxia	768.5
Mild or moderate birth asphyxia	768.6
Unspecified birth asphyxia in liveborn infant	768.9
Other Conditions of Fetus and Newborns	
Fetal death from asphyxia during labor	768.1
Fetal distress before labor in liveborn infant	768.2
Fetal distress first noted during labor in liveborn infant	768.3
Fetal distress unspecified in liveborn infant	768.4
Congenital pneumonia	770.0
Neonatal hypoglycemia	775.6
Convulsions in newborn	779.0
Other and unspecified cerebral irritability in newborn	779.1

Table 1. Births by Mode of Delivery in Each Year of the Study (N = 8367)

Mode of Delivery	Years				Odds* Ratio	95% Confidence Interval
	1986 N%	1987 N%	1988 N%	1989 N%		
Cesarean	180 (15.9%)	294 (13.1%)	324 (13.9%)	304 (11.4%)	1.47	1.21, 1.80+
Spontaneous Vaginal	874 (77.1%)	1783 (79.4%)	1809 (77.5%)	2120 (79.2%)	0.89	0.75, 1.05
Forceps	39 (3.4%)	90 (4.0%)	119 (5.1%)	131 (4.9%)	0.69	0.48, 1.00**
Vacuum	40 (3.5%)	79 (3.5%)	80 (3.4%)	121 (4.5%)	0.77	0.54, 1.11

*Odds ratios by mode of delivery compared 1986 with 1989

+P < .001

**P = .047

Table 2. Maternal Morbidity* by Mode of Delivery and Year

Mode of Delivery	Years				Odds** Ratio	95% Confidence Interval
	1986 N%	1987 N%	1988 N%	1989 N%		
Cesarean	16/180 (8.9%)	25/294 (8.5%)	32/324 (9.9%)	31/304 (10.2%)	0.859	0.456 - 1.619
Spontaneous Vaginal	204/874 (23.3%)	413/1783 (23.2%)	416/1809 (23.0%)	500/2120 (23.6%)	0.987	0.819 - 1.188
Forceps	20/39 (51.3%)	61/90 (67.8%)	65/119 (54.6%)	84/131 (64.1%)	0.589	0.287 - 1.211
Vacuum	20/40 (50%)	29/79 (36.7%)	39/80 (48.8%)	63/121 (52.1%)	0.921	0.449 - 1.886

*Some mothers had more than one condition. The percentages reflect the number of morbid conditions, divided by the number of each kind of delivery in a particular year times 100.

**Odds Ratios by mode of delivery compare 1986 morbidity with that of 1989.



delivery in our study group was lower than that of the entire Kaiser Permanente population for each year (e.g., 15.9% vs 16.2% in 1986). We attribute this finding to attrition from the population of mothers and neonates whom we could not match.

Maternal Morbidity

Maternal morbidity is displayed in Table 2. Some mothers had more than one condition. The percentages reflect the total number of morbid conditions divided by the number of deliveries by year and mode of delivery. The differences in morbidity were not significant for any mode of delivery. Overall, there was no increase in maternal morbidity during the year of the lowest cesarean rate.

Neonatal Morbidity

Neonatal morbidity is shown in Table 3. Neonatal morbidity decreased in each year of the study with the exception of a slight rise among neonates delivered by vacuum extraction in 1989, reflecting a greater proportion of injuries to the scalp. For each mode of delivery, there were significantly fewer problems in 1989 compared with 1986.

Several specific conditions were collectively identified as "birth trauma" (Figure 2). An analysis of these conditions occurring among all neonates during the study years revealed their infrequent occurrence. In 8,387 deliveries, there were only 9 instances of subdural and cerebral hemorrhage (0.1%); 243 (2.9%) injuries to the scalp, including cephalohematoma; 5 clavicular fractures (0.06%); 57 fractures of large bones or skull (0.7%); 4 cases of facial palsy (0.05%); and 6 cases of Erb's palsy (.07%). It was of interest, however, that there were proportionately more injuries to the scalp resulting from vacuum births than other modes of delivery in all study years. Overall birth

Mode of Delivery	Years				Odds* Ratio	95% Confidence Interval
	N%	N%	1988 N%	N%		
Cesarean	133/180 (73.9%)	207/294 (70.4%)	224/324 (69.1%)	160/304 (52.6%)	2.547	1.713, 3.787+
Spontaneous Vaginal	431/874 (49.3%)	667/1783 (37.4%)	392/1809 (21.7%)	419/2120 (19.8%)	3.950	3.348, 4.659+
Forceps	35/39 (89.7%)	66/90 (73.3%)	51/119 (42.9%)	56/131 (42.7%)	11.719	4.593, 29.898++
Vacuum	41/40 (102.5%)	55/79 (69.6%)	39/80 (48.8%)	62/121 (51.2%)	77.112	5.476, 149.230+

*Odds Ratios by mode of delivery compare 1986 morbidity with that of 1989. Some neonates had more than one condition. The percentages reflect the number of morbid conditions divided by the number of each kind of delivery in a particular year times 100.

+P < .001

++P < .0001

trauma is shown in Table 4, with significantly fewer occurrences amongst neonates delivered spontaneously in 1986 compared with 1989. When the 243 cases of injury to the scalp (ICD-9, 767.1) were removed from this analysis, there was no statistically significant difference between the two years.

Maternal Postpartum Length of Hospital Stay

Mean maternal postpartum lengths of stay by mode of delivery and year are compared in Figure 3. Overall, there was a significant difference when the years of low (1989) and high (1986) cesarean delivery rates were compared for all modes of delivery. The mean maternal postpartum lengths of stay for all deliveries in 1986 and 1989 were 2.3 days \pm 1.3 and 1.6 \pm 1.1, respectively (P < .0001). Also, compared with 1986, lengths of stay were significantly shorter for mothers in 1989 for each mode of delivery.

Neonatal Length of Stay

As anticipated, the shortest lengths of stay were experienced by vaginally delivered neonates (mean for all years = 2.0 \pm 3.8 days). During the years studied, only 5% of those with cesarean birth stayed for two days or less, while 91.6% of those delivered spon-

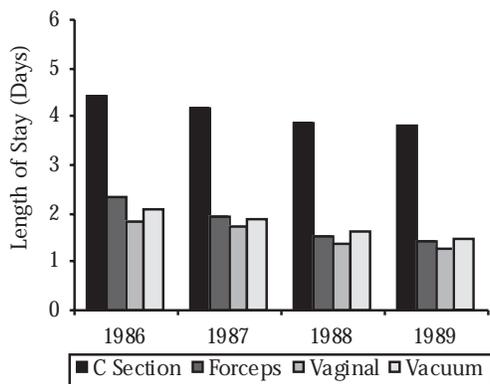


Figure 3.

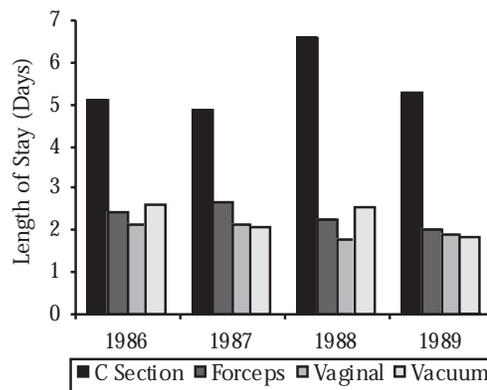


Figure 4.

FIGURE 3. Mean maternal postpartum lengths of stay by mode of delivery and year. Compared with 1986, the overall mean length of stay was significantly shorter in 1989 (P < .0001).

FIGURE 4: Mean neonatal lengths of stay by mode of delivery and year. Compared with 1986, the overall mean length of stay was significantly shorter in 1989 (P = .0078).

taneously, 85.6% of those delivered by vacuum extraction, and 84.2% of those delivered by forceps stayed for two days or less. Trends over the years can be seen in Figure 4. The mean neonatal lengths of stay for all deliveries were 2.7 ± 3.0 days in 1986 and 2.3 ± 5.1 days in 1989 ($P = 0.0078$). However, for each mode of delivery, analyzed separately, there was no difference in neonatal length of stay in 1986 and 1989.

Comment

In this retrospective study, we found that a significant decrease in the cesarean rate was not accompanied by an increase in important delivery-related maternal and neonatal problems as identified from hospital discharge data. In fact, we observed a significant decrease in overall neonatal morbidity in the year of the lowest cesarean rate compared with the highest year. We saw an increase in "birth trauma" in the spontaneously delivered group in 1989 compared with 1986 because of the number of injuries to the scalp (ICD-9, 767.1). The main conditions of this code, caput succedaneum and cephalohematoma, are entities which usually resolve without clinical sequelae. When these "injuries" were removed from the analysis of birth trauma, the difference was no longer significant.

During the two comparison years, overall maternal postpartum length of stay decreased. This finding is compatible with national trends in postpartum care over the period studied. Length of stay also decreased for each of the three modes of vaginal delivery in 1989 compared with 1986. The lower rate of cesarean delivery in 1989 also contributed to the decrease in maternal length of stay. We also found a decrease in neonatal length of stay for all modes of delivery combined ($P = .0078$).

Although these results support the view that cesarean rates can be lowered without harm, we recognize limitations of this study. First, although we saw a significant decrease in rates of cesarean birth over the study years, we are unable to substantiate the reasons for the decline. We speculate that the decrease was due to fewer cesarean deliveries for dystocia and to fewer repeated cesarean deliveries. However, hospital discharge records, the source of our study data, do not provide data regarding the demographic characteristics of mothers such as obstetric history or chronic medical conditions which would clearly influence the selection of a mode of delivery. Second, we cannot provide evidence that clinical practices (e.g., management of labor, use of oxytocin) remained exactly the same during the study period.

Table 4. Birth Trauma by Mode of Delivery and Year

Mode of Delivery	Years				Odds* Ratio	95% Confidence Interval
	1986 N%	1987 N%	1988 N%	1989 N%		
Cesarean	8/180 (4.4%)	5/294 (1.7%)	9/324 (2.8%)	19/304 (6.2%)	0.698	0.300, 1.623
Spontaneous Vaginal	15/874 (1.7%)	36/1783 (2.0%)	39/1809 (2.2%)	103/2120 (4.9%)	0.342	0.203, 0.577**
Forceps	3/39 (7.7%)	5/90 (5.5%)	7/119 (5.9%)	11/131 (8.4%)	0.909	0.240, 3.449
Vacuum	6/40 (15.0%)	7/79 (8.9%)	11/80 (13.7%)	24/121 (19.8%)	0.713	0.269, 1.893

*Odds Ratios by mode of delivery compare 1986 morbidity with that of 1989. The percentages reflect the number of morbid conditions divided by the number of each kind of delivery in a particular year times 100. ** $P < .001$ When injuries to scalp (ICD-9, 767.1) were removed, odds ratio = 1.58 (95% CI 0.74 - 3.36).

As noted earlier, several studies have demonstrated that some strategies lower the cesarean delivery rate. Programs using trials of labor after cesarean birth, active management of labor, second opinions before performing cesarean delivery, labor support personnel, or using narcotic analgesia rather than epidural anesthesia have all lowered cesarean birth rates.⁵⁻¹³ Traditionally troubling perinatal outcomes such as low Apgar scores, acidemia at birth, admissions to NICU, and perinatal mortality have not increased when cesarean rates were lowered. These papers reported no increase in other adverse outcomes, including maternal endometritis, maternal transfusion, need for ventilatory support, hyperbilirubinemia, neurologic abnormalities, hypoglycemia, and seizures. In contrast to the aforementioned papers, the decrease in our cesarean rate occurred without any implementation of formal program or guidelines. This phenomenon has been previously reported by Sandmire and DeMott,¹⁴ who also observed no change in traditional measures of perinatal morbidity.

Although "target rates" of 8 to 15% were achieved routinely in the past, they occur infrequently today. To assure that good perinatal outcomes are maintained when cesarean rates are lowered, precise definitions of maternal and neonatal morbidity must be used. Organizations should develop both perinatal and neonatal data bases to better track the effect of changes in the rates. Only in this way can appropriate cesarean birth rates for defined populations be established. Some hospitals serve higher-risk mothers than others and hospital cesarean rates may vary with the number of mothers with high risk factors. In 1986, our cesarean rate was already near the target range. Our data indicate that the further lowering to the 1989 rate was not accompanied by a clinically significant increase in maternal or neonatal morbidity. ❖

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"We observed a significant decrease in overall neonatal morbidity in the year of the lowest cesarean rate compared with the highest year. ... During the two comparison years, overall maternal postpartum length of stay decreased."

"Programs using trials of labor after cesarean birth, active management of labor, second opinions before performing cesarean delivery, labor support personnel, or using narcotic analgesic rather than epidural anesthesia have all lowered cesarean births rates."⁵⁻¹³



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