Controlling the Rise in Cesarean Section Rates by the Dissemination of Information from Vital Records

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Abstract: The recent rapid increase in cesarean childbirth is a source of growing public health concern. We suggest that one method of ameliorating the rise would be to disseminate hospital-specific cesarean section rates. To make such rates comparable between hospitals, it is necessary to adjust for variations in maternal and newborn factors associated with cesarean section. We therefore applied an indirect standardization technique to three years of California vital records data. The results show sizable variations in cesarean section rates among individual hospitals and by hospital type, both before and after standardization. For such a method to be effective, complete and accurate information from birth certificates is an obvious prerequisite. (*Am J Public Health* 1983; 73:863–867.)

Introduction

It is now a well-known fact that the cesarean section rate grew explosively during the decade of the 1970s.[1–3] Many theories have been proffered to explain this phenomenon, including the advent of electronic fetal monitoring, changes in the approach to high-risk deliveries, the threat of medical malpractice suits, and an increased emphasis on improving newborn outcomes. While it seems very unnatural for one in six babies to be delivered abdominally, there is yet little evidence that the increased cesarean rate has had an adverse impact on maternal and newborn mortality.[4,5] And, although cesarean childbirth is undoubtedly more expensive than a vaginal delivery, if cesarean section for high-risk cases lowers the probability of adverse perinatal outcomes then it might be argued that the cost is worth the benefit. Thus, it is unlikely that an "optimal" cesarean rate can be readily determined. It is possible, however, to apply statistical methods to detect aggregates of births in which the cesarean section rate is higher than one would expect based on the distribution of predictive factors. The observed rate can be compared with the expected rate and a statistic to test the significance of the difference can be computed. It is possible that the availability of such information will promote self-regulation by medical care providers and help to stem the growth in cesarean birth rates.

Materials and Methods

Birth and fetal death certificates for the 1978, 1979, and 1980 California cohorts were the sources of study data. Cesarean section rates were computed by several maternal and newborn characteristics that are known to be predictive factors and are also well-reported on birth and fetal death certificates. These were: maternal age and parity, plurality, type of presentation, and the infant's sex, race, and birthweight. Three categories were used for maternal age: less than 18 years, 18–34 years, and 35 or older. Three groups were also used for birthweight: 500–2499 grams, 2500–4499 grams, and 4500 grams or more. Parity was divided into two groups: primiparas and multiparas. The infant's race was also specified dichotomously: non-Black versus Black. In view of the special risk circumstances surrounding breech presentations, separate cells were provided for breech deliveries combining both multiple and singleton pluralities. Singleton and multiple vertex presentations were grouped separately. Because of the small number of multiple births, the two sexes and the highest birthweight groups were combined.

Women who delivered vaginally, but who had had a previous cesarean, could not be identified from birth certificates. If such information were available, it could be combined with repeat cesareans (which were identified from birth certificates) to develop a method of predicting the likelihood of a repeat cesarean versus a vaginal delivery following a previous cesarean. Since the necessary information was not available, the study was confined to the primary cesarean section rate (primary cesarean births divided by the sum of live births and fetal deaths excluding repeat cesareans).

Specific primary cesarean section rates were computed for each combination of predictive factors. These "reference" rates were computed using the three combined cohort years, encompassing 1,059,230 births. All births were identified by the hospital of occurrence and, using the cesarean predictors for each individual birth, an "expected" probability of a primary cesarean was obtained from the appropriate cell in the reference rates. These probabilities were summed for all births in a particular hospital to obtain the expected number of primary cesarean sections. The expected number of cesareans was then used to form an indirectly standardized ratio by dividing the number of events observed by the number expected.[6] We multiplied this ratio by 100 to convert it to percentage units. If it was less than 100, then a hospital's cesarean birth rate was lower than would be expected based on the cesarean predictors of its maternal/newborn population. If it was greater than 100, then its observed rate was higher than would be expected. To determine if the standardized ratio for a specific hospital differed significantly from 100, a chi square statistic was computed by squaring the difference between the observed and expected number and dividing the result by the number of expected cesareans.

This procedure was applied to each active delivery service during 1978–80. Hospitals were grouped by type (level of neonatal intensive care, size, ownership, and peer grouping) as determined from classification listings provided by the State of California Department of Health Services. The relationships between the observed, expected, and standardized measures and hospital type were studied using weighted multiple regression with binary independent variables. This method facilitates statistical hypothesis tests for evaluating the differences in the three cesarean measures by hospital type.

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TABLE 1—Primary Cesarean Section Rates* for non-Black Vertex Presenting Singleton Live Births and Fetal Deaths by Birthweight, Age, and Parity: California 1978–1980 (N = 905,602)

Birth weight (g)	Maternal age (years)	Cesarean Section Rate (per cent) Primiparas	Multiparas	All Parities
500–1499	<18	12.9	4.9	9.8
	18–34	21.2	12.9	16.4
	35+	23.4	17.8	18.9
	All Ages	20.3	12.9	16.1
1500–2499	<18	10.2	5.8	9.5
	18–34	15.1	10.9	13.0
	35+	25.4	19.1	20.5
	All Ages	14.7	11.6	13.2
2500–4499	<18	10.0	3.5	9.2
	18–34	14.8	3.4	8.5
	35+	31.4	7.2	11.0
	All Ages	14.6	3.7	8.7
4500+	<18	31.2	9.6	28.5
	18–34	43.7	9.4	20.1
	35+	67.5	16.9	21.0
	All Ages	43.6	10.4	20.4
All Weights	<18	10.2	3.7	9.4
	18–34	15.2	3.9	9.0
	35+	31.6	8.2	11.9
	All Ages	15.1	4.3	9.1

*Primary Rate = 100 × Primary Caesareans/(Live Births + Fetal Deaths − Repeat Caesareans)

Results

A total of 180 standardizing cells were used as reference rates to compute the expected rates. To describe in detail the variation in cesarean section according to all possible predictor groups is too complex a task for the space available here.* Yet, since many of these relationships have not been previously reported and/or are not well understood, their major features are of interest. Accordingly, the most salient features are reported using aggregates of the smaller classes of risk factors.

Table 1 presents primary cesarean section rates for non-Black vertex presenting singletons by birthweight, age, and parity with both males and females combined. Here, we observe that the primary cesarean section rate:

- Is consistently higher for primiparas—overall, it is 3.5 times greater than that for multiparas;
- Generally increases with maternal age (although the trend is stronger for primiparas) with the rate 2–3 times higher for older versus younger mothers;
- Is high for low birthweight babies, lowest for normal weight babies, and highest for heavy babies (i.e., is bimodal with birthweight);
- Varies greatly, from 3.4 per cent for normal birthweight (2500–4500g) babies born to normal aged (18–34 years) multiparas to 67.5 per cent for large babies born to older primiparas.

There was an overall higher primary cesarean section rate (9.9 versus 8.3 per cent) among vertex presenting non-Black male singletons compared with females. When the weight-age-parity patterns like those in Table 1 were contrasted by sex, the source of this difference was traced to the normal birthweight group independently of age and parity. Since males are generally heavier than females and because the cesarean rate increases with birthweight above 3500g, some of the male-female differential might be attributed to the relatively wide birthweight grouping, but it might also be the result of a higher male weight-specific risk status.

*Details available on request to author.

The overall cesarean rate was higher (10.5 per cent versus 9.1 per cent) for Blacks compared to non-Blacks. This excess could be attributed primarily to infants in the 2500–4500g class independently of maternal age and parity. Since Blacks are generally of lower birthweight than non-Blacks, the excess cesarean rate among Blacks must be attributed to something other than the coarseness of the birthweight intervals used. As with the male-female differences, the highest cesarean section rate among Blacks is consistent with their having a higher risk status.

Although similar patterns of variation in cesarean section rates were observed for multiple vertex presentations (N = 14,193) as compared to singletons, there was a notable exception: the age effect in normal birthweight multiples among multiparas was reversed compared to that for singletons (in singletons the cesarean rate increased with age, but in multiples it decreased). The most striking difference, however, was the much higher cesarean rate for multiples in every category; the overall multiple primary cesarean section rate (24.4 per cent) was more than 2½ times greater than that for singletons. There were no significant differences in cesarean rates by race among vertex presenting multiples.

Breech and other abnormal presentations among non-Blacks (N = 32,762) when compared to vertex presentations, had consistently much higher rates (79.2 per cent). Some patterns of variation of breech cesarean section rates with the predictive factors were similar to those for vertex; e.g., parity continued to play an important role. Others were different: e.g., although there was an increasing breech cesarean rate with birthweight, its effect is no longer bimodal; the lowest cesarean rates are at normal birthweights. In addition, the independent age effect was not present for breeches, i.e., the cesarean section rate did not vary significantly with age after holding birthweight and parity constant. When the breech cesarean rates were dichotomized by sex, there were no substantive differences. On the other hand, the overall cesarean rate for Black breech deliveries was significantly lower than that for non-Blacks (70.4 per cent versus 79.1 per cent), and this disparity was found to be independent of birthweight, maternal age, and parity.

The large variation in primary cesarean section rates across the standardizing categories, ranging from 3 per cent to 90 per cent, suggests that the differentials in the distribution of cesarean indications between hospitals could possibly account for a sizable variation in the observed cesarean section rates. As shown in Table 2, some of the variance in hospital-specific cesarean birth rates can also be explained by type of hospital. For each hospital type, the class of hospital having the largest number of births, i.e., the "mainstream," is listed first and hypothesis tests were performed to measure the statistical significance of the difference between its rate and those for the remaining subclasses. For example, both the observed cesarean rate and the standardized cesarean section ratio were significantly lower in Level III as compared to Level I hospitals, but there were no significant differences between Level II and Level I services. The results show that differentials in cesarean rates between hospital types decrease after standardization. This finding indicates that some of the interhospital variation in cesarean rates is the result of differences in the distribution of cesarean predictors by hospital type.

The results in Table 2 reveal that it was not tertiary level

TABLE 2—Observed and Expected Primary Cesarean Section Rates and Standardized Cesarean Section Ratios by Type of Hospital: Active Delivery Services in California, 1978–1980

			Cesarean Section		
Type of Hospital	N	Total Births	Observed Rate (%)	Expected Rate (%)	Standardized Ratio (%)
All Active	345	1,051,717	11.9	11.9	100.2
By Level of Neonatal Intensive Care[a]					
Level I	295	698,486	12.2	11.9	102.8
Level II	30	168,191	12.1	12.1	100.2
Level III	20	185,040	10.5*	11.6	90.2*
By Size of Delivery Service[b] (deliveries/year)					
>2000	39	391,339	11.0	11.8	92.6
1501–2000	31	165,024	13.0*	12.1	107.2*
1001–1500	53	193,278	12.8*	12.0	106.2*
501–1000	95	207,264	12.5*	11.7	106.4*
251–500	64	71,309	11.4	11.7	97.5
1–250	63	23,503	9.1	11.4	79.8
By Peer Grouping[c]					
Large Urban	82	447,886	12.8	12.3	103.8
Medium Urban	99	284,033	12.6	11.8*	106.4
Small Urban	32	55,073	11.1*	11.3*	98.7
Large Rural	22	52,537	11.6	11.3*	102.5
Small Rural	97	80,086	10.4*	11.4*	90.7*
Teaching	13	132,102	8.6*	11.0*	78.0*
By Ownership[d]					
Nonprofit	153	485,495	13.3	12.4	107.9
Proprietary	70	144,649	12.4	11.4*	108.8
District	53	82,440	12.5	11.9	105.2
Kaiser Foundation	15	129,551	10.2*	11.8*	87.2*
County	33	135,933	8.6*	10.4*	82.2*
University of California	5	33,369	9.6*	11.8	80.9*
Federal	16	40,280	9.6*	12.6	76.0*

*Statistically significant ($p < .05$) difference between this subclass and the first subclass (Level I, >2000, Large Urban, and Nonprofit) within each major category.
[a]From California Childrens Services Approved Level III and Level II Units.
[b]From California Vital Records Tabulations.
[c]From California Health Facilities Commission Memoranda.
[d]From California Department of Health Services Licensing Classifications.

or teaching hospitals that had the highest reported cesarean birth rates, but rather the nonprofit institutions. The results also showed that size of delivery service was relatively unimportant between 501 and 2,000 births per year: both above and below that level, however, there was a rapid decrease in the observed and standardized cesarean ratios. The peer group results showed significantly lower crude and standardized cesarean ratios in teaching institutions and in rural hospitals. The most notable differences in cesarean rates were observed by type of hospital ownership, with nonprofit, proprietary, and district hospitals having significantly higher observed cesarean rates and standardized birth ratios compared to federal, Kaiser Foundation, county, and University of California hospitals.

Descriptive statistics for the observed and expected cesarean rates and the standardized cesarean ratio for active California delivery services in 1978–80 are reported in Table 3. There was more variation in the observed rate compared to the expected, with the former having an interquartile range nearly three times greater than the latter. This differential was reflected by the wide range in the standardized cesarean section ratio. Chi square values for the standardized ratio revealed that 225 of the 345 active delivery services during 1978–80 had values greater than 4.0, corresponding to the .05 level of statistical significance. Of the 225, 100 had standardized ratios greater than 100 and 125 had ratios less than 100. Thus, 29 per cent of the active services had significantly higher than average standardized ratios and 35 per cent had ratios significantly lower than 100. The percentage of significant outliers will of course be reduced when only one year is considered due to smaller numbers of deliveries; e.g., for 1980, 22 per cent of the active services had standardized ratios significantly ($p < .05$) greater than 100, and 20 per cent had ratios significantly less than 100.

Discussion

The study results support the notion that some of the inter-institutional variation in cesarean section rates can be explained by differentials in patient factors or "case mix." This finding was obtained under a conservative study design since the patient factors were selected on the basis of their obvious definitions and completeness of reporting on the birth certificate. Such indications as "cephalopelvic disproportion," "failure to progress," "dystocia," and "fetal distress" might also be included, but their accuracy and completeness of reporting is presently uncertain. On the other hand, age, parity, birthweight, plurality, and type of presentation are unambiguous and objective, and, except possibly for the latter, are also well-reported. Ideally, additional objective medical complications such as cord prolapse, antepartum hemorrhage, placenta previa, active genital herpes simplex virus, etc., should also be employed, but they are not presently included on California's birth certificate. The technique could also be improved by incorporating the probability of a repeat cesarean, given that a previous

TABLE 3—Percentiles, Interquartile Range,* Minimum, and Maximum for Observed and Expected Primary Cesarean Section Rates and Standardized Cesarean Ratio for Active Delivery Services in California: 1978–1980

Measure	Percentiles 10th	50th	90th	Interquartile Range	Minimum	Maximum
Observed Cesarean Section Rate (%)	5.8	11.1	16.9	5.1	0.0	24.1
Expected Cesarean Section Rate (%)	9.7	11.8	13.3	1.8	4.9	14.6
Standardized Cesarean Ratio (%)	52.5	96.3	137.5	41.1	0.0	222.3

*Difference in value of 75th and 25th percentiles.

cesarean had occurred, and thus include repeat cesareans in the standardizing procedure. This refinement will not be possible, however, until reliable information reporting previous cesareans (regardless of mode of present delivery) becomes available on birth certificates.

Perhaps the most noteworthy study finding was the relatively low observed and expected cesarean section rates and low standardized ratios for Level III hospitals and teaching institutions. This result differs from the prevailing view of such research facilities serving as the principal sources of intervention-oriented obstetrics. While some of the lower rates in Level III units and teaching hospitals may be the result of less complete reporting by interns and residents, it was nevertheless the "mainstream" of medicine, the private nonprofit and proprietary institutions, that led all other hospital types. Since women served by private hospitals tend to have better insurance benefits and are more likely to be delivered by obstetric specialists, we anticipated a higher cesarean rate for the same level of risk, but the higher expected cesarean section rate for the private institutions was somewhat suprising. Compared to other types of ownership, however, private hospitals tend to have higher proportions of primiparas, older mothers, and larger infants. In addition, whether a fact or a reporting artifact, nonprofits were also characterized by a higher proportion of breech presentations. Thus, the usual distribution of perinatal risk, which is related primarily to low birthweight, does not hold for cesarean risk. Nevertheless, even with the higher incidence of risk factors among private hospitals, their standardized cesarean section ratios remain significantly higher than those for other ownership groups.

At the other extreme, we examined statistics for specific hospitals having very low standardized cesarean ratios and found evidence of uneven reporting. Some of these hospitals had erratic and precipitous downward trends in their observed cesarean section rates, suggesting an increased degree of underreporting. We believe that this phenomenon may be, in part, a consequence of the confusion following in the wake of California's Brown Act (AB 2152) in 1978.[7,8] Prior to that time, the cesarean section data field on the birth certificate had two check boxes: one labeled "no" and one labeled "yes." Beginning in 1979, the "yes" check box was eliminated, and if a cesarean was performed, it was necessary to report a numerical code indicating the type: primary or repeat, elective or emergency. This involves more information and reporting effort, which some institutions may have been less willing to perform. Furthermore, the Brown Act mandated that two items (race and occupation) on the birth certificate were to be reported on a voluntary basis, and this led to misinformation regarding the reporting requirement for other data items as well.

The much smaller mean standardized cesarean section ratios for Kaiser Foundation and federally-owned hospitals was a finding with potential policy implications. Since these services are staffed by prepaid or salaried physicians, it would appear that nonmedical considerations might play some role in establishing the cesarean section rates. Again, however, these results must be tempered with the possibility of differentials in the completeness of reporting of vital records.

The increased use of cesarean section is a controversial issue and it is doubtful that a consensus can ever be reached regarding the proper means for controlling the rising rate. In lieu of that, the statistical methods applied here will allow extremes to be identified, providing information that could help to ameliorate excessive rates. Since cesarean childbirth is now a relatively frequent event, it should not take long to acquire sufficient cases to detect statistically significant differences. Given the current level of expected primary cesarean rates (roughly 12 per cent), it will take approximately $333{,}333/X^2$ deliveries to identify ($p < .05$) a hospital having a standardized cesarean section ratio more than X per cent above (or below) 100. Thus, approximately 3,333 births would be necessary to detect a 10 per cent deviation, about 833 to detect a 20 per cent differential, and about 133 for a 50 per cent difference. With the average delivery service in California having nearly 1,000 births, it would take only one or two years to detect a meaningful difference for most hospitals.

The release of hospital-specific standardized perinatal mortality information as part of health system agency perinatal appropriateness review activities in California during 1981–82 met with a significant degree of success, hence the precedent of disseminating this type of information has already been set. Although the standardization procedure uses current cesarean rates for reference and thus tends to sustain the status quo, it would, nevertheless, be a useful step toward controlling rising cesarean rates.

Since pregnant women are far from homogeneous in their demands for technology in medicine, the availability of such information should assist them in their decisions regarding the care provider. Providers would also be aware of their relative rates, and those having high standardized rates might find it difficult to justify their levels of cesarean childbirth, unless they could demonstrate superior perinatal outcomes. Similarly, those units having very low standardized cesarean section ratios and high perinatal mortality rates would also be accountable. This method of self-regulation might tend to stabilize the cesarean rate at a level that both providers and consumers view as acceptable, given contemporary values regarding the tradeoff between relatively predictable maternal costs and uncertain newborn benefits. There is, however, the risk of an increased degree of underreporting of selected birth certificate items. Yet, with added public awareness of the value of vital records, we believe that this risk could be minimized by increased provider accountability. Furthermore, the knowledge that a standardizing system was in place based on predictors obtained from vital records might actually increase the completeness and accuracy of reporting. We are thus in agreement with Wennberg and Gittlesohn who concluded that: "Informed patients may therefore be the most important factor in making rates of treatment reflect health needs and eliminating unnecessary medicine."[9]

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