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The Effect of Physician Factors on the Cesarean Section Decision

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The number of deliveries by cesarean section (c-section) has increased dramatically. Clinical and demographic factors have not adequately explained the increased rate, however. This study investigates the role of nonclinical (i.e., physician) factors in explaining variations in c-section rates, including the physician's training/experience, financial and convenience incentives, and practice characteristics. The study measures the impact of these factors on the decision to perform a c-section rather than opting for vaginal delivery, controlling for a host of patient and hospital characteristics. Physician effects are evaluated in terms of their overall contribution to the explanatory power of logistic regression models, as well as in terms of specific hypotheses to be tested. The analyses are based on 33,233 deliveries performed by 441 physicians in 36 hospitals in 1 state during 1989. As a set, physician factors contribute more to the explanatory power of the model than do hospital factors, despite being added last to the equation. Parameter estimates provide more support for the hypothesized effects of physician convenience incentives than background/training. The log odds of performing a c-section increase with the physician's rate of c-sections in the prior year, delivery on a Friday, and delivery between 6 AM and 6 PM, and decrease with the concentration of the physician's hospital practice. Patient factors appear much more important than both physician and hospital factors, however. Efforts to reduce unnecessary c-sections should focus on identifying the appropriate clinical indications for c-section and disseminating this information to physicians. Key words: cesarean; physician; variation. (Med Care 1995;33:365–382)

The number of deliveries by cesarean section (c-section) in the United States increased 350% between 1970 and 1991. By 1991, the 966,000 c-sections accounted for 23.5% of all births, making it the most common surgical procedure in the United States,[1–3] although a recent report by the Centers for Disease Control and Prevention (CDC)[3] indicates this rate has stabilized.

Some analysts estimate that 50% of c-sections are unnecessary.[4,5] There is little evidence that maternal and child health status have improved during this time and, in fact, higher complications for both mothers and newborns are associated with cesarean deliveries.[3] As a result of these findings, the Public Health Service[6] has stated that one of its national health care objectives for the year 2000 is to reduce the overall c-section rate to 15% or lower.

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Factors commonly associated with this increase in cesarean delivery include trends in delivery, pregnancy and labor complications, and demographics and birthing practices of U.S. women. Researchers argue, however, that these clinical and demographic factors do not sufficiently explain the increased c-section rate.[7–9]

Several studies suggest that nonclinical factors may influence the use of c-section as a method of delivery,[10–13] as well as account for variations in obstetric care[14] and other medical practice patterns.[11,15] These factors include hospital characteristics such as ownership, size, and the presence of special facilities.[16,17] They also include the physician's training and experience, financial and convenience incentives, and practice characteristics (e.g., payer mix). We lack a clear picture of how these factors influence the c-section rate. One reason is that no single factor or explanation can account for the complex web of influences on the decision to perform a c-section. Past studies often have not adequately controlled for either the clinical and demographic characteristics of the patient or the influences of multiple nonclinical factors.

Physician factors, in particular, are infrequently studied in analyses of c-sections. The few investigations that do report physician effects have specified either a physician identifier or a limited set of background characteristics. Influences regarding practice variations are typically based on these effects or on residual variation in c-section rates not accounted for by patient and hospital factors.

There are at least two explanations for the lack of attention to physician effects. First, research studies suffer from small hospital samples (1 to 2 institutions) with few obstetricians practicing within them (often as few as 11 physicians).[18,19] Second, data on physician characteristics and obstetric practice often are difficult to obtain and to merge with patient-level data.

Research from New York State has attempted to address these shortcomings. Using hospital discharge data, Tussing and Wojtowycz[13] analyzed the joint effect of patient, hospital, and physician influences on the probability of c-section among a large sample of patients. Their findings suggest that hospital and physician factors exert significant effects on the c-section decision. The study was unfortunately limited in the kinds of physician factors that could be measured. The handful of characteristics encompass the physician's background (e.g., age, gender, graduation from a foreign medical school, board certification) rather than practice characteristics. The authors also fail to mention the relative explanatory power of patient, hospital, and physician factors in their regression model.

We believe that such a comprehensive approach can advance our understanding of current obstetrical practice variation. Our study has three aims. First, we seek to replicate Tussing and Wojtowycz's findings using similar data from the state of Arizona. Second, we attempt to extend their analysis of the influence of physician factors on the rate of c-section by specifying more direct measures of the physician's practice characteristics. Third, we calculate the relative importance of the three sets of influences (patient, hospital, physician) on the c-section rate.

Our analyses take advantage of a rich, statewide database containing information on the mother (patient), the hospital, and the attending physician. Physician factors examined here include not only background characteristics, but place of training, admitting patterns, and history of cesarean delivery.

The following section summarizes the importance of c-section rates for three contemporary issues in health policy and management: quality of care, health care costs, and practice variations. Next, we briefly review the research literature regarding patient, hospital, and physician effects on c-section rates and formulate the hypotheses to be tested. The remaining sections outline the data and methods employed to test these hypotheses, the results, and our conclusions regarding the relative importance of physician-level effects.

Implications of Rising Cesarean Section Rates

The dramatic rise in the incidence of c-sections has important quality-of-care implications. For both mother and infant, morbidity and mortality rates are higher after cesarean delivery than after vaginal delivery.[20] The risk of maternal death from c-section is two to four times that of vaginal delivery,[21] whereas maternal morbidity, particularly postpartum infection (urinary and wound infections), is common after c-section.[21–23] Elective c-section occurring before the onset of labor carries the risk of iatrogenic prematurity and respiratory distress syndrome in the infant.[24] Also, independent of premature delivery, studies have observed that infants delivered by c-section are at higher risk for low Apgar scores and respiratory distress syndrome when relevant demographic and obstetric factors are taken into account.[25,26]

The increasing incidence of c-section also entails higher health care costs.[27–29] In 1991, the average costs for cesarean and vaginal deliveries were $7,826 and $4,720, respectively.[3] The average total cost of a cesarean delivery is about 61% higher than a vaginal delivery,[30] in general because of longer hospital stays and higher physician fees. The CDC estimates that lowering the c-section rate from 23.5% to 15% (the year 2000 objective) would result in a savings of more than $1 billion in physician and hospital charges.

Finally, as Anderson and Lomas[8] have noted, the significant variation in c-section rates across hospitals suggests the presence of clinical policies and practice styles that may be at odds with task force recommendations and published evidence regarding the indications for c-section. Consequently, there is growing interest in studying the role of physician practice characteristics and decisions in health care utilization.

Prior Research

Prior research has investigated both the clinical and nonclinical indications for c-section.

Clinical Indications

There is general agreement that four clinical indications are responsible for 80% of all cesarean births: dystocia, malpresentation, fetal distress, and previous cesarean delivery.[7] The emphasis on clinical explanations for the high c-section rate has prompted national efforts directed at physician education and peer review as strategies for controlling the use of this procedure.[12,17] These efforts, however, have been very slow to effect any change.[9,31]

This emphasis on clinical indications for c-section is important for two reasons. First, in the past 20 years, there has been a substantial rise in the percentage of deliveries based on these four clinical diagnoses. It is unclear, however, whether this reflects the increasing incidence of these medical problems or the increasing use of these somewhat subjective indications by physicians. Second, regardless of clinical indication, there is considerable variation in c-section rates among women based on other medical and personal characteristics.[20] This variation is described below.

Patient-Level Factors

Among the medical characteristics, the probability of cesarean delivery rises with multiple births (plurality), low birth weight, other complications of pregnancy (e.g. hypertension, eclampsia), gestational age of the baby, and the number of prior deliveries (parity). Among the personal characteristics, the probability of cesarean delivery is positively associated with the mother's age,[17,32] nonwhite racial background,[13] and socioeconomic status.[33]

There is fairly consistent evidence regarding the impact of the patient's method of payment on the c-section decision. Several researchers[12,20,34,35] have found that c-section rates are highest among patients covered by private insurance, intermediate among patients covered by Medicaid, and lowest among self-paying patients. Such findings suggest that physicians and hospitals may be motivated by economic self-interest. The study by Tussing and Wojtowycz,[13] however, found that method of payment had little effect, except for significantly lower rates among self-paying patients. The authors failed to find much support for the idea that obstetricians sometimes perform c-sections to enrich themselves from the additional fee income.

Hospital-Level Factors

Hospital characteristics also appear to be associated with the c-section rate.[20,36,37] The highest rates have been found in investor-owned hospitals, whereas the lowest have been reported in government-owned institutions.[20,37–39] Such differences may be the result of the financial incentives of the hospital, the financial incentives of physicians (i.e., fee-for-service vs. salaried) working within the hospital, and patient case-mix.[11] Higher c-section rates have also been found in teaching hospitals[8,13,37,40] and hospitals lacking neonatal intensive care units (NICU),[13,20] although Oleske et al[41] found a lower overall cesarean birth rate in teaching hospitals.

There is less consistent evidence regarding the impact of hospital scale. Goldfarb[20] and Tussing and Wojtowycz[13] report higher c-section rates in hospitals with larger maternity units. On the other hand, Oleske et al[41] found no association between number of hospital beds and c-section rate, whereas Stafford[37] found a dramatic decrease in repeat c-section use with increasing obstetric volume.

Physician-Level Factors

There is comparatively little evidence regarding the impact of physician factors on c-section rates. The findings reported thus far are also rather inconclusive. For example, Berkowitz et al[16] and Tussing and Wojtowycz[13] find no effect of physician gender, Phillips et al[42] and Evans et al[43] find no effect of physician convenience (i.e., time of day and day of week) on c-section rates, whereas Fraser et al[44] and Tussing and Wojtowycz[13] find significantly lower rates on weekends. Similarly, Berkowitz et al[16] report that the physician's age and experience are negatively related to the percentage of c-sections, whereas Tussing and Wojtowycz[13] and Goldfarb[20] find that more recently graduated physicians are not significantly more likely to perform c-sections.

Inconsistent evidence is also reported for the effect of physician practice setting. Berkowitz et al[16] find no differences in c-section rates between solo and group-practice physicians, and McCloskey et al[17] find no such differences between private practice and HMO physicians in most age groups. On the other hand, researchers have noted higher c-section rates among private as opposed to salaried, clinic, or house-staff physicians.[17,35]

Evidence presented by Tussing and Wojtowycz[13] indicates that medical training does have an impact on c-section use. The probability of cesarean delivery is greater for foreign medical graduates and board-certified obstetricians, although the direction of causation for board certification is not clear. The authors believe that where a c-section is indicated, a family practitioner may refer the delivery to a board-certified physician. Other studies emphasize the importance of the individual physician's practice "style" as a major determinant of method of delivery.[18,19] This effect, however, is measured either globally by a unique physician identifier or indirectly by the degree of variation left unexplained by nonphysician factors.

Study Hypotheses

This study measures the influence of patient, hospital, and physician factors on the probability of cesarean delivery. Because our first aim is to replicate the recent work by Tussing and Wojtowycz,[13] their findings regarding patient and hospital effects are taken as an initial set of hypotheses to be tested. Extending the work by Tussing and Wojtowycz, we undertake as our second aim to specify an additional set of hypotheses regarding the impact of physician background/training, financial and convenience incentives, and practice characteristics. For the sake of parsimony, only the physician-level hypotheses are outlined in the following.

We argue that the physician's choice of delivery method is based not only on medical factors (e.g. complications of pregnancy, labor, and delivery), patient factors (e.g. social and demographic characteristics), and hospital factors, but on the physician's background/medical training and role as self-interested economic agent.[10,45]

Background and medical training factors encompass the physician's gender, year of graduation from medical school, specialty (e.g. family practice vs. obstetrician), board certification, graduation from a foreign medical school, and (in the United States) the particular medical school attended. We hypothesize that female physicians will perform significantly fewer c-sections than their male counterparts (hypothesis 1). Research suggests that in areas relating to "women's issues," female medical students and physicians are more sensitive to issues regarding appropriate health care for women.[46,47] Such differences in attitude are found to persist from medical school throughout residency and into practice.[48–50]

We expect the probability of cesarean delivery to be negatively associated with the duration of time since graduation from medical school (hypothesis 2). More recent graduates are younger in age and less experienced as practitioners. They may thus seek to manage the greater uncertainty in performing deliveries by relying more heavily on c-sections. In addition, more recent graduates have undergone different training that emphasizes high technology and interventionist medicine, which may also increase their c-section rates. The probability of cesarean delivery will also be higher for board-certified obstetricians/gynecologists than for non–board-certified obstetrician/gynecologists and general/family practitioners (hypothesis 3). This may reflect both the likelihood of cesarean referrals to specialists and their more specialized training, as Tussing and Wojtowycz suggest, as well as the tendency of specialists to utilize more intensive services. It may also reflect heightened concern among specialists regarding the role of obstetric malpractice. Finally, the probability of cesarean delivery will be higher for foreign medical graduates (hypothesis 4), and is likely to be associated with the particular medical school attended by the physician (hypothesis 5), reflecting differences in medical uncertainty and obstetric training offered across institutions.

Economic models of physician behavior[10,45,51] characterize physicians as self-interested economic agents. As such, they are expected to maximize their income and their convenience. Empirical evidence suggests that such considerations influence the hospitals to which physicians admit a given patient[52] and their admitting loyalty to particular hospitals over time.[53]

Researchers have argued that the probability of cesarean delivery likewise varies according to the physician's convenience. Measuring convenience by time of day and day of week, c-sections are most likely during daylight hours (i.e. 6 AM to 6 PM; hypothesis 6), and on Fridays (hypothesis 7). C-sections are less likely on weekends (hypothesis 8). Convenience may also be dictated by the size of the physician's obstetric practice and the panel of hospitals utilized. Thus, busy physicians with higher obstetric patient volume may be more likely to perform c-sections to manage their time (hypothesis 9). Conversely, physicians who already concentrate most of their obstetric practice in one hospital may have less need to substitute expensive hospital inputs (e.g., surgical services) for their own time and thus be less likely to perform c-sections (hypothesis 10). Finally, convenience may reflect the ease of practicing in habitual ways. Physicians' attitudes and knowledge, economic environment, patient mix, and use of hospitals change slowly over time. Thus, the probability of cesarean delivery will be higher for physicians with high c-section rates observed in the previous year (hypothesis 11). Similar effects have been reported at the hospital level.[13]

Researchers have also argued that the probability of cesarean delivery is positively influenced by direct financial incentives facing the physician. For example, the probability of a c-section is expected to be greatest among patients with private insurance and least among self-paying patients (hypothesis 12). Because insurance is a patient-level effect, we also attempt to develop proxy measures of the physician's financial incentives using various practice-setting characteristics. Thus, we expect the probability of cesarean delivery to be greater for physicians who spend a greater proportion of their time treating commercially insured patients (hypothesis 13) and to be lower for physicians who spend more of their time treating managed-care patients (hypothesis 14).

Methods and Measures

We attempt to measure the impact of physician factors on the c-section decision, controlling for a host of patient and hospital characteristics. Physician effects are evaluated in terms of their overall contribution to the explanatory power of logistic regression models, as well as in terms of specific hypotheses to be tested. The unit of analysis is the individual patient seen by her physician in a particular hospital in Arizona during 1989. This allows data to be directly linked on the patient, hospital, and physician, thus avoiding the threat of aggregation bias. This also acknowledges that physicians may practice in several hospitals.

Logistic regression is used to evaluate the study's research hypotheses. The dependent variable is a binary indicator of whether the delivery was by c-section (1 = cesarean delivery, 0 = vaginal delivery). Because our data consist of merged hospital discharge and state birth files, delivery by c-section is indicated when two sets of criteria are met: diagnosis-related group (DRG) procedure codes (370 and 371 for c-section with and without complications) are present in the hospital discharge file, and cesarean birth is indicated in the state birth file. In the logistic regression model, the dependent variable is defined as the log of the odds of a c-section being performed on a particular patient (i.e., log $[P/(1 - P)]$). Here the contribution made by each set of factors is assessed by the improvement in the model chi-square.

Three logistic regression models are estimated: the first enters only patient characteristics, the second adds hospital factors, and the third adds physician factors. Several patient characteristics are included to control for clinical, medical, and sociodemographic effects. We utilize dummy variables whenever categorical variables are tested in the model. We include four variables to represent each of the four clinical indications for c-section (dystocia, malpresentation, fetal distress, and prior delivery by c-section). Sociodemographic measures include categorical measures of the mother's age and education, three variables for race (Hispanic, black, American Indian; white is the excluded contrast), and three variables for type of insurance (HMO/Blue Cross (HMO and Blue Cross patients are coded together on the Arizona discharge database), AHCCCS/Medicaid, and self-pay; commercial is the excluded contrast). We control for the potentially confounding medical effects of plurality, low birth weight, severity of illness, parity, gravida, trimester during which prenatal care began, obstetric procedures (induction of labor, stimulation of labor), complications of labor and delivery (placenta previa, placenta abruptio, cord prolapse, excessive bleeding, seizures, prolonged labor, dysfunctional labor), and other medical risk factors (anemia, cardiac disease, lung disease, diabetes, genital herpes, hypertension, eclampsia, previous large infant). We also include several factors relating to the newborn: weeks of gestation, congenital anomalies of the newborn (anomalies that can be diagnosed prenatally), and infant birth weight.

The regression models include several hospital characteristics found to be associated with cesarean rates. We utilized one variable indicating investor ownership and two variables denoting public ownership (municipal/county and county tax district; voluntary nonprofit ownership is the omitted contrast). We also use a variable denoting membership in a multihospital system, two variables indicating affiliation with a residency program and presence of an NICU, two variables indicating hospital bed-size categories (less than 200 beds, 400 beds or more; bed size of 200–399 beds is the omitted contrast), and a continuous measure of the hospital's c-section rate in the previous year. Two variables are used to denote the hospital's geographic location, one for the state's second-largest city, the other for smaller and rural communities (the state's largest city is the omitted contrast).

Finally, the regression model incorporates several characteristics of the physician's background and training, financial and convenience incentives, and practice characteristics. The background/training characteristics include a measure of physician experience, defined as the number of years from the date of medical school graduation to 1989. Bivariate analyses revealed that c-section rates varied across deciles (i.e., cohorts) of physicians graduating from medical school 20 years ago or less, 21 to 30 years, and 31 to 40 years. We utilize the latter two categories in our model. The background/training characteristics also include the physician's gender (1 = female), whether the physician is a foreign medical graduate, board certification, and specialty. Owing to the strong association between the last two variables, we substituted an indicator for whether the physician is a board-certified obstetrician/gynecologist (OBGYN).

Measures of the convenience incentives facing the physician include the variables denoting weekend delivery, delivery during different periods of the day (6 AM–noon, noon–6 PM, and 6 PM–midnight; midnight–6 AM is the omitted contrast), the physician's c-section rate during the previous year (1988), the log volume of deliveries by each physician across all hospitals utilized, and the concentration of the physician's practice across all hospitals utilized (Hirschman-Herfindal Index, or HHI = sum of squared proportions of patients admitted to each hospital).* Measures of the physician's practice characteristics include the percentages of the physician's obstetric caseload that are commercially insured and managed care.

Sources of Data

The data needed to conduct these analyses are taken from several sources. Patient discharge data are reported by hospitals to

*The HHI is a standard economic measure of industry concentration. When applied to physician practice organization, the HHI is calculated by summing the squared proportion of the physician's admissions across all hospitals in the market. Physicians with totally concentrated practices have an index of 1.0; this value decreases as other hospitals are utilized.

the State Department of Health Services, which then collates and releases the information. In addition, the Department of Health Services also collates and releases the state birth file. The former data set includes only nonfederal general hospitals with 50 or more beds. All federal (e.g., VA, DOD, and Public Health Service), nongeneral (e.g., psychiatric), and general hospitals with fewer than 50 beds are omitted. We are thus missing information on deliveries that occur in these facilities. Such exclusions do not seriously bias our findings, however, because these hospitals account for only 12% of all deliveries and 1.5% of all c-sections in the state during the study period. One reason why the latter percentage is so low is that the excluded hospitals (IHS, DOD, and <50 beds) have level-one nurseries (i.e., cannot provide care to critically ill babies) and thus transfer any high-risk obstetric cases to hospitals with NICUs.

The state discharge database includes information on each patient's gender, date of birth, dates of admission and discharge, length of stay, status at discharge, principal diagnosis (DRG), secondary diagnoses and procedures, insurance coverage, attending physician and license number, and hospital utilized. The birth file includes extensive information on each patient delivery, including personal, medical, and clinical data. In the current study, patient data cover the hospital reporting period from January 1 to December 31, 1989.

We directly matched records on the state discharge database with the birth file by hospital identification number and by mother's date of birth. We also indirectly matched the baby's date of birth on the birth file to the interval between the mother's admission and discharge from the hospital. Utilizing this approach, we were able to match on 80% of all cases. t-Tests revealed no significant difference in the c-section rate between the successfully and unsuccessfully matched groups. We did detect statistically significant differences on some of the independent measures (mother's age and race, baby's birth weight, geographic location of hospital); however, the differences were extremely small in magnitude.

Data on hospital ownership, system membership, teaching affiliation, presence of an NICU, and bed size are taken from the *Annual Guide*[54] published by the American Hospital Association. Physician data are obtained from two sources. Using the physician's license number, we merged the clinical information contained in the state discharge database with biographical information obtained with the cooperation of the Arizona State Medical Association. For each physician, we also computed the volume of patients treated and the proportion of the physician's admissions to each hospital using the discharge database. From these variables we then computed the two measures of physician volume and concentration.

Description of the Sample

Patients and Conditions

The analyses are based on a subsample of 33,233 deliveries performed in Arizona in 1989; 7,065 (21%) of these deliveries involved a c-section. Univariate statistics on the demographic characteristics of mothers and newborns are shown in Table 1. The mean maternal age is 26 years; the distribution of deliveries by race/ethnicity is 26% Hispanic, 3% American Indian (however, IHS hospitals are not included in the state discharge data file), and 3% black; and the mean number of years of the mother's education is 12 years. About 68% of all women had previous pregnancies, with an average 1.08 previous births. In terms of payment method, 27% of women have commercial insurance, 29% are covered by HMOs/Blue Cross, 28% by AHCCCS (Arizona's version of Medicaid), and 15.7% are other/self-paying.

Table 1 also includes univariate statistics relating to delivery. Common clinical diagnoses for c-section include dystocia (03.4% of all deliveries), breech or other abnormal presentations (04.1%), and fetal distress (03.9%); 10% of all deliveries occur among women with previous c-sections. About 93% of all newborns are born between 37 and 42 weeks, and the average birth weight is 3,351 g. The average 1-minute and 5-minute Apgar scores are 8.1 and 8.9, respectively.

Hospitals and Physicians

Table 2 presents the univariate statistics for hospital and physician measures used in the analyses. Most deliveries occur in voluntary nonprofit hospitals (91.7%); smaller numbers of deliveries occur in investor-owned (3.1%), municipal/county (3.7%), and county tax district hospitals (1.4%). More than half (57.8%) of all deliveries are in hospitals belonging to multihospital systems. Nearly half (45.2%) of all deliveries are in hospitals affiliated with teaching programs; however, only about one fifth (21.4%) occur in hospitals with NICUs. About two thirds (60.9%) of all deliveries occur in hospitals in the state's largest city (population in excess of 1 million), with the remainder somewhat evenly divided between the second-largest city (approximately 0.6 million population) and small rural communities (20.7% and 18.4%, respectively). More deliveries occur in hospitals with a bed size between 200 to 399 beds (46.3%); deliveries in hospitals with fewer than 200 beds and 400 beds or more are roughly equally distributed (28.0% and 25.7%, respectively).

Most physicians performing these deliveries are male (89%), with an average of 17 years experience since medical school graduation. Nearly three fourths (72.5%) are board-certified OBGYNs, whereas only 12% are foreign medical graduates.

TABLE 1. Univariate Statistics for Mothers and Newborns

	Mean	SD
Variables relating to mother		
Age	26.23	5.79
Race		
Mother Hispanic	.260	.439
Mother Black	.035	.184
Mother American Indian	.031	.173
Education	12.27	2.76
Previous births	1.08	1.26
Previous pregnancies	.683	.465
Variables relating to delivery		
Method of Payment		
Commercial	.269	.444
HMO	.290	.454
AHCCCS	.283	.451
Other	.157	.364
Clinical indications for cesarean		
Dystocia	.034	.181
Breech/other abnormal presentations	.041	.198
Fetal distress	.039	.193
Previous C-section	.100	.300
Variables relating to newborn		
Gestational age		
30–37 weeks	.062	.241
37–42 weeks	.926	.262
>43 weeks	.004	.061
Birth weight (g)	3351.41	567.27
1 minute APGAR	8.090	1.311
5 minute APGAR	8.910	0.720
n = 34,045		

SD, standard deviation.

Table 2 also describes some of the practice characteristics of physicians. The high HHI reveals that physicians heavily concentrate their obstetric practice in one institution. The physician's obstetric caseload is evenly distributed across commercially insured patients (26.9%), HMO/BC patients (28.9%), and AHCCCS patients (28.3%).

TABLE 2. Univariate Statistics for Hospital and Physician Characteristics[a]

	Mean	SD
Hospital characteristics		
Ownership		
Voluntary non-profit	.917	.275
Investor-owned	.031	.174
Public: Municipal/County	.037	.188
Public: County Tax District	.014	.119
Multihospital system membership		
% system members	.578	.494
Teaching affiliation		
With residency program (%)	.452	.498
With NICU (%)	.214	.410
Geographic location		
Largest city	.609	.488
Second largest city	.207	.405
Small/rural communities	.184	.388
Bed size		
<199 beds	.280	.449
200–399 beds	.463	.499
>400 beds	.257	.437
Physician characteristics		
Age	43.97	10.15
Gender		
Male	.89	
Female	.11	
Experience		
Number of years since graduation	17.10	10.39
21–30 years experience(%)	.184	.388
31–40 years experience(%)	.112	.316
Certification/specialty		
Board-certified OB/GYN	.725	.446
Foreign medical graduate	.122	.327
Concentration of practice (Hirschman-Herfindal Index)	.865	.208
Log volume of deliveries	5.06	.746
OB caseload		
Commercial (%)	.269	.204
HMO (%)	.289	.278
AHCCCS (%)	.283	.270

SD, standard deviation.
[a]N = 34,045.

Empirical Results

Decomposition of Model Chi-Square

Table 3 presents the results from three logistic regression models. The first entry provides the model chi-square, degrees of freedom, and statistical significance for the equation including only patient characteristics. The second and third entries show the improvement in the model's fit resulting from the sequential addition of hospital and physician characteristics, respectively.

An overview of Table 3 indicates that patient characteristics are significant determinants of a cesarean delivery, as much of the literature suggests. Hospital characteristics contribute significantly to the explanation of the probability of a c-section for a given delivery. Physician factors as a set contribute more to the explanatory power of the model than do hospital factors (even when added last), according to the pseudo R-square (i.e., the reduction in the model logarithmic likelihood compared to an intercept-only model). This is a conservative test of the power of physician effects. The relative explanatory power of hospital and physician factors is not influenced by their order of entry into the model, however.

Parameter Estimates

Table 4 presents the coefficients from the logistic regression of type of delivery on the three sets of characteristics. Similar to Tussing and Wojtowycz,[13] we find that patient characteristics exert significant, consistent effects on the c-section decision. The probability of a cesarean delivery decreases for younger women (less than 25–29 years of age) but increases for older women (older than 29 years). The mother's education, previous pregnancies, and previous births all significantly reduce the probability of a cesarean delivery. The mother's race/ethnicity (Hispanic) increases the probability of a c-section compared to white women, al-

TABLE 3. Significance of Increment in Model Chi-square Explained by Addition of Each Set of Characteristics

Patient Characteristics	Hospital Characteristics	Physician Characteristics
χ^2 (61 df) = 17802[a]	χ^2 (10 df) = 156[a]	χ^2 (16 df) = 448[a]
Pseudo R^2 = 51.7	Pseudo R^2 = 52.2	Pseudo R^2 = 53.5

[a] $P < .001$.

though this is not the case for other racial minorities (black and American Indian). Nor do data on father missing, a proxy for single parent, significantly influence the probability of a c-section.

Late babies (gestation of 42 weeks or more) and infants of high birth weight (4,500 g or more) are significantly more likely to be cesarean deliveries. We find that low–birth-weight babies, however, are less likely to be born by c-section. As expected, there is a positive, significant effect of plurality (multiple birth) on the probability of a c-section. Women receiving little or late (third trimester) prenatal care are less likely to deliver by c-section, whereas women receiving more prenatal visits are more likely to have a c-section.

As reported in much of the research, the four common clinical indications of c-section all significantly increase the probability of a c-section. Numerous other complications of pregnancy, labor, and delivery (e.g, eclampsia, placenta previa, placenta abruptio, cord prolapse, herpes, seizures, prolonged and dysfunctional labor) also increase the odds of a cesarean delivery.

Although models were run with hospital dummy variables to account for institutional variation, we also ran a model with hospital variables for purposes of comparison with Tussing and Wojtowycz's findings. Similar to their results, Arizona women are more likely to have a cesarean birth in teaching hospitals and hospitals lacking NICUs. Consistent with Oleske et al, we find no effect for number of hospital beds, however. For-profit hospital ownership exerts a strong influence on the probability of a cesarean delivery. We also find a higher probability of a c-section in county tax district hospitals, but no significant difference between municipal/county and not-for-profit hospitals. In terms of geographic location, women delivering in rural Arizona are most likely to deliver by c-section, whereas women in the second-largest city are least likely.

The physician background/training factors exhibit some significant effects. Contrary to hypothesis 1, but similar to Tussing and Wojtowycz, we find an insignificant (negative) effect of physician gender on the c-section decision. We do find that older medical graduates are significantly less likely to perform c-sections (hypothesis 2), but contrary to hypothesis 3, we do not find an effect for board-certified OBGYNs. We also find that foreign medical school graduates are significantly more likely to perform a c-section than physicians trained in the United States (hypothesis 4). In a separate analysis, we investigated whether the probability of performing a c-section is influenced by the physician's medical school training (hypothesis 5). We added a classification variable denoting the particular medical school attended to the physician model reported in Table 4. The medical school variable significantly added to the explained variation in the c-section rate; however, the explanatory power of this variable is quite small.

Table 4 provides stronger evidence for the effects of convenience incentives. The probability of performing a c-section increases with delivery between 6 AM and 6 PM (hypothesis 6) and delivery on Fridays (hypothesis 7), and decreases with delivery

TABLE 4. Logistic Regression of Method of Delivery (Cesarean vs. Vaginal) on Patient, Hospital and Physician Factors

Independent Variable	Parameter Estimate (Standard Error)
Variables relating to mother	
Age (yr)	
≤18	-.6755 (.1038)[d]
>18 ≤ 25	-.1805 (.0592)[c]
>29 ≤ 35	.2575 (.0613)[d]
>35	.5507 (.0925)[d]
Race	
Hispanic	.1229 (.0581)[b]
Black	.1429 (.1198)
American Indian	.0990 (.1309)
Education	
≤8years	-.0547 (.0753)
≥13 years	-.1358 (.0516)[c]
Previous pregnancies	-.5439 (.0588)[d]
Previous births	-.2631 (.0254)[d]
Data on father missing	.0123 (.0664)
Variables relating to delivery	
Late baby (>42 weeks)	.5184 (.2998)[a]
Birth Weight	
≥500 ≤2,500 g	-.2615 (.1042)[c]
>2,500 ≤3,500 g	-.1981 (.0465)[d]
>4,500 g	.7198 (.1540)[d]
Plurality	1.2010 (.1364)[d]
Prenatal care	
No prenatal care	-.2969 (.1750)[a]
Prenatal visits	.0227 (.0057)[d]
Means of payment	
HMO/BC	-.0459 (.0633)
AHCCCS	-.0220 (.0756)
Other (self-pay)	-.4022 (.0761)[d]
Principal indications for cesarean	
Fetal distress	2.6919 (.0921)[d]
Breech and other abnormal presentations	3.9483 (.0974)[d]
Dystocia	6.3906 (.3027)[d]
Previous C-section	4.1327 (.0649)[d]
Other complications of pregnancy, labor, delivery	
Eclampsia	1.0109 (.2180)[d]
Placenta previa	3.2474 (.3015)[d]
Placenta abruptio	1.1212 (.2311)[d]
Cord prolapse	2.3629 (.3463)[d]
Herpes	1.6833 (.1625)[d]
Seizures	2.0802 (.7396)[c]
Prolonged labor	0.3683 (.1923)[b]
Dysfunctional labor	1.6500 (.1548)[d]
Variables relating to physician	
Medical experience	
21–30 yrs.	.0035 (.0630)
31–40 yrs.	-.1905 (.0852)[b]
Gender	-.0580 (.0775)
Foreign medical graduate	.3373 (.0738)[d]

(Continued)

TABLE 4. (Continued)

Independent Variable	Parameter Estimate (Standard Error)
Board-certified OBGYN	.0217 (.0627)
Prior C-section rate	3.6616 (.3416)[d]
OB caseload	
HMO	.0458 (.1280)
Commercial	-.0919 (.1937)
Day of delivery	
Friday	.1706 (.0586)[c]
Weekend	-.2900 (.0557)[d]
Time of delivery	
Shift 1 (midnight–6 AM)	-.3773 (.0711)[d]
Shift 2 (6 AM–noon)	.4262 (.0598)[d]
Shift 3 (noon–6 PM)	.1739 (.05970)[c]
Concentration of obstetrical practice	-.2409 (.1265)[b]
Volume of deliveries	.0306 (.0437)

n = 33,233.
[a]$P < .1$.
[b]$P < .05$.
[c]$P < .01$.
[d]$P < .001$.

on weekends (hypothesis 8). We find no effect for the physician's volume of deliveries (hypothesis 9), but do find a negative effect for concentration of obstetric practice in one hospital (hypothesis 10). Moreover, the probability of performing a c-section increases with the physician's rate of c-sections in the prior year (hypothesis 11).

One reviewer has suggested that the effects of time and day of delivery may simply reflect the performance of scheduled c-sections during busy hospital periods. Because of limitations in our database, we were not able to distinguish between scheduled and nonscheduled c-sections. We were able, however, to examine c-section rates for emergency room versus non-emergency room admissions. Our analyses (available from the first author) indicate that, regardless of the type of admission, the probability of a c-section increases between 6 AM and 6 PM and during weekdays.

Similar to Tussing and Wojtowycz, but unlike much of the research, we did not find that patients covered by private health insurance had higher c-section rates as compared to HMO and AHCCCS patients (hypothesis 12). Similar to much of the research findings, however, women without health insurance are less likely to have a c-section compared to women with commercial insurance. And consistent with these findings, but contrary to hypothesis 14, we find no effect for the physician's financial incentive. Physicians with a heavier caseload of commercially insured patients are not more likely to perform a c-section than are physicians treating managed-care patients.

Finally, we investigated whether physicians differentially interpret clinical indications for c-sections. We constructed interaction terms between a physician identifier and *each* of the four clinical indications for c-section (dystocia, breech, fetal distress, and previous c-section). None of these interaction terms significantly added to the explanatory power of our model. When we added an interaction term to our model for physician identifier with absence of *all* four clinical indications, however, we found it explained a significant increment of variation. This suggests that in the absence of the four major clinical indications for c-section, physicians face a high degree of medical uncertainty regarding the appropriate means of delivery.

Discussion

This study investigates the effect of various factors on the c-section decision. We have specified three major sets of characteristics (patient, hospital, and physician) and weighed their relative importance in explaining variation in the occurrence of a cesarean delivery. We have developed explanatory models at the individual rather than the aggregate level, and examined the effects of several previously unexplored physician characteristics.

Certain data limitations may limit the study's external validity. The data are taken from only one state and one calendar year (1989). We therefore make no claims regarding the generalizability of these results over other geographic areas and time periods. These data also exclude small, rural hospitals and federal hospitals (IHS), and thus are not representative of all institutions and women delivering in those hospitals.

With these caveats in mind, our findings offer some important contributions. First, our research replicates some but not all of Tussing and Wojtowycz's findings regarding the impact of physician characteristics. Like Tussing and Wojtowycz, we find that female physicians are no less likely than their male counterparts to perform c-sections. Also like Tussing and Wojtowycz, we find that foreign medical graduates and younger physicians are more likely to perform c-sections. Unlike Tussing and Wojtowycz, we find no evidence of significantly higher c-section rates among board-certified OBGYN physicians, although the relationship is positive. Our findings suggest that physicians may perform c-sections to manage their time better, but not to enrich themselves financially. Tussing and Wojtowycz also found that obstetricians sometimes perform c-sections to manage their time better; however, they interpret this as a form of economic self-interest.[13]

Second, our research extends these findings by examining the predictive power of physician factors on the c-section decision. As a set of factors, these variables contribute additional explanatory power to the model beyond that of patient and hospital factors. In fact, physician factors contribute more explanatory power to the model than do hospital factors, even when added last.

Third, our research provides support for the hypothesized effects of several physician factors not previously studied or demonstrated. Factors of convenience and habit appear to influence the physician's decision making. Physicians are more likely to perform a c-section on Friday as opposed to the weekend and during the day as opposed to the night. These results are replicated for both emergent and nonemergent admissions. Moreover, physicians with a previously high rate of cesarean deliveries continue to have a higher c-section rate. We also find the probability of cesarean delivery to be associated with the particular medical school attended. Physicians trained in different institutions appear to carry the imprint of this training beyond the residency period.

Policy Implications

Overall, the results confirm that nonclinical (both hospital and physician) factors play a statistically significant role in the c-section decision. Focusing on the role of the physician, the model suggests that physician convenience and habit exert significant influences. Substantively, however, nonclinical factors play a smaller, secondary role compared to patient and clinical factors in explaining practice variations in deliveries. The results suggest that efforts to reduce unnecessary c-sections should be directed at identifying the appropriate clinical indications for c-section and disseminating this information to physicians. This may require such intervention strategies as continuing clinical education, promulgation of explicit practice guidelines, peer evaluation, and audit and feedback.

Such strategies have been successful in changing practice style for other medical procedures. In the 1960s there was a dramatic reduction in the number of elective tonsillectomies and adenoidectomies. Physician education, in particular feedback comparing one's performance to other doctors, was found to be more effective than regulation by government or peer review mechanisms.[55,56]

Although c-sections often are not elective procedures, educational strategies are possible in obstetric practice. Successful efforts are likely to focus on instituting explicit protocols regarding obstetric services. Myers and Gleicher[57] reported on a program that successfully reduced c-section use through the implementation of rigorous practice protocols. Even though this was a voluntary program, the c-section rate was reduced from 17.5% in 1985 to 11.5% in 1987.[11] Although institutional protocols may achieve some success, our results suggest that considerable variability in physician practices continues to exist, even when we control for the specific hospital.

Several other programs aimed at reducing c-sections have also been implemented.[58] Many of these programs make use of explicit practice guidelines and utilization review. Research suggests, however, that although practice guidelines are a useful component, they do not by themselves change physician behavior.[59,60] Supplementary local activities may be required to change physician practice.[59–61]

One such innovative approach utilized opinion leader education, as compared to audit and feedback, as a method of encouraging compliance with practice guidelines for the management of women with a previous c-section.[62] The authors found that the educational strategy of opinion leaders (physicians within the obstetrics department) had a significant impact on practice patterns. Physicians in the opinion leader group exhibited a significantly higher rate for trial of labor and vaginal birth after cesarean than did the audit and feedback group.

Many of these strategies, however, depend on the initiative and cooperation of individual hospitals. Therefore, it would appear that a joint commitment on the part of hospitals and physicians is needed for successful implementation. Other recommendations for decreasing c-section rates include greater public awareness of physician and hospital c-section rates[3] and equalizing reimbursement for vaginal and cesarean deliveries, thereby eliminating any possible financial incentives on the part of physicians and hospitals. For example, in the state of Arizona, different payers reimburse hospitals at different rates for c-sections. Private HMOs and AHCCCS/Medicaid pay hospitals the same per diem rate, whether the delivery is vaginal or cesarean, with an average payment of $3,000 for a c-section. Indemnity plans, on the other hand, are not billed on a flat rate, and an average hospital stay for a c-section costs about $5,300.

The patient factor is another important consideration in this change process. Given the medical uncertainty that surrounds the c-section decision, approaches to lower the c-section rate must seek ways to extend reeducation not only to physicians and hospitals, but to patients. Although we were unable to investigate this issue, other research has shown patient demand to have an important effect on the utilization of services and to influence physicians' prescription of those services.[10] For example, Lomas et al[62] found that even when a trial of labor was offered to women with a previous c-section, many of them refused.

One issue that relates to the patient–physician relationship is the fear of malpractice. We were not able to investigate this question; however, defensive practices caused by fear of malpractice claims are widely cited as a factor contributing to high c-section rates.[9,22] Tussing and Wojtowycz[13] found no relationship between fear of malpractice and increased probability of a c-section; however, a study of the relationship between malpractice claims and cesarean delivery[63] found a positive association between malpractice risk and the rate of cesarean delivery.

In conclusion, this research has measured the influence of patient, hospital, and physician factors on the probability of cesarean delivery. The results have extended our understanding of the factors, both clinical and nonclinical, that influence the c-section decision. We have found that although nonclinical factors play a significant role in the c-section decision, substantively these factors play a smaller role compared to clinical factors. Therefore, greater attention to the influence of clinical factors in the c-section decision is warranted. Any solution to reduce the c-section rate, however, must include a cooperative effort among patients, hospitals, and physicians.

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