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The Relationship Between Cesarean Section and Labor Induction

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Abstract

Background: Numerous study results vary when analyzing the relationship between labor induction and the likelihood of cesarean delivery; and few have accounted for the multiple influences of maternal sociodemographic characteristics combined with the provider and hospital in subsequent birth outcomes such as cesarean section.

Objective: This study evaluated the likelihood of cesarean birth following labor induction while accounting for maternal, hospital, and provider characteristics.

Methods: A cross-sectional retrospective descriptive design using secondary data was employed to determine what variation in cesarean births was due to differences of hospitals, providers, and patients using the Quality Health Outcomes Model (QHOM). Data were partitioned by primiparous and multiparous women. The individual demographic, system, and provider outcomes in all hospitals and single birth center for Maricopa County in 2005 (N=62,816) were analyzed, using both random effects and fixed effects models.

Results: For primiparous women, an increased likelihood of cesarean births was associated with medical inductions, maternal age, being Black, and the number of prenatal visits; and less likely in teaching hospitals and women with higher educational attainment. In multiparous women, cesarean births were associated with increased maternal age and medical inductions; and less likely in for-profit hospitals and following elective induction.

Discussion: Labor inductions were associated with an increased likelihood of cesarean sections based on parity, age, race, number of prenatal visits, education, and hospital teaching status and ownership. Because the QHOM emphasizes multiple contextual variables that influence the delivery and outcomes of care, it can prove ideal for the study of birth outcomes following interventions such as the induction of labor.

Clinical Relevance: Nurses should be well educated about the risks of elective labor induction prior to term gestation and "elective" cesarean birth.

One area in obstetrical care that has demonstrated considerable variation among providers and hospitals is the cesarean section rate, even after controlling for high-risk maternal demographic risk factors. A major variable influencing the rise in primary cesarean section births may be the increase in the number of labor inductions (Dublin, LydonRochelle, Kaplan, Watts, & Critchlow, 2000). The induction of labor is now one of the most common occurrences in modern obstetrical care; however, the relationship of labor induction to cesarean births is controversial. Although several studies demonstrate an increase in the odds of cesarean births following labor induction (Bodner-Adler et al., 2005; Wilson, 2007), others have refuted this relationship (Caughey, Nicholson,

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Cheng, Lyell, & Washington, 2006; Gulmezoglu, Crowther, & Middleton, 2006; Sanchez-Ramos, Olivier, Delke, & Kaunitz, 2003). Results vary significantly by parity and gestational age; however, the majority of studies that have evaluated the effect of labor induction on cesarean birth in nulliparous pregnancies prior to 40 weeks of gestation indicate an increased likelihood of cesarean births.

Most studies that examine the effect of labor induction on increased cesarean delivery have evaluated only selected maternal sociodemographic characteristics and did not account for the added influence of the provider or hospital in subsequent birth outcomes. Therefore, the purpose of this study was to evaluate the likelihood of cesarean birth following labor induction while accounting for patient sociodemographics as well as for hospital and provider influence. The Quality Health Outcomes Model (QHOM; Mitchell, Ferketich, & Jennings, 1998) was used as the conceptual framework, which allowed patient, provider, and hospital characteristics to be examined with relation to their influence on birth outcomes following labor induction. Although labor management is a complex and multifaceted process, understanding how labor induction might influence neonatal and maternal outcomes is important, particularly given the proposed relationship of labor induction to higher cesarean rates.

Background

Labor Induction

Considerable variation exists both within and between hospitals and providers related to induction of labor, a phenomenon described as "variation within variation" (Glantz, 2003). A significant portion of the increase in preterm birth rate (infants born before 37 weeks of gestation) has been attributed to the increase in preterm labor induction, often performed without a compelling medical need. Inductions carried out in the absence of a medical necessity are termed "elective inductions" and are generally done for provider and/or patient convenience. Elective inductions now account for over two thirds of all inductions in the United States (Simpson & Atterbury, 2003).

Variations within and between hospitals in the management of labor and the induction of labor have significant clinical implications as well as cost implications, both for the institution and the individual patient. Births to women undergoing induction of labor are significantly more costly, requiring additional personnel and supplies (Seyb, Berka, Socol, & Dooley, 1999). Not only does the incidence of labor induction differ between hospitals, it also differs within hospitals between individual providers. Notable examples of these variations in practice were detected through studies conducted in the late 1980s that evaluated specific physician practices on the escalating rates of primary cesarean births (Maslow & Sweeny, 2000). The individual provider was found to be a significant risk factor for increased cesarean birth following induction (de Regt, Minkoff, Feldman, & Schwarz, 1986; Goyert, Bottoms, Treadwell, & Nehra, 1989). Because the provider's training and philosophical orientation tend to influence practice patterns, once a provider has initiated one form of active intervention (e.g., induction of labor), there may be a tendency to more readily adopt further interventions, such as a cesarean birth.

The organizational environment (hospital and system) are believed to affect the cesarean rates as well. Clark, Xu, Porter, and Love (1998) found that as organizations moved to a high-volume teaching model with anesthesiology and obstetrical specialists, the cesarean rate declined. Organizational features also correlate with provider practice style and the characteristics of the population served (Chung et al., 2006); and organizational factors such as teaching status, technology, and bed size have been directly linked to variations in morbidity and mortality (Mitchell, Heinrich, Moritz, & Hinshaw, 1997).

That practice patterns and decision making vary between certified nurse midwives (CNMs) and obstetricians is well understood. The practice of CNMs differs from that of traditional physicians; they are less likely to use technological interventions such as induction or augmentation of labor. Differences in labor management and birth outcomes have been shown to exist between obstetricians and CNMs for low-risk (Wilson, 1989), moderate-risk (Davis, Riedmann, Sapiro, Minogue, & Kazer, 1994) and high-risk (Davidson, 2002) women. Midwives account for only 10% of the live births involving vaginal deliveries in the United States, but they direct obstetrical care in most European countries with lower neonatal, maternal, and infant mortality rates (Davidson). Although most foreign healthcare delivery systems differ from those in the United States in profound ways (e.g., socialized medicine and paid maternity leave), nurse midwives have had a profound impact on maternal and newborn outcomes. The extent to which varying provider types influence the likelihood of cesarean birth when accounting for maternal risk is not completely understood, but could be examined using the QHOM as a theoretical framework. The skill and experience of the intrapartum nurses are also believed to exert significant influence on birth outcomes; however, we were unable to extract the primary nurses from the available dataset. Hence, that analysis was excluded from this particular study, although it warrants further examination.

Cesarean Births

Cesarean births have been a hotly contested issue in healthcare debates since rates began to climb steadily starting in the mid-1990s, increasing by 46% from 1996 to 2006 (Hamilton, Martin, & Ventura, 2006). Second only to circumcision, cesarean delivery is the most common surgical procedure performed in the United States, contributing significantly to maternal morbidity, mortality, and escalating healthcare costs. Cesarean births have a long-term impact on maternal reproductive health, placing women at an increased risk for placenta previa, placenta accrete, uterine rupture, and stillbirths in subsequent pregnancies (Liu et al., 2007; Luthy, Malmgren, & Zingheim, 2004). Both the World Health Organization and the Department of Health and Human Services have established a goal for cesarean delivery rates at 15% by 2010, yet the cesarean birth rate is now at 31.1%, an all time high (Centers for Disease Control and Prevention, 2009).

Although cesarean births are now so commonplace that the absence of their occurrence is almost as notable as their presence, the impact of cesarean deliveries on the overall recovery, health, and future well-being of the childbearing woman cannot be ignored. In addition to their adverse influence on the future reproductive well-being of the mother, cesarean births were demonstrated to be significantly more costly (Maslow & Sweeny, 2000; Seyb et al., 1999).

Maternal Characteristics

Maternal characteristics are known to also influence birth outcomes, including such variables as socioeconomic status (SES), number of prenatal visits, occupational status, race, insurance, and educational level. For that reason, it is important to consider multiple client characteristics when analyzing their influence on maternal and newborn outcomes. For example, Black childbearing women have an alarming incidence of adverse outcomes, even when financial barriers to health care and income are not present (Gennaro, 2005; Lu & Halfon, 2003).

Minority women appear to experience bias in the healthcare system related to the induction of labor. There are significant differences in the incidence of labor induction according to nonclinical factors, including race and ethnicity (Coonrod, Bay, & Kishi, 2000). The incidence of elective labor inductions is highest among older non-Hispanic Whites (Glantz, 2005) who are covered by commercial insurance (Dublin et al., 2000). In general, inductions are more frequent among married women with more than 12 years of education who are privately insured and deliver in nongovernmental facilities (Coonrod et al.). Whether non-Hispanic White women have differential access to elective inductions or inductions in general is not completely understood. It is not known whether minority women do not request induction or simply are not given this option (Glantz, 2005).

There are clear and compelling studies that also link better overall health with higher levels of education. Social economic status deprivation has a profound effect on the health of a population from birth to death, yet disparities in birth outcomes for Black women persist even when socioeconomic conditions are optimum (Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2005). Access to care is another critical issue in addressing health disparities and outcomes. Women with insurance are more likely to seek prenatal care than women without insurance or those insured through Medicaid, yet over one fourth of women of reproductive age have no coverage for maternity-related care. Minorities have a greater likelihood of being uninsured: 32% of Hispanics and 20% of Blacks are uninsured compared with 11% of non-Hispanic Whites (Betancourt & Maina, 2004). Lack of insurance becomes a critical issue when addressing Hispanic childbearing women, given their significantly higher fertility rate compared with the general population and high rates of immigration into the United States. Hispanics and Mexican Americans are also more likely to give birth at earlier ages; in one study of Mexican American adolescents (Burk, Wieser, & Keegan, 1995), 31% of females 15 to 19 years of age reported having given birth, a rate twice the national average.

There are statistically significant correlations between labor induction and increased cesarean births based on parity, where primiparous women have demonstrated an increased likelihood of cesarean birth following labor induction (Luthy et al., 2004), but not multiparous women (Heinberg, Wood, & Chambers, 2002). The risk for cesarean birth among nulliparas with induced labor is three times as high as for nulliparas in spontaneous labor, and twice as high as multiparas who were induced (Maslow & Sweeny, 2000). Because of the correlation between labor induction and increased risk of cesarean birth for nulliparous women, parity must also be considered when evaluating birth outcomes. The propensity for induction ending in cesarean births is even more marked when the induction is elective (Luthy et al., 2004), indicating elective labor induction for primiparous women should be offered with caution. Bishop (1964) questioned the use of labor induction for nulliparous patients, noting that even in the presence of favorable circumstances the induction of labor brings little advantage to the physician or patient due to the unpredictability of labor duration in the first-time mother.

Conceptual Framework

In 1998 the QHOM was developed to provide a conceptual framework for quality and outcomes research (Mitchell et al., 1998) using a three-dimensional, nonlinear expansion of Donabedian's structure, process, and outcome formulation (Donabedian, 1985; **Figure**). The QHOM addresses the integration and interaction of four constructs; systems, intervention, patient/client, and outcome. Multiple related variables influence healthcare delivery and ensuing outcomes by positing relationships with variables that not only act upon but are equally affected by other components in the model, reflected in the model's bidirectional arrows. Several researchers have used the QHOM to assess health outcomes in the hospital setting, evaluating processes such as second stage labor management (Mayberry & Gennaro, 2001). In this study, the QHOM provided a valuable framework to allow the analysis between intervention (induction of labor), client, and system characteristics (including hospital and provider) and their subsequent impact on increased cesarean rates.

Methods

Study Design and Setting

Utilizing the QHOM, several dimensions of delivery outcomes were examined for all births (N=62,816) in Maricopa County (the largest county in Arizona and fourth largest in the United States) using a large integrated dataset (Arizona HealthQuery [AZHQ]). With a

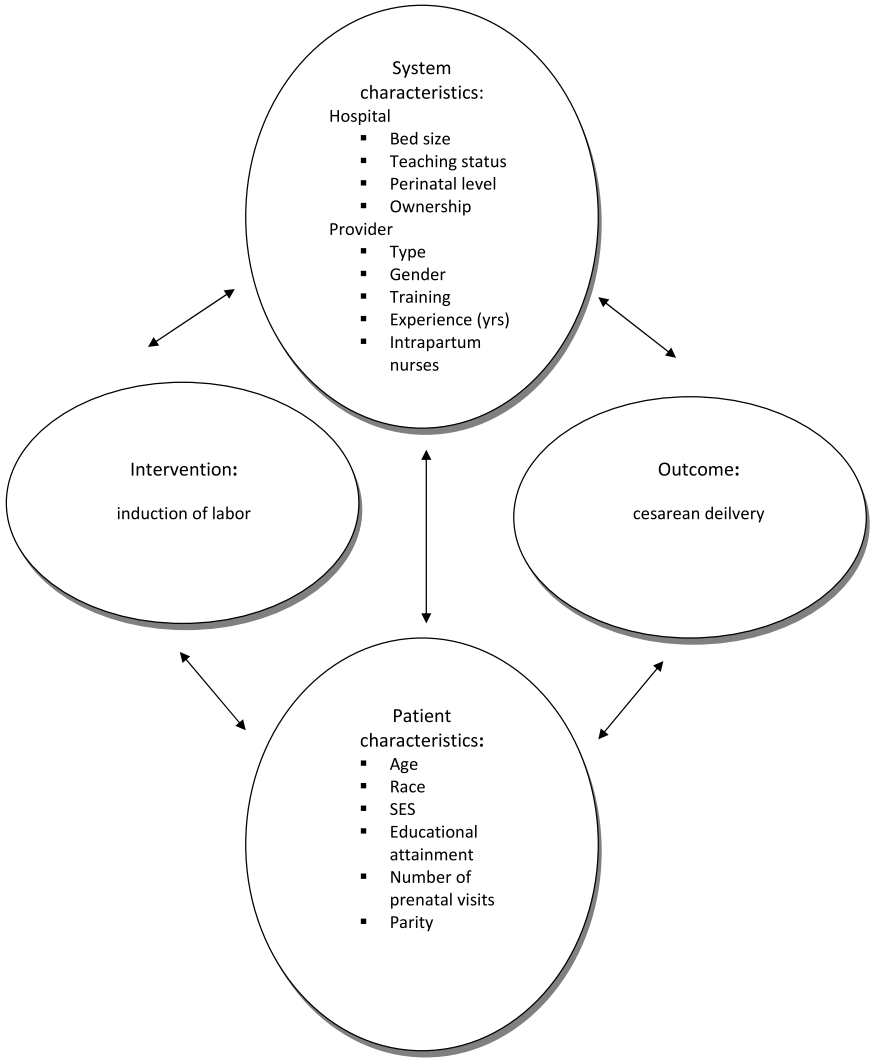

Figure. Using the Quality Health Outcomes Model for induction of labor.

cross-sectional descriptive retrospective design, factors for analysis included variation in cesarean section rates due to (a) hospital organizational characteristics, (b) provider characteristics, and (c) maternal characteristics on the likelihood of cesarean birth (see the **Figure**).

Data Abstraction

The data were abstracted from birth certificates and physician licensing renewal information housed in AZHQ, a continuously updated community health data system managed through the Center for Health Information and Research at Arizona State University (ASU). Institutional review board approval was obtained from ASU and the University of Arizona, and permission to use birth certificate data was granted by the Arizona Department of Health.

In addition to obtaining information from birth certificates, AZHQ also houses Physician Workforce information that is linked to physician license renewal. This information allowed us to examine provider-specific characteristics, such as where medical training was obtained (domestic or foreign), gender, and length of time in practice, another advantage of this data source. To determine the influence of provider characteristics on birth outcomes, the physician information from the AZHQ dataset was matched based on license renewal with the provider or attendant listed on the birth certificates. Doing so required a series of complex, iterative steps starting with matching physicians' first, middle, and last names, and suffix. Provider addresses on licensure information were used to confirm matches. Ultimately, a 98% match between the physicians and the birth certificates was obtained.

Other variables were carefully selected to identify relationships between the intervention of interest (labor induction) and the influences that provider, hospital, and patient characteristics have on the incidence of cesarean birth. Maternal variables included race, socioeconomic status (using insurance provider as a proxy), maternal education and age, and the number of prenatal visits at the time of delivery. Birth outcomes included the indication and outcome of labor induction (medical versus elective) and mode of delivery (vaginal versus cesarean section).

Quality Health Outcomes Model

Intervention

The QHOM allows researchers to analyze the relationships or linkages between an intervention (such as labor induction) and the mediating influences of both system characteristics and patient characteristics on clinical outcomes. Interventions include clinical processes, both direct and indirect, and the activities by which they are delivered. Typically, interventions are those things that are altered with the intent of changing other constructs in the model. The context in which the intervention is provided also influences outcomes, along with the patient's characteristics and response to treatment.

In utilizing the QHOM for this study, the intervention of interest was labor induction. Although "induction of labor" was one of the available codes on the birth certificate, traditional birth certificates offer no differentiation between elective and medically indicated inductions. This was achieved by evaluating all births that were coded as "induction of labor" and then abstracting the medically indicated inductions from elective using the guidelines from the American College of Obstetricians and Gynecologists. Even though indications for induction are not absolute and should take into account maternal and fetal factors, the American Congress of Obstetricians and Gynecologists (ACOG) list is widely accepted as medical indications for the stimulation of uterine contractions prior to labor onset.

System Characteristics

In measuring the impact of system characteristics on outcomes, Mitchell et al. (1998) proposed the use of such variables as hospital ownership, provider network, and hospital size. In the current model (see Figure 1), system variables included hospital and provider characteristics. Provider characteristics consisted of type (medical doctor [MD], doctor of osteopathic medicine [DO]), gender, years in practice, and whether training was domestic or foreign. Hospital variables included teaching status, ownership, bed size, and classification of the level of perinatal services offered through Arizona Perinatal Trust (APT). APT is a voluntary referral and perinatal transport system and includes the following levels: (a) Level I (basic care for low-risk obstetrical patients and newborns); (b) Level II (specialty care for low-risk obstetrical patients and selected high-risk newborns born at >32 weeks of gestation); (c) Level IIEQ (specialty care with enhanced qualifications); and (d) Level III (all levels of perinatal and newborn care). Including APT level as a hospital variable was deemed important, as it is believed to reflect the presence of high technology or its proxies.

Patient Characteristics

For the purposes of this study, patient characteristics included race, SES, educational attainment, number of prenatal visits, and parity. Patient characteristics have a

significant and obvious influence on outcomes, where variations in outcomes must be adjusted according to patient health, demographics, and risk factors.

Outcome

The final construct in the QHOM model represents end result of care. Although nurses and primary care providers are known to "buffer" patients from the adverse effects of harmful or problematic organizational patterns, clinical outcomes are still the mainstay of quality healthcare research in which relevant performance outcomes include clinical and organizational factors. The primary outcome of interest in this study was cesarean birth. Because parity is known to influence outcomes following labor induction (Wilson, 2007), outcomes were partitioned by primiparous and multiparous births.

Data Analysis

Multiple regression and nonlinear estimation models were used to control for confounding and effect-modifying variables that could influence the relationship of labor induction on birth outcomes (not included). General material demographics were collected (**Table**). We evaluated the likelihood of cesarean section by parity for all births in one large county, and then separated out those births coded as induction (whether elective or medically indicated) and examined the characteristics (hospital, provider, and patient) and their influence on cesarean birth.

Table. Maternal Demographic Characteristics

Maternal variables	Sample (*N*=62,816)
Maternal age (years), mean	27.32
Education attainment (years), mean	12.3
Prenatal visits (number), mean	10.8
Parity, *n* (%)	
Primiparous	23,443 (37.3%)
Multiparous	39,373 (62.7%)
Plurality, *n* (%)	
Singleton	60,932 (97%)
Multiples	1,884 (3%)
Insurance provider, *n* (%)	
AHCCCS (Arizona Medicaid)	32,350 (51.5%)
Indian Health Services	251 (0.4%)
Private insurance	28,456 (45.3%)
Self	1,570 (2.5%)
Unknown	188 (0.3%)
Race, *n* (%)	
Asian/Pacific Islander	1,633 (2.6%)
Black	2,638 (4.2%)
Hispanic/Mexican	26,194 (41.7%)
Native American/American Indians	4,397 (7%)
Non-Hispanic White	27,765 (44.2%)
Other or not identified	188 (0.3%)

Arizona Health Care Cost Containment System.

Results

Multiple factors influenced the likelihood of cesarean birth. For example, medical inductions increased the likelihood of cesarean births for both multiparous (52%) and primiparous (33%) women. Advancing maternal age at the time of delivery increased the likelihood of cesarean birth regardless of parity by approximately 5% per each year of age ($p<.0001$), a finding not surprising given that older mothers are more likely to experience pregnancy complications necessitating medical intervention (Gilbert, Nesbitt, & Danielsen, 1999).

Elective induction did not increase the likelihood of a cesarean birth in this sample. When examining those women coded as "induction of labor" (n=12,398), women who had an elective induction were significantly less likely ($p<.0001$) to experience a cesarean birth (50% less likely) compared with women in spontaneous labor or those induced for medically indicated reasons. In the induction group, maternal education was associated with an increased likelihood of cesarean birth following labor induction ($p<.05$) and with a negative correlation between higher maternal education and the likelihood of cesarean births for first time mothers in general ($p<.001$): for each additional year of educational attainment, the likelihood of a cesarean birth fell by about 2%.

Non-Hispanic Whites were the least likely of all ethnic groups to have a cesarean section following labor induction (elective and indicated; $p<.01$); followed by Hispanic women ($p<.05$). For all births, Black women were most likely to require a cesarean section in both multiparous and primiparous women; in the primiparous group, this difference was statistically significant ($p<.001$). The link between lower SES and adverse outcomes was not demonstrated in this study. The type of insurance bore no relationship to the likelihood of adverse birth outcomes (including cesarean delivery), a significant finding because the majority (52%) of women who delivered in Arizona in 2005 were on Arizona's Medicaid program.

The number of prenatal visits was a significant predictor in increased cesarean rates for primiparous women in general, and for all women following induction of labor. For each additional prenatal visit, the likelihood of deliver by cesarean section increased by about 1%, which may reflect higher-risk pregnancies (e.g., the higher risk the pregnancy, the more prenatal visits were required). The only hospital variable that was statistically significant relating to increased cesarean sections was teaching status;

in teaching hospitals, primiparous women were less likely to require a cesarean birth (p=.0001).

Unfortunately, reviewing births attended by CNMs was not possible because the birth certificate database included only licensed physicians, and any provider who did not "match" to the physician licensing survey was considered as missing data. It is possible that all providers who were not matched with the survey were midwives; however, because births could also have been attended by medical students or nurses (in the event of precipitous deliveries), no attempt was made to compare the characteristics of those not matched to those licensed physicians that were. To understand the actual influence of midwives on birth outcomes in this population, a medical record review would have been needed and was beyond the capacity of this study utilizing secondary data. However, it is believed this information is important and warrants additional study.

Discussion

This study utilized a robust sample that included all births in the largest county in Arizona for a 1-year period, representing 65% of the total births in the state. In addition to the large sample size, only 0.05% of the variables were missing, minimizing concerns regarding generalizability and sampling error. In addition, we were able to link birth outcomes by provider through the Physician Licensing Survey, a unique and unparalleled feature of the AZHQ. Utilizing both linear and nonlinear probability models, we were able to evaluate multiple influences of provider, hospital, and patient on cesarean rates. Elective induction did not increase the likelihood of a cesarean birth in this sample, which varies from other studies. This finding was consistent with a recent study suggesting that induction of labor appears to actually lower the cesarean rate when compared with expectant management (Caughey et al., 2006).

Higher levels of maternal education increased the likelihood of cesarean birth following induction of labor and in first-time mothers. Although somewhat surprising, expectant women and their pregnancies are changing. On average, women are almost 4 years older at the time of their first delivery compared with women who gave birth in the early 1970s (Ecker & Frigoletto, 2007). There has also been a continual decrease in newborn gestational age at the time of delivery, where only 22.7% of births in 2002 were reported to be at 40 weeks of gestation (Davidoff et al., 2006). A resource-intensive childbirth is the norm for many healthy women, and the results suggest better educated women may be more accepting of technological interventions and approaches.

Although SES has previously been directly linked to birth disparities and adverse maternal and neonatal outcomes in numerous studies, it was not demonstrated in this study. There was not a link between lower SES and increased likelihood of cesarean birth. One explanation for this finding may be that physician incentives or reimbursement rates based on insurance provider were either inconsequential or did not influence practice. It may also be that the insurance provider was not an appropriate proxy for SES in this population, necessitating additional studies looking at other proxy variables such as ZIP codes or census tracts.

Prenatal visits predicted the likelihood of cesarean birth in first-time mothers; that is, as the number of prenatal visits increased, the likelihood of cesarean delivery also increased. The correlation between number of prenatal visits and increased cesarean births could indicate that women who were higher risk had more prenatal visits, and ultimately these resulted in a higher probability of cesarean birth. It could also reflect the transformation of women requesting a home-like birth experience to the reemergence of a more intensive, high-tech delivery experience, where women are more likely to accept various technological approaches.

Limitations

Although the use of administrative datasets is widely known to support outcomes research, there is a tradeoff between the credibility of the data versus the feasibility of collecting data on large groups of people. Variability in the quality of the data collection may compromise the precision of the data. We were also unable to abstract provider information beyond MD and DO. Midwives are known to have a different style of labor management, and it is believed that variations in their style influences birth outcomes. Ultimately this would require matching birth certificates with hospital discharge records, which was outside the scope of this study. It is also not known whether the medical inductions were clearly identified in this study; that is, there may have been other medical risks that were not captured by the ACOG criteria, Nonmedical inductions have been found to account for two thirds (67%) of all labor inductions (Simpson & Atterbury, 2003); in this study, they accounted for approximately 80%.

Implications for Nursing

Choices women make before and during their birth experience are strongly influenced by their obstetrical providers, because women place an unusually high level

of trust in their caregivers (primary care providers and nurses) during pregnancy and childbirth (Tillett, 2007). Nurses should be well educated about the risks of elective labor induction prior to term gestation and "elective" cesarean birth. Nurses can promote a philosophy that national professional standards (e.g., ACOG; Association of Women's Health, Obstetrics, and Neonatal Nurses) drive practice decisions (Simpson, 2006). Although the direct relationship between obstetrical nurses and likelihood of cesarean birth is difficult to quantify and therefore measure, further research is warranted to extrapolate the role that nursing plays in unplanned cesarean births. Such an understanding could translate into safeguards in minimizing unnecessary surgical interventions and optimizing outcomes for the childbearing family.

Conclusions

Using the QHOM as the framework, we were able to determine the provider, patient, and hospital factors that increased the likelihood of cesarean delivery following labor induction for primiparous and multiparous women. The multiple feedback loops in the QHOM were intended to help define the relationships between structural and process variables and proved useful in this study. As with any theoretical model, further examination and model testing should be implemented; however, the QHOM proved ideal for the study of birth outcomes following interventions such as the induction of labor, where the relationships between intervention, system, and patient cannot be adequately examined without considering the complex association and interactions among them.

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Clinical Resources

- American College of Obstetrics and Gynecologists (ACOG) Practice Bulletin No. 107: Induction of Labor (updated August 2009; replaces Practice Bulletin No. 10, 1999). http://journals.lww.com/greenjournal/Citation/2009/08000/ACOG_Practice_Bulletin_No_107_Induction_of_Labor.30.aspx
- Cochrane Collaborative Review: Information for pregnant women about cesarean birth. http://www.cochrane.org/reviews/en/ab003858.html
- Childbirth Connection: Cesarean section: Why does the national U.S. cesarean section rate keep going up? http://www.childbirthconnection.org/article.asp?ck=10456

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