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CLINICS IN
PERINATOLOGY

Clin Perinatol 35 (2008) 293–307

Cesarean Birth in the United States: Epidemiology, Trends, and Outcomes

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The percentage of all births in the United States that are cesarean deliveries has increased substantially in recent years, from 20.7% in 1996 to an all-time high of 31.1% in 2006 [1,2]. Cesarean delivery currently is the most common major surgical procedure for women in the United States [3] with more than 1.3 million cesareans performed annually [1]. The cesarean rate increased dramatically during the 1970s and early 1980s and began to decline in the late 1980s (based on data from the National Hospital Discharge Survey). Between 1989 and 1996 the total cesarean rate decreased as a result of a decrease in the primary rate and an increase in the rate of vaginal birth after cesarean (VBAC). Since 1996, these trends have reversed, and increases have been rapid and sustained for primary and repeat cesareans over the past decade [2]. This article examines recent trends in cesarean delivery for the overall population and for women who have no reported medical indications for cesarean delivery, and it examines neonatal outcomes for primary cesarean births among low-risk women.

Methods

Data on cesarean delivery used in this article are based on the method of delivery as reported on the more than 4 million birth certificates filed each

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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doi:10.1016/j.clp.2008.03.007

year in the United States and compiled by the National Center for Health Statistics (NCHS). Cesarean data became available from birth certificates in 1989, and by 1991 all states and the District of Columbia were reporting this information. Before 1989, data from the National Hospital Discharge Survey were used to track trends in cesarean delivery.

Several measures of cesarean delivery are used and computed as follows. The total cesarean rate is the percent of cesarean births of all births in a given year. The primary rate is the percent of cesarean births among women in a given year who have not had a previous cesarean delivery. The rate of repeat cesarean delivery is the percent of all cesarean births among women who have had a previous cesarean. A related measure, the rate of VBAC, is defined as the percent of vaginal births among women who have had a previous cesarean.

This article examines changes in cesarean rates among all United States mothers by maternal age, race/ethnicity, gestational age, and state. Total cesarean rates are examined from 1989 to 2006 whereas primary and repeat cesarean rates are examined from 1989 to 2004. National estimates of primary and repeat cesarean rates for 2005 and 2006 are not available because of a change in the wording and formatting of the question on prior cesareans between the 1989 and the 2003 revisions of the United States Standard Certificate of Birth. Because of the staggered implementation of the 2003 revision among states, both revisions currently are in use in different states, making national estimates of primary and repeat cesareans problematic, although state-level estimates are available.

Cesarean rates also are examined for mothers who have ''no indicated risk'' (NIR) for cesarean delivery. This is a subgroup of United States births comprising the lowest-risk population identifiable from birth certificates: mothers who have full-term, singleton, vertex presentation births and none of the 16 medical risk factors (eg, diabetes, hypertension) or 15 labor and delivery complications (eg, fetal distress, prolonged labor) reported on birth certificates and no prior cesarean. Neonatal outcomes by method of delivery for low-risk women also are examined and available literature is reviewed.

Results

The percentage of United States births delivered by cesarean has increased by 50% in the past decade. In 2006, 31.1% of United States births were delivered by cesarean compared with 20.7% in 1996 (Fig. 1). The pace of the increase shows no signs of slowing, as increases are more rapid since 2000 [1,2]. The rapid increase in the cesarean rate reflects two concurrent trends: an increase in the primary cesarean rate and a steep decline in the VBAC rate (Fig. 2). The primary cesarean rate increased from 14.6% in 1996 to 20.6% in 2004. Sixty percent of the increase in the total cesarean rate from 1996 to 2004 was the result of increases in primary cesareans. At

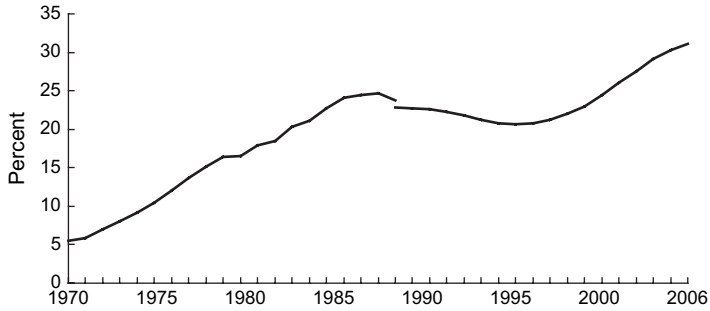

Fig. 1. Total cesarean delivery rate: United States, 1970–2006. (*Data from* Data for 1970–1988 are from the National Hospital Discharge Survey. Data for 1989–2006 are from the National Vital Statistics System, NCHS, Centers for Disease Control and Prevention [CDC]. Data for 2006 are preliminary.)

the same time, the VBAC rate decreased from 28.3% to 9.2%. A decrease in the VBAC rate implies a corresponding increase in the repeat cesarean rate, which reached almost 91% in 2004 [4]. Thus, the adage, "once a cesarean, always a cesarean," seems true for more than 90% of women in the United States.

National estimates of primary and repeat cesarean rates for 2005 and 2006 are not available because of a change in the wording and formatting of the method of delivery item on the 2003 revision of the United States Standard Certificate of Birth (used by 12 states in 2005) [2]. An examination of state-level data reveals, however, that primary and repeat cesarean rates continued to increase in 2005 [2]. The United States cesarean rate is high compared with that in many industrialized countries (Fig. 3); most developed countries, however, also have experienced increases over the past decade [5].

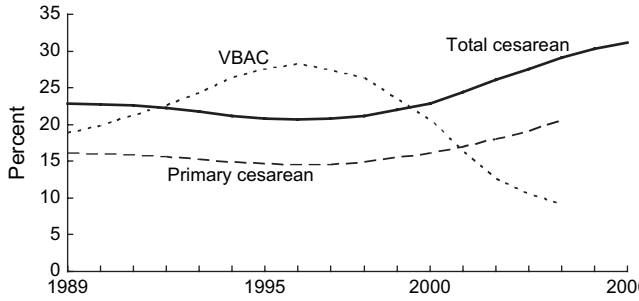

Fig. 2. Total cesarean delivery rate, United States, 1989–2006, and primary cesarean and VBAC Rates, 1989–2004. (*Data from* National Vital Statistics System, NCHS, CDC. Data for 2006 are preliminary.)

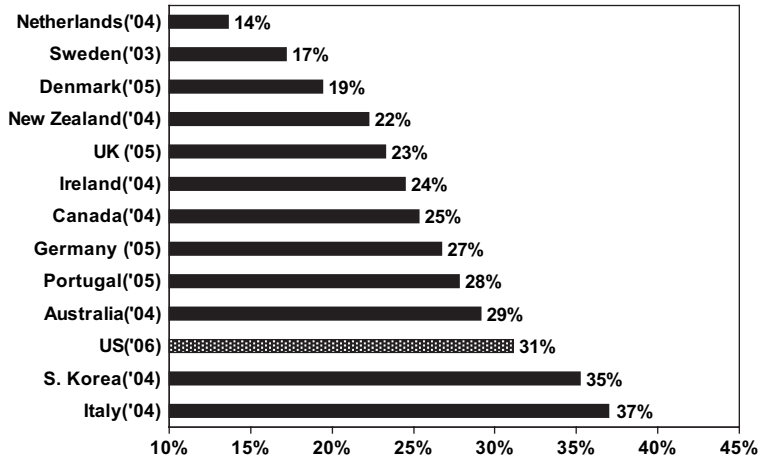

Fig. 3. Cesarean rates in industrialized countries, 2003–2006. (*Data from* Organization for Economic Cooperation and Development health data 2007; United States birth data for 2006 are preliminary.)

Variations by maternal age, race/ethnicity, gestational age, and state

Cesarean rates increase with increasing maternal age (Fig. 4). In 2006, nearly half (47.6%) of births among women ages 40 and over were delivered by cesarean compared with 22.2% of teen births. The higher rates for older mothers may be related to patient/practitioner concerns, increased rates of multiple births, and other biologic factors [6]. Still, for each maternal age group, cesarean rates increased sharply (by 45%–53%) from 1996 to 2006.

In 2006, cesarean rates were highest for non-Hispanic black women (33.1%), followed by non-Hispanic white (31.3%), Asian or Pacific Islander (30.6%), Hispanic (29.7%), and Native American women (27.4%) (Fig. 5).

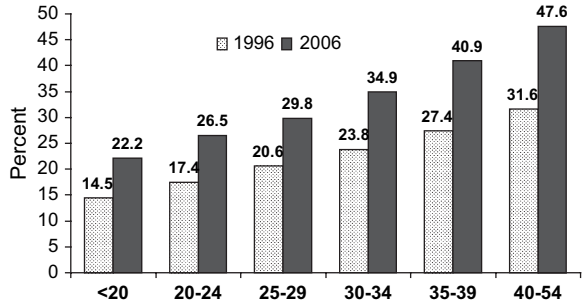

Fig. 4. Cesarean rates by age of mother: United States, 1996 and 2006. (*Data from* National Vital Statistics System, NCHS, CDC. Data for 2006 are preliminary.)

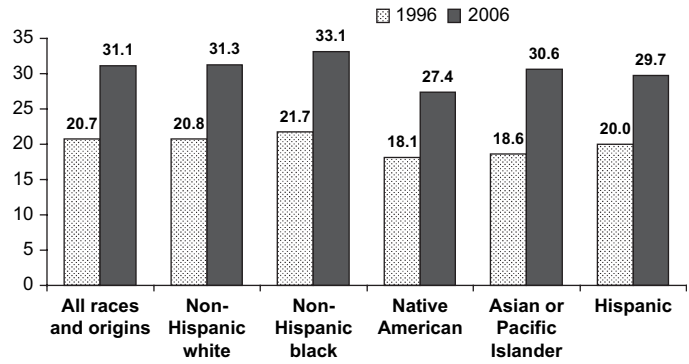

Fig. 5. Cesarean rates by race and Hispanic origin of mother: United States, 1996 and 2006. (*Data from* National Vital Statistics System, NCHS, CDC. Data for 2006 are preliminary.)

Cesarean rates increased rapidly from 1996 to 2006 for women of all race and ethnic groups. Increases were largest for Asian or Pacific Islander women (65%), followed by non-Hispanic black (53%), Native American (51%), non-Hispanic white (50%), and Hispanic women (49%).

Cesarean rates increased for births at all gestational ages between 1996 and 2005 (detailed data on cesarean delivery by gestational age for 2006 are not yet available) [2]. When only singleton births were examined (births in plural deliveries are more likely to be delivered by cesarean section), the trend was similar. The average annual increase in the cesarean rate at each gestational age category from 1997 to 1999 was 1% to 3%, compared with an average annual increase of 4% to 6% from 2000 to 2005. Between 1996 and 2005, cesarean rates rose by 33% to 50% for each gestational age category, including very preterm infants (<32 weeks of gestation) (Fig. 6). Cesarean rates were highest for very preterm infants. In 2005, nearly half

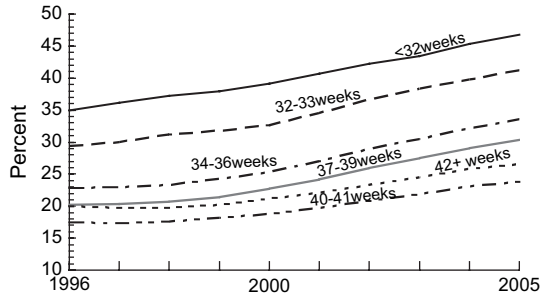

Fig. 6. Cesarean rates by gestational age, singleton births: United States, 1996–2005. (*Data from* National Vital Statistics System, NCHS, CDC.)

(46.8%) of very preterm singleton infants were delivered by cesarean. Approximately one third of singleton 34- to 36-week (late preterm) and 37- to 39-week infants were delivered by cesarean compared with approximately one quarter of singleton infants born at 40 weeks or greater.

In 2006, cesarean rates varied considerably by state, from a low of 21.5% in Utah to a high of 37.4% in New Jersey (Fig. 7) [1]. Although there is no clear-cut regional pattern, cesarean rates tended to be higher in the Southeastern states, selected Appalachian states, and some states on the Eastern Seaboard. Cesarean rates were lower in the Western Mountain and Upper Midwestern states. From 1996 to 2006, cesarean rates increased sharply in all states [1,2].

Questions and controversy generated by the increasing trends

The increasing trend in cesareans has generated controversy in the medical literature. Fundamental questions have been raised about the reasons for the increasing trend. Is the increase the result of changes in physician practice patterns regarding cesarean delivery, increases in maternal requests for cesarean section, or some combination of the two? Is the overall increase in the cesarean rate the result in part of increases in medically elective cesareans? Has there been a change in the medical risk profile of expectant mothers, such that more births are now at higher risk? And, finally, what are the benefits and harms of cesarean delivery for mothers and neonates?

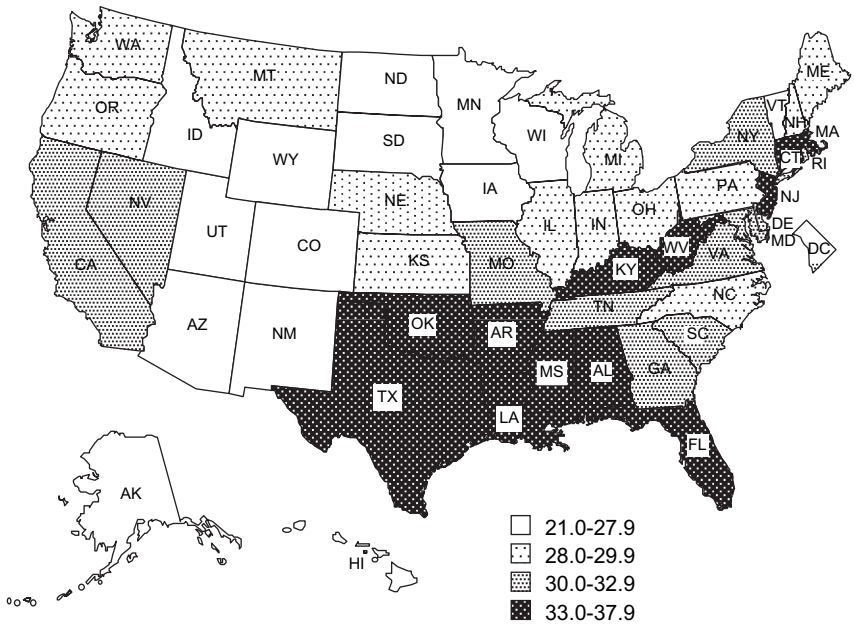

Fig. 7. Cesarean rates by state: United States, 2006. (*Data from* Preliminary data from the National Vital Statistics System, NCHS, CDC.)

Trends in the medical risk profile of mothers

Studies examining changes in the medical risk profile of mothers over time have found little evidence to suggest that the rising cesarean rates are due to such changes [7–10]. Declercq and colleagues [9] used birth certificate data to examine the medical risk profiles of women over time with regards to age, race/ethnicity, parity, gestational age, and birthweight and for a wide variety of medical risk factors and complications of labor or delivery. They found that changing primary cesarean rates were not related to general shifts in mothers' medical risk profiles. Rather, cesarean rates associated with virtually every demographic or medical risk factor reported on birth certificates shifted in the same pattern as with the overall cesarean rates. They concluded, "changes in obstetric practices were the major influence on the shifting pattern of primary cesarean rates" [9]. A related study used multivariate logistic regression analysis to examine changes in primary cesarean rates over time for NIR deliveries after controlling for parity; birthweight; and maternal ethnicity, age, and education and found that the odds of having a primary cesarean in 2001 were 50% higher than the odds in 1996 [7]. Similarly, Rhodes and colleagues [10] found that excess weight gain during pregnancy and macrosomia did not explain the increase in cesarean delivery as cesarean rates increased in all weight gain categories, and the incidence of macrosomia actually declined from 1990 to 2000.

Recent studies also have suggested that prepregnancy obesity (a measure currently not available from national birth certificate data) is related to higher primary cesarean rates [11,12]. (Information on maternal prepregnancy weight and weight gain is being collected on the 2003 revision of the birth certificate, but these data are not yet available in combination for all states.) Rates of obesity among United States women in all age groups increased, however, during the 1990s [13], whereas cesarean rates fell from 1991 to 1996 and then increased from 1996 to 2000. Conversely, obesity rates did not increase from 1999 to 2004 among United States women of reproductive age [14], whereas the cesarean rate continued to climb; thus, changes in obesity do not seem to be the primary driving force behind the increase in the cesarean rate.

Trends for women who have no indicated medical or obstetric risk for cesarean

Studies estimating population-based trends in cesarean deliveries with no reported medical indications generally have used birth certificate data, hospital discharge data, or a combination of both. DeClercq and colleagues [7] used United States birth certificate data to identify a group of women who had NIR for cesarean delivery. These comprised full-term, singleton, vertex presentation births with no medical risk factors or complications of labor or delivery reported on the birth certificate and no prior cesarean. For this very low-risk group, the rate of primary cesareans has been rising since 1991 and especially rapidly since 1996 [7]. When data from this study were updated to

2003 [15], the overall primary cesarean rate for births to mothers who had NIR was 6.9%, nearly twice the 3.7% in 1996. The rate for first-time mothers was even higher, at 11.2% in 2003 (Fig. 8).

These results are comparable to those of other studies. Bailit and colleagues [16], using birth certificate data, estimated the primary cesarean delivery rate among women who had no medical or obstetric indication at approximately 7% in 2001. Two other recent studies used hospital discharge data to estimate the cesarean rate among women who had no reported medical or obstetric indication at 3% to 7% [17,18]. The methodology for the hospital discharge studies is similar to that for the birth certificate studies and involves identifying mothers who had low-risk births (full term or singletons) and no *International Classification of Disease* codes associated with labor or with complications of labor and delivery in their hospital discharge records [17,18]. A study that identified the subset of women who had NIR factors in birth certificate or hospital discharge data found a lower rate of medically elective cesareans (1.4%), based on 1998 to 2003 data [19]. Regardless of the exact level in a given year, all available studies document a recent rapid increase in cesarean delivery in low-risk women who had no medical indications for cesarean delivery.

Data on physician intention for method of delivery is not reported in birth certificate or hospital discharge data systems. Also, comparisons may be limited by possible under-reporting of medical risks and complications on birth certificates (see discussion later). Still, cesarean deliveries among low-risk women who have no medical indications represent the best approximation of a "medically elective" cesarean group possible from these large data sets.

Maternal opinions regarding cesarean delivery

The concept of maternal request cesarean has been defined variously in the medical literature. In some cases, it is defined simply as "primary elective

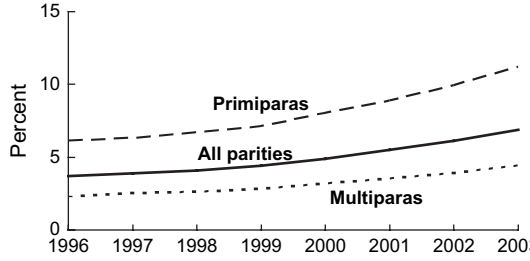

Fig. 8. Primary cesarean rates by parity for women who had NIR: United States, 1996–2003. NIR indicates women who had full-term vertex singleton births, birthweight less than 4000 g, and no reported medical risk factors or complications of labor or delivery. (*Data from* National Vital Statistics System, NCHS, CDC.)

cesarean delivery in the absence of a medical or obstetric indication'' [20,21]. This definition, however, does not take into account the complex and nuanced interaction between an obstetric care provider and a patient in decision making. A recent review of studies on decision making surrounding cesarean delivery concluded, ''the medical norms of health services . . . seem to drive nonmedically indicated cesarean delivery rates,'' and advocated for more detailed studies that examined patient-practitioner interactions within the context of care [22].

Despite widespread discussion in the medical literature about maternal request cesareans, few United States studies have asked pregnant women directly about their preferences for delivery method. *Listening to Mothers II* was a survey of 1573 mothers ages 18 to 45 who gave birth in a hospital to a singleton, still living infant in 2005. Results were weighted to reflect the national population [23]. In this study, for a mother to have a maternal request primary cesarean, she needed to meet two criteria: (1) have had the cesarean for no medical reason and (2) have made the decision for herself, before labor. Of the 252 mothers who had a primary cesarean in the survey, three indicated there was no medical indication for the cesarean and of these only one responded that she had made the decision to have a cesarean herself before beginning labor [23].

Results from the first *Listening to Mothers* survey, conducted in 2002, found little interest in a future elective primary cesarean, with only 6% of primiparous mothers interested in that option in the future [24]. A British national survey of mothers also found the phenomenon of maternal request cesareans to be rare [25]. Research from other countries with high cesarean rates, notably Brazil [26] and Chile [27], has found that rather than the cesarean rate being driven primarily by maternal demands, it is the interaction between mothers and their providers that leads to the decision to perform a cesarean without a clear medical indication. For example in Potter and colleagues' study in Brazil [26], more than 80% of primiparous mothers in the study anticipated a vaginal birth 1 month before their due date, yet almost half of these mothers (66% in private hospitals) ended up with a cesarean. Thus, although true maternal request cesareans doubtless occur, direct surveys of women seem to indicate that they are not numerous enough to account for the recent increase in the United States cesarean rate.

Neonatal and maternal outcomes by method of delivery

Several recent review articles have examined the risks and benefits of medically elective cesarean versus vaginal delivery for the mother and infant [28–33]. Several of these reviews were an outcome of the March 2006 National Institutes of Health (NIH) State-of-the-Science Conference: Cesarean Delivery on Maternal Request [31–33]. The NIH panel, after a systematic review of the literature, noted the lack of well-controlled studies for many outcomes of interest [34]; however, four findings were supported by at least a moderate level of

evidence. Medically elective cesarean delivery (compared with the combination of planned vaginal and unplanned cesarean delivery) was associated with: (1) a decreased risk for maternal hemorrhage; (2) an increased risk for respiratory problems for infants; (3) greater complications in subsequent pregnancies, including uterine rupture and placental implantation problems, and (4) longer maternal hospital stays [34]. Several recent studies have corroborated these findings [19,35–39]. The NIH panel further noted that studies on neonatal and maternal mortality lacked statistical power and consistent methodologies to reliably assess the effect of the planned delivery route [34]. As maternal and neonatal mortality are rare events for low-risk women in developed countries, very large sample sizes often are needed to detect statistically significant differences.

Several studies published in 2006 and 2007, and thus not included in the NIH conference and other reviews, may have the potential to shed further light on these issues. MacDorman and colleagues [40] examined neonatal mortality using linked birth and infant death certificate data for 1998 to 2001 from 5.7 million births with NIR for cesarean delivery. They found that even in the most conservative model (excluding congenital anomalies and Apgar scores less than 4 and adjusting for sociodemographic and medical risk factors), the odds ratio for neonatal mortality for primary cesarean delivery was 2.02 (1.60–2.55) compared with vaginal delivery.

The NIH conference advocated using an ''intention-to-treat'' methodology to analyze outcome data by method of delivery [34]. Using this methodology, emergency cesareans performed after a woman is in labor are combined with vaginal births to create a ''planned vaginal delivery'' category, because the original intention was evidently a vaginal delivery. The ''planned cesarean'' category includes only those deliveries where a cesarean section was performed without labor. When the MacDorman and colleagues' [41] data were reanalyzed using this methodology, the neonatal mortality rate for the cesarean without labor category was 1.73 compared with 0.72 for the planned vaginal category. In the most conservative model (excluding congenital anomalies and Apgar scores less than 4 and adjusting for sociodemographic and medical risk factors), the odds ratio for neonatal mortality for cesarean without labor was 1.69 (1.35–2.11) compared with ''planned vaginal'' delivery [41].

Although using different methodologies and not all using the intention-to-treat framework, several other recent studies have examined maternal or neonatal mortality in relation to method of delivery. Villar and coworkers [42], in a Latin American study, found, for infants in cephalic presentations, an odds ratio of neonatal mortality for cesarean delivery of 1.9 (1.6–2.3) compared with vaginal deliveries. Betran and colleagues [43], in a global study of the relationship between method of delivery and maternal and neonatal mortality, found that for countries with overall cesarean rates below 15%, higher cesarean rates were correlated with lower maternal mortality. For countries with national cesarean rates above 15%, however,

"higher cesarean rates are predominantly correlated with higher maternal mortality. A similar pattern is found for infant and neonatal mortality." These findings were corroborated by Villar and coworkers for Latin America [44]. Other recent studies found increased risks for maternal mortality for low-risk women delivered by cesarean [45,46], whereas an additional study found substantial serious maternal morbidity associated with cesarean section but no significant difference in maternal mortality [39].

Discussion

Cesarean rates in the United States fell between 1991 and 1996 and then began to rise rapidly. In 2006, nearly one third (31.1%) of United States births were cesarean deliveries. Over the past decade, cesarean rates increased sharply for women of all ages, all race/ethnic groups, all periods of gestation and in all states. Cesarean rates were highest for women ages 35 and over, for non-Hispanic black women, and for preterm births. Sixty percent of the increase in the cesarean rate from 1996 to 2004 was the result of increases in the primary cesarean rate. Based on the trend in the repeat cesarean rate, a first cesarean delivery now virtually guarantees that subsequent deliveries will be cesarean deliveries. Repeat cesarean deliveries are associated with significantly higher maternal and neonatal morbidity and mortality compared with cesarean or vaginal deliveries for women who do not have a prior cesarean [34,36–38,47–48]. For example, in one study, the odds ratios of having a life-threatening placenta accreta were 2.4 (1.3–4.3) for a third cesarean and 9.0 (4.8–16.7) for a fourth cesarean compared with a primary cesarean [47,48].

Primary cesarean rates also have increased rapidly for women who have NIR for cesarean delivery, which is the closest approximation to a medically elective cesarean group available from birth certificates. Although comparisons are limited by differences in methodology between various studies, there seems to be more evidence now than at the time of the NIH conference for an increased risk for maternal and neonatal mortality and morbidity for medically elective cesareans compared with vaginal births. In addition, the increase in the primary cesarean rate seems primarily the result of changes in obstetric practice and not to changes in the medical risk profile of births or increases in maternal request.

Strengths of the birth certificate data to track trends in cesarean delivery include the comprehensive population-based nature of these data, which include all births in the United States for a given year. Most demographic items and some medical items (including maternal age and parity and method of delivery) are considered well reported [49,50]. There are limitations with regard to a measure of no indicated medical or obstetric risk. There has been documentation of under-reporting of medical risk factors and complications of labor and delivery on birth certificates [49–51]. Reporting a risk factor or complication

associated with a resulting cesarean, however, would be expected to be encouraged. Also, there is no reason to suspect that the reporting of these variables has changed systematically over the past decade, potentially biasing trend analysis [9]. Unfortunately, future research using birth certificate data to identify NIR women will be further limited by differences in the specific risk factor data collected between the 1989 and 2003 revisions of the United States Standard Certificate of Birth. Because of the staggered implementation of the 2003 revision among states, both revisions are in use in different states, making it difficult to construct national estimates for the NIR group [1,2,52].

Discussions of the reasons for the growth in primary cesareans have centered on changing attitudes concerning cesareans among physicians and mothers [53–56]. Leitch and Walker [56] related the rise in the cesarean rate to a change in medical practice and concluded that although indications for cesarean did not change much over time, ''there has been a lowering in the overall threshold concerning the decision to carry out a caesarean section.'' This, combined with the increase in medically elective cesareans, probably accounts for much of the increase in the cesarean rate over the past decade. A more detailed examination is needed of mother, insurer, hospital, and provider attitudes toward medically elective cesareans and of the nature of the interaction between mothers and their obstetric care providers in decision making about the method of delivery. Research on the economic implications of the rising cesarean rate for hospitals, providers, insurers, and parents also is essential.

There are markedly different practice recommendations regarding cesarean delivery from American and international obstetric groups. In discussing the ethics of medically elective cesareans, the American College of Obstetricians and Gynecologists states [54],

> In the absence of significant data on the risks and benefits of cesarean delivery…if the physician believes that cesarean delivery promotes the overall health and welfare of the woman and her fetus more than vaginal birth, he or she is ethically justified in performing a cesarean delivery.

In contrast, the International Federation of Gynecology and Obstetrics states [57],

> At present, because hard evidence of net benefit does not exist, performing cesarean section for non-medical reasons is not ethically justified.

In 2004, Queenan [58] noted that the underlying ''question is not the ethics of patient choice, but lack of scientific proof of risks and benefits.'' It is hoped that with an increasing body of research on the harms and benefits of medically elective cesarean versus vaginal delivery, decision making regarding medically elective cesarean versus vaginal delivery will be increasingly evidence based.

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