OBSTETRICS

Morbidity associated with cesarean delivery in the United States: is placenta accreta an increasingly important contributor?

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OBJECTIVE: The purpose of this study was to examine cesarean delivery morbidity and its predictors in the United States.

STUDY DESIGN: We used 2000-2011 Nationwide Inpatient Sample data to identify cesarean deliveries and records with 12 potential cesarean delivery complications, including placenta accreta. We estimated cesarean delivery morbidity rates and rate changes from 2000-2011, and fitted Poisson regression models to assess the relative incidence of morbidity among repeat vs primary cesarean deliveries and explore its predictors.

RESULTS: From 2000-2011, 76 in 1000 cesarean deliveries (97 in 1000 primary and 48 in 1000 repeat cesarean deliveries) were accompanied by ≥1 of 12 complications. The unadjusted composite cesarean delivery morbidity rate increased by 3.6% only among women with a primary cesarean delivery ($P < .001$); the unadjusted rate of placenta accreta increased by 30.8% only among women with a repeat cesarean deliveries ($P = .025$). The adjusted rate of overall composite cesarean delivery morbidity decreased by 1% annually from 2000-2011 ($P < .001$). Compared with women with a primary cesarean delivery, those women who underwent a repeat cesarean delivery were one-half as likely (incidence rate ratio, 0.50; 95% CI, 0.49–0.50) to experience a complication, but 2.13 (95% CI, 1.98–2.29) times more likely to have a placenta accreta diagnosis. Both cesarean delivery morbidity and placenta accreta were positively associated with age >30 years, non-Hispanic black race/ethnicity, the presence of a chronic medical condition, and delivery in urban, teaching, or larger hospitals.

CONCLUSION: Overall, cesarean delivery morbidity declined modestly from 2000-2011, but placenta accreta became an increasingly important contributor to repeat cesarean delivery morbidity. Clinicians should maintain a high index of suspicion for abnormal placentation and make adequate preparations for patients who need cesarean deliveries.

Key words: cesarean delivery, United States

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Cesarean delivery is the most common major operating room procedure performed in the United States[1]; almost 1.3 million women had a cesarean delivery in 2012, the most recent year with available information.[2] The cesarean delivery rate reached an all-time high of 32.9% of all births in 2009 and remained stable at 32.8% from 2010-2012.[2] Contemporary cesarean rates represent a 60% rise since 1996, a year that marked the end of a brief period of decline in cesarean delivery rates because of a decrease in primary cesarean deliveries and a parallel increase in vaginal births after cesarean delivery.[3,4]

Short-term maternal risks of cesarean delivery include peri- and postoperative complications such as infection; hemorrhage that requires transfusion or hysterectomy; bowel, bladder, or ureteral injury; thromboembolic disease; and maternal death. In the long-term, cesarean delivery can be associated with decreased subsequent fertility or increased risk of ectopic pregnancy, miscarriage, abnormal placentation, and uterine rupture in subsequent pregnancies.[5,6] Concerns that are related to the latter condition lead to women with a previous cesarean delivery usually being offered a repeat cesarean delivery.[7] In

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turn, pregnancies after cesarean deliveries, especially after multiple cesarean deliveries, are accompanied by significantly higher risks of abnormal placentation and peripartum hysterectomy.[5,8-11] Given the increase in the proportion of deliveries by cesarean section, the incidence of placenta accreta appears to have risen in the United States over the last 2 decades.[12] Placenta accreta can result in major obstetric morbidity, notably life-threatening obstetric hemorrhage, unplanned cesarean hysterectomy, and complications related to the abnormal invasion of the placenta into adjacent organs.[8,10] In addition to health and safety risks for women and newborn infants, hospital charges for cesarean delivery are almost double those for a vaginal delivery.[4]

The high frequency of cesarean delivery in the United States may have contributed to a sense of confidence on the part of both women and providers about the safety of the procedure, irrespective of women's obstetric histories,[5] and warrants an analysis of morbidity and in-hospital mortality that is associated with cesarean delivery. Thus, the objectives of this study were to (1) examine morbidity that is associated with primary and repeat cesarean delivery with a focus on placenta accreta and (2) explore patient- and hospital-related factors that are associated with such morbidity and separately with placenta accreta in the United States from 2000-2011.

Materials and Methods

We used 2000-2011 data from the Nationwide Inpatient Sample, which is the largest all-payer hospital inpatient care database in the United States and is maintained by the Agency for Healthcare Research and Quality as part of its Healthcare Cost and Utilization Project. The Nationwide Inpatient Sample is a stratified sample of approximately 20% of all community hospitals in the United States and includes all discharges from an average of 1000 hospitals each year.[13] Thus, when weights are applied during analysis to account for the complex survey design, nationwide estimates can be derived. Each discharge record has the potential to list up to 15 *International Classification of Disease*, 9th Revision, Clinical Modification (ICD-9-CM) diagnoses and 15 ICD-9-CM procedures as well as diagnosis-related group codes. Because this analysis used publicly available data lacking personal identifiers, the Centers for Disease Control and Prevention's Institutional Review Board determined it to be research that does not involve human subjects.

We identified all delivery hospitalization records using the algorithm developed by Kuklina et al.[14] This algorithm uses ICD-9-CM diagnosis codes for delivery outcomes, ICD-9-CM procedure codes for selected delivery-related procedures, and diagnosis-related group delivery codes. Cesarean deliveries were identified by the presence of an ICD-9-CM procedure code for cesarean delivery (74.0, 74.1, 74.2, 74.4, 74.99). Among cesarean deliveries, those with an ICD-9-CM diagnosis code 654.2 were classified as repeat cesarean deliveries and those without such code were considered primary cesarean deliveries. We used the ICD-9-CM diagnosis or procedure codes shown in Table 1 to identify records with the following 11 complications or conditions that potentially are associated with cesarean delivery: (1) urinary bladder operations, (2) cystotomy, (3) anesthesia complications, (4) obstetric wound complications, (5) blood transfusion, (6) ventilation support, (7) renal failure, (8) sepsis, (9) shock, (10) prolonged hospital stay defined as stay longer than five days (ie, 90th percentile of the length of hospital stay distributions for all cesarean deliveries in the sample), and (11) death during the delivery hospitalization.

In addition, of special interest for this analysis was the identification of

TABLE 1
ICD-9-CM codes for cesarean delivery complications and chronic conditions examined in the analysis

Condition	Diagnosis or procedure codes
Cesarean delivery complications	
Urinary bladder operations	57.x
Cystotomy	57.1
Anesthesia complications	668.0x, 668.1x, 668.2x
Blood transfusion	99.0x
Ventilation support	93.90, 96.01-96.05, 96.7x
Renal failure	669.3, 584.x
Sepsis	038.0-038.4, 038.8, 038.9, 995.91, 995.92
Shock	669.1, 998.0, 995.0, 995.4, 785.5x
Obstetric wound complications	674.10, 674.12, 674.14, 674.30, 674.32, 674.34
Chronic conditions	
Preexisting diabetes mellitus	249.x, 250.x, 648.0x
Chronic hypertensive disease	401.x-405.x, 642.0x, 642.1x, 642.2x, 642.7x
Chronic heart disease	412.x, 413.x, 414.x, 394.x, 395.x, 396.x, 397.x, 424.x, 428.22, 428.23, 428.32, 428.33, 428.42, 428.43
Chronic respiratory disease	491.x-496.x
Chronic renal disease	581.x-583.x, 585.x, 587.x, 588.x, 646.2x
Chronic liver disease	571.x, 572.x
HIV/AIDS	042.x, V08.x

ICD-9-CM, International Classification of Disease, 9th Revision, Clinical Modification.

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