American Journal of Obstetrics and Gynecology (2006) **194**, 402–7

ELSEVIER

American Journal of
Obstetrics & Gynecology
www.ajog.org

# Quality of obstetric care and risk-adjusted primary cesarean delivery rates

**Jennifer L. Bailit, MD, MPH,[a] Thomas E. Love, PhD,[b] Neal V. Dawson, MD[c]**

*Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine,[a] Department of Operations,[b] Department of Medicine,[c] Center for Health Care Research and Policy, MetroHealth Medical Center, Case Western Reserve University, Cleveland, OH*

Received for publication March 24, 2005; revised June 24, 2005; accepted July 12, 2005

**KEY WORDS**
Quality of care
Risk adjustment
Cesarean delivery rate
Obstetric

**Objective:** The purpose of this study was to examine the association between risk-adjusted primary cesarean delivery rates and maternal and neonatal outcomes.
**Study design:** California birth certificate data that were linked to hospital discharge data for 2001 were used to create a primary cesarean delivery rate risk-adjustment model. Two hundred eighty-five hospitals were divided into 3 groups that were above, below, or within expected rate confidence intervals. Maternal and neonatal outcomes were compared within each of the 3 hospital groupings.
**Results:** Of the 285 hospitals, 27% had primary cesarean delivery rates that were above expected confidence intervals; 34% had primary cesarean delivery rates that were below expected confidence intervals, and 39% had primary cesarean delivery rates that were within expected confidence intervals. Neonatal asphyxia rates were higher in hospitals that had lower than expected rates of cesarean deliveries (0.05%, 0.1%, 0.07% for above, below, and within the confidence intervals, respectively; $P < .0001$). Maternal infection rates (2.1%, 2.3%, 1.8%, respectively; $P < .0001$) and third-degree tears (2.3%, 3.0%, 2.6%, respectively; $P < .0001$) were also higher in hospitals for which the cesarean delivery rates were above or below the expected rates.
**Conclusion:** Risk-adjusted primary cesarean delivery rates are a good marker for maternal and neonatal outcomes.


Obstetric quality indicators are an important part of the national health agenda. In part this is due to the sheer number of deliveries each year. There were just over 4 million deliveries in the United States in the year 2001, which makes the delivery of an infant the second leading cause of hospitalization in the United States.[1,2]

An ideal quality evaluation process in obstetrics would encompass 5 major characteristics: (1) association with meaningful maternal and neonatal outcomes, (2) relation to outcomes that are influenced by physician/health system behaviors, (3) reliability and reproducibility, (4) inexpensive ways to apply on a large scale basis, and (5) acceptability to practicing obstetricians as a meaningful marker of quality. The identification of high- and low-quality obstetrics hospitals is important because it is the first step in the determination of which hospital characteristics and practice patterns are associated with good

Supported in part by the Women's Reproductive Health Research Career Development Program (grant K12: HD98004; J.L.B).
Reprints not available from the authors.

0002-9378/$ - see front matter © 2006 Mosby, Inc. All rights reserved.
doi:10.1016/j.ajog.2005.07.045

quality of care and provides an opportunity to improve care in the poorer quality hospitals.

Many traditional measures of obstetric quality (such as hospital cesarean delivery rates) are becoming obsolete, and new measures have been developed recently. Risk-adjustment for cesarean delivery rates is one of these new methods. Risk-adjusted cesarean delivery rates are a way of assessing cesarean delivery rates that take maternal risk factors into account. Risk adjustment is critical because, when cesarean delivery rates are compared without risk adjustment, hospitals that treat patients with complex conditions appear to be providing poor quality care when, in fact, they may be providing superb care. Additionally, hospitals that provide care to low-risk patients may appear to be providing high-quality care when in fact they are not.

Risk-adjusted cesarean delivery rates have been validated recently as a marker of quality intrapartum care in several published studies. Several studies in different states that use different methods of risk-adjustment have shown that low risk-adjusted cesarean delivery rates are associated with poorer neonatal outcomes.[3-5] Additionally, risk-adjusted cesarean delivery rates that are higher than expected have been associated with poorer neonatal outcomes.[3,4] Risk-adjusted cesarean delivery rates show potential to capture both maternal and neonatal outcomes and are a step toward an "ideal" quality measure for obstetrics. Additionally, risk adjustment of cesarean delivery is attractive because it can be performed on a well-established, complete, uniform, and inexpensive data source: birth certificate data.

An ideal quality assessment tool in obstetrics would capture both maternal and neonatal outcome. Although there is a growing body of data to support the association of risk-adjusted cesarean delivery rates and neonatal outcomes, there are little data on the association of maternal outcomes and risk-adjusted cesarean delivery rates.

Our objective was to determine whether risk-adjusted cesarean delivery rates that are above or below expected rates are associated with poorer maternal outcomes and to confirm that these rates are associated with poorer neonatal outcomes.

## Methods

With the approval of the MetroHealth Medical Center Institutional Review Board and the California State Committee for the Protection of Human Subjects, we obtained California birth certificate data that were linked to maternal and neonatal hospital discharge data and infant death certificates for 2001. This data set is virtually complete for the population of California because >99% of all births are registered.[6] Hospital discharge data contain ICD-9 diagnosis codes for all hospitalizations.

We excluded all women with a previous cesarean delivery because they were not at risk for a primary cesarean delivery. Nonviable deliveries, those at <23 weeks of gestation or <450 g, and babies with major anomalies were excluded because these babies are not typically at risk for cesarean delivery. Mothers who were delivered outside of a hospital were excluded. We excluded hospitals with <50 deliveries in 2001. Reports from deliveries that contained data that was judged to be improbable were deleted (maternal age <11 or >51 years, gestational age >45 weeks, and vaginal delivery of an infant who weighed >6000 g) Last, reports with missing data were excluded.

We risk-adjusted primary cesarean delivery rates using methods that were previously described.[3,7-9] In brief, a logistic regression model was developed and used to predict the probability of a cesarean delivery for each obstetrics patient. Probabilities of cesarean delivery for all obstetrics patients were added together for each hospital to yield the predicted number of cesarean deliveries for that hospital. We then divided this predicted number of deliveries by the total number of patients who were delivered in that hospital to obtain the hospital's predicted cesarean delivery rate. Confidence intervals (2.5% to 97.5%) around the ratio of actual to predicted cesarean delivery rates were then calculated.

Our risk adjustment model included maternal age; birth weight; gestational age; parity; Hispanic ethnicity; race; multiple gestation; maternal insurance; severe, mild, and moderate maternal medical complications; prenatal care; and labor complications. Severe maternal complications included eclampsia, renal disease, cardiac disease, RH-sensitization, incompetent cervix, and genital herpes. Moderate maternal complications included preeclampsia, hypertension, pyelonephritis, diabetes mellitus, bleeding before labor, polyhydramnios, oligohydramnios, preterm labor, previous large infant, previous small infant, previous preterm delivery, cerclage, and tocolysis. Mild maternal complications included anemia, hemoglobinopathy, sexually transmitted disease, rubella, smoker, amniocentesis, chorionic villus sampling, ultrasound evaluation, and other. Labor complications included cord prolapse, breech, previa, and abruption. The model was bootstrapped for 200 repetitions to insure reproducibility. Bootstrapping is a technique in which a random sampling of the data with replacement is performed over multiple iterations to be sure that the model gives the same results. C statistics were also bootstrapped for 200 repetitions to assess the predictive ability of the model.

Hospitals were classified into 3 categories: cesarean delivery rates above, below, or within expected intervals. Expected cesarean delivery intervals are the range of cesarean delivery rates that were predicted at each hospital on the basis of the hospital's patient mix. Hospitals were classified by the creation of a ratio of observed-to-expected rates and the creation of a 95% CI