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# Paradoxical Trends and Racial Differences in Obstetric Quality and Neonatal and Maternal Mortality

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## Abstract

**OBJECTIVE—**To evaluate trends by race in Agency for Healthcare Research and Quality (AHRQ) obstetric-related quality and safety indicators, and their relationships to trends in inpatient maternal and neonatal mortality.

**METHODS—**We used the Nationwide Inpatient Sample from 2000 through 2009 and calculated obstetric hospital quality and patient safety indicators and inpatient maternal and neonatal mortality stratified by race. We examined differences in age and comorbidity-adjusted trends in black compared with white women over time in the United States and by geographic region. Proportions were analyzed by chi-square test and trends by regression analysis.

**RESULTS—**Obstetric quality indicators varied by geographic region but changes over time were consistent for both races. Cesarean deliveries increased similarly for black and white women and vaginal births after cesarean delivery declined for both races, but more rapidly for whites than blacks. Obstetric safety indicators improved over the study period for black and white women with obstetric trauma decreasing significantly for whites and blacks (28% compared with 35%, respectively) and birth trauma – injury to neonate declining for both, but changes were not significant. In striking contrast, inpatient maternal and neonatal mortality remained relatively constant during the study period, with persistently higher rates of both seen among black compared with white women (12.0 compared with 4.6 per 100,000 deliveries, $P<.001$ and 6.6 compared with 2.5 per 1000 births, $P<.001$, respectively in 2009).

**CONCLUSION—**Improvements in AHRQ quality indicators for obstetrics are not reflected in improvements in maternal and neonatal morbidity and mortality, and do not explain continued racial disparities for outcomes in pregnancies in black and white women. Quality measures that are related to pregnancy outcomes are needed and these should elucidate obstetric health disparities.

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## INTRODUCTION

Over four million births occur annually in the United States, and childbirth is the largest category for hospital admissions for commercial payers and Medicaid programs.[1,2] Complications associated with delivery are not rare and are sensitive to quality of care at delivery.[3–6] Further, persistent racial disparities in perinatal outcomes exist with neonatal mortality rates in black women twice that of whites and maternal mortality rates in black women three to four times that of whites.[7,8]

Hospital quality is associated with neonatal and obstetric outcomes and quality among hospitals varies.[9–11] Preventable causes account for one third to one half of maternal deaths including hospital practices such as the management of hypertension, deep venous thrombosis, chronic diseases, and hemorrhage during delivery.[12–14] Given these facts, there is a rising focus on the quality of hospital care as a means to reduce both overall maternal and neonatal mortality and to narrow racial disparities in perinatal outcomes.

The Agency for Healthcare Research and Quality (AHRQ) developed seven indicators of obstetric health care quality and safety that make use of readily available hospital inpatient administrative data.[15] The objectives of this study were to examine differences between black and white women in these indicators, explore geographic variation in these indicators by race, and examine differences between black and white women in maternal and neonatal mortality over time. We hypothesized that data over the last decade would demonstrate improving trends in quality and decreasing neonatal and maternal mortality for both black and white women.

## MATERIALS AND METHODS

We used data from the 2000 through 2009 Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project, a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality (AHRQ). The Nationwide Inpatient Sample is a stratified sample representing 20% of U.S. community hospitals.[16] We examined all deliveries that occurred in hospitals with at least 10 deliveries annually, as we wanted to analyze hospitals with an obstetric volume high enough to preclude accidental births. The number of states participating in the Nationwide Inpatient Sample ranged from 28 in 2000 to 44 in 2009.[16] Validity and reliability of the Nationwide Inpatient Sample have been studied extensively.[17] Nationwide Inpatient Sample data are publicly available and do not include personal identifiers. The Mount Sinai Program for Protection of Human Subjects (Institutional Review Board) deemed this research exempt.

We computed indicators of patient safety, hospital quality of care, and neonatal and maternal mortality. We used the three AHRQ patient safety indicators related to obstetrics: birth trauma – injury to neonate, obstetric trauma with instrument, and obstetric trauma without instrument. Obstetric trauma refers to third and fourth degree perineal lacerations. We also examined the four AHRQ inpatient quality indicators related to obstetrics: cesarean delivery, primary cesarean, uncomplicated vaginal birth after cesarean delivery (VBAC), and all VBACs. Agency for Healthcare Research and Quality specifies the numerator and denominator for each indicator. For example, to measure birth trauma – injury to neonate we included all deliveries with these *International Classification of Diseases, Ninth Revision* (ICD-9) codes: 7670, 7671, 7673, 7674, 7675, 7677, 7678. As specified by AHRQ, we excluded infants with any diagnosis code of infants with a birth weight of less than 2000 grams. We also excluded infants with any injury to brachial plexus or any diagnosis code of ostoegenesis imperfecta. The denominator was all liveborn births (newborns) with these ICD-9 codes: V3000, V3001, V3100, V3101, V3200, V3201, V3300, V3301, V3400,

V3401, V3500, V3501, V3600, V3601, V3700, V3701, V3900, V3901 or with specified newborn admission codes and age at admission equal to zero days. Each patient safety indicator and inpatient quality indicator has specific inclusion and exclusion criteria detailed by AHRQ.[15]

We computed inpatient maternal mortality using Diagnosis-Related Group (DRG) 370–375 and disposition equal to died. We computed inpatient neonatal mortality by identifying newborns admissions with disposition equal to died for newborns up to one year of life, which has been recommended to avoid bias from not including deaths who are hospitalized for long periods and for whom death is related to perinatal causes.[18] Ninety-nine percent of deaths occurred within 28 days of birth in this cohort. We identified newborns using the same algorithm as recommended by AHRQ for identification of live newborns.

For each hospital, we computed risk-adjusted rates of patient safety and inpatient quality indicators. Risk adjustment consisted of controlling for age, sex, modified DRG, and comorbidities as specified by AHRQ. We examined risk-adjusted patient safety and inpatient quality indicators by each of four geographic regions: Northeast, Midwest, South and West. Proportions were analyzed by chi-square test and trends by linear regression of the adjusted annual rate on time. Because the ICD-9 codes used by AHRQ for birth trauma – injury to neonate changed in 2003, we used data from 2004 to 2009 to calculate trends in birth trauma rates.

We conducted race-specific analyses and limited our analyses to white and black women. We then compared specific risk-adjusted rates for quality and safety indicators and for neonatal and maternal mortality overall and by geographic region in black and white women. To examine whether trends in quality indicators differed by race we included interaction terms between race and a linear time term. To account for nonlinear trend, we included both time and the square of time year as main effects and interactions with race. Race was missing for approximately 28% of the hospitals. Race data in Nationwide Inpatient Sample is incomplete because of differences in state and hospital procedures for collecting race data.[19] We therefore conducted sensitivity analyses comparing rates of inpatient quality indicators and patient safety indicators for all hospitals compared with those hospitals with race for at least 80% of deliveries. We conducted these analyses to verify that rates and trends based on the restricted sample were similar to those in the overall sample of hospitals. We also conducted sensitivity analyses for delivery volume and compared rates of inpatient quality indicators and patient safety indicators for all hospitals and those with at least10 deliveries.

## RESULTS

Patient safety indicators improved from 2000 to 2009 overall. Obstetric trauma decreased by 28% for white women (201.9 to 145.7 per 1000 vaginal deliveries with instrument) and by 35% for black women (140.4 to 90.9 per 1000 vaginal deliveries with instrument) (Table 1 and Figure 1). Similar trends were evident for vaginal deliveries without instrument which decreased by 44% for white women (43.7 to 24.3 per 1000 vaginal deliveries without instrument) and by 43% for black women (23.5 to 12.3 per 1000 vaginal deliveries without instrument). The proportion of instrumental deliveries also declined from 11% to 8% over the study period. Birth trauma – injury to neonate declined 6% for black women and 21% for white women from 2004 through 2009. Rates of change for patient safety indicators were similar for black and white women except for a small but statistically significant difference in the rate of decline in obstetric trauma among vaginal deliveries without instrument. This decline was more rapid for white women than black women.

Changes in inpatient quality indicators were evident over the study period with primary cesarean delivery rates increasing and VBACs decreasing. Cesarean delivery rates for white women increased from 197.5 per 1000 deliveries in 2000 to 303.0 per 1000 deliveries in 2009, an increase of 53%. Likewise, cesarean delivery rates for black women increased from 225.1 per 1000 deliveries in 2000 to 330.8 per 1000 deliveries in 2009, an increase of 47%. The rate of change was similar for both groups. Throughout the study period, risk-adjusted cesarean delivery rates were higher for black women than for white women (Figure 1).

In contrast, the rate of decline for VBAC was more rapid for white women than black women. Rates of VBAC decreased by 74% for white women compared with 66% for black women, $P<.0001$ and the decline occurred earlier for whites (Figure 1). Throughout the study period risk-adjusted VBAC rates remained higher among black women than white women.

Quality and patient safety indicators varied by geographic region for white and black women, but trends over time were similar for both groups (Table 2). For example, although primary cesarean delivery rates increased for black and white women over the 10-year period, there was wide variation in rates of cesarean delivery depending on geographic region. Rates in 2009 ranged from a low for white and black women (170.9 and 185.2 per 1000 births, respectively) in the Midwest to a high (206.9 and 219.7 per 1000 births, respectively) in the South. Similar to national trends, the decline in VBAC rates occurred more rapidly for white women than for black women, and this decline appeared to be most pronounced for the Northeast region.

Unlike dramatic changes in patient safety and inpatient quality indicators during the study period, inpatient maternal and neonatal mortality did not change substantially between 2000 and 2009 (Figure 2), with persistently higher rates of both seen in black women compared with white women (12.0 compared with 4.6 per 100,000 deliveries, $P<.0001$ and 6.6 compared with 2.5 per 1000 births, $P<.001$, respectively in 2009).

Sensitivity analyses were conducted to compare rates of inpatient quality indicators and patient safety indicators for all hospitals compared with those hospitals with race for at least 80% of deliveries. Rates and trends in the overall sample were very similar to those in the group of hospitals with race data (Table 3). We also conducted sensitivity analyses for delivery volume and compared rates of inpatient quality indicators and patient safety indicators for all hospitals and those hospitals with at least 10 deliveries and found no significant difference in reporting between these two groups.

## DISCUSSION

This paper provides a nationally representative overview of obstetric quality for black and white women as measured using the AHRQ quality indicators. Our analyses demonstrate that some parameters of obstetric-related quality improved from 2000 to 2009. We found that patient safety indicators, in particular obstetric trauma during delivery, decreased markedly overall, and for black and white women during this period. At the same time, inpatient quality indicators also changed for women. Cesarean delivery rates rose while VBAC rates decreased during this period and these changes are consistent with published literature of this period and with changes in American College of Obstetricians and Gynecologists guidelines on safety of VBAC.[20–22] However, our findings suggest a paradox: despite improvements in some parameters of hospital quality, inpatient maternal and neonatal mortality remained relatively stable.

During this period of increased attention to hospital quality, parameters of hospital quality and patient safety in obstetrics had similar patterns for black and white women. However,

one exception was the rate of decline in VBAC rates which was higher for white women than for black women and raises the hypothesis that the rate of uptake of practice based guidelines may vary for patients by race. Whether this finding is due to hospital site of care, patient decision making, or provider decision making cannot be determined with the use of this data set. Our findings that black women had lower rates of obstetric trauma and higher rates of cesarean deliveries than white women and that cesarean delivery rates vary by region are consistent with previous literature.[23–26]

Our findings suggest that the seven AHRQ obstetric quality and safety indicators are not associated with maternal and neonatal mortality. The AHRQ indicators were extensively tested for feasibility, validated according to strict criteria, and do assess domains within the Institute of Medicine's suggested six domains of quality (safety, effectiveness, patient centered, timeliness, efficiency, and equity.)[15,27] However, they may not be associated with the underlying factors that are most important for explaining variation between hospitals in maternal and neonatal mortality.

Quality measures focused on more crucial processes of care on the pathway to maternal and neonatal mortality (such as the use of antenatal steroids in the setting of preterm delivery or the use of hemorrhage protocols in the delivery suite) are needed and may be targets for quality improvement activities.[13,28,29] The Joint Commission recently endorsed the use of antenatal steroids as a perinatal quality measure.[30] Others have endorsed quality measures such as elective delivery before 39 weeks, health care-associated bloodstream infections in newborns, deep venous thrombosis prophylaxis, and antibiotics in different settings including preterm premature rupture of membranes (PPROM).[31–34]

Our findings also suggest that quality measures sensitive to disparities, or measures that are helpful in reducing disparities, are needed in obstetrics. The National Quality Forum has endorsed disparities-sensitive quality measures in other areas of medicine.[35] One such potential obstetric measure is the use of antibiotics in the setting of PPROM. Given the high prevalence of PPROM among black mothers,[36] its strong association with neonatal morbidity and mortality,[37] and the evidence base for use of antibiotics in this setting,[33] this measure may have the potential to help hospitals narrow disparities.

There are limitations with our study. Maternal mortality is underreported and rates of inpatient maternal mortality from the Nationwide Inpatient Sample are lower than reports enhanced by case ascertainment.[38,39] Race data in the Nationwide Inpatient Sample is incomplete because of differences in state and hospital procedures for collecting race data and this could create bias if hospitals with missing race had different rates for these indicators or if differentials between white and black women did not follow the patterns observed in other hospitals.[19] However, sensitivity analyses demonstrated no differences between hospitals that coded race and those that did not code race in terms of quality and safety indicators. We were also not able to sufficiently control for socioeconomic and environmental factors that likely contribute to disparities in outcomes with the use of administrative data. There are limitations inherent to use of ICD-9-CM codes to conduct medical research. Nevertheless, one of the strengths of AHRQ quality indicators is that they are ascertainable from routine administrative data.

Our study examined national trends in obstetric quality and safety and neonatal and maternal mortality stratified for black and white patients. We found that trends in AHRQ obstetric quality indicators and maternal and neonatal mortality were not aligned. Despite improvements in some parameters of obstetric quality, neonatal and maternal mortality rates stagnated and these indicators are unable to inform care focused on narrowing disparities. Given that minority women account for 50% of births and persistent racial disparities in

maternal and neonatal mortality persist, quality measures that address disparities are very much needed. Future research should document what modifications to existing measures or which new measures might help elucidate disparities that exist as well as the improvement initiatives that could be used to reduce morbidity and mortality and the intractable racial disparities in perinatal outcomes.

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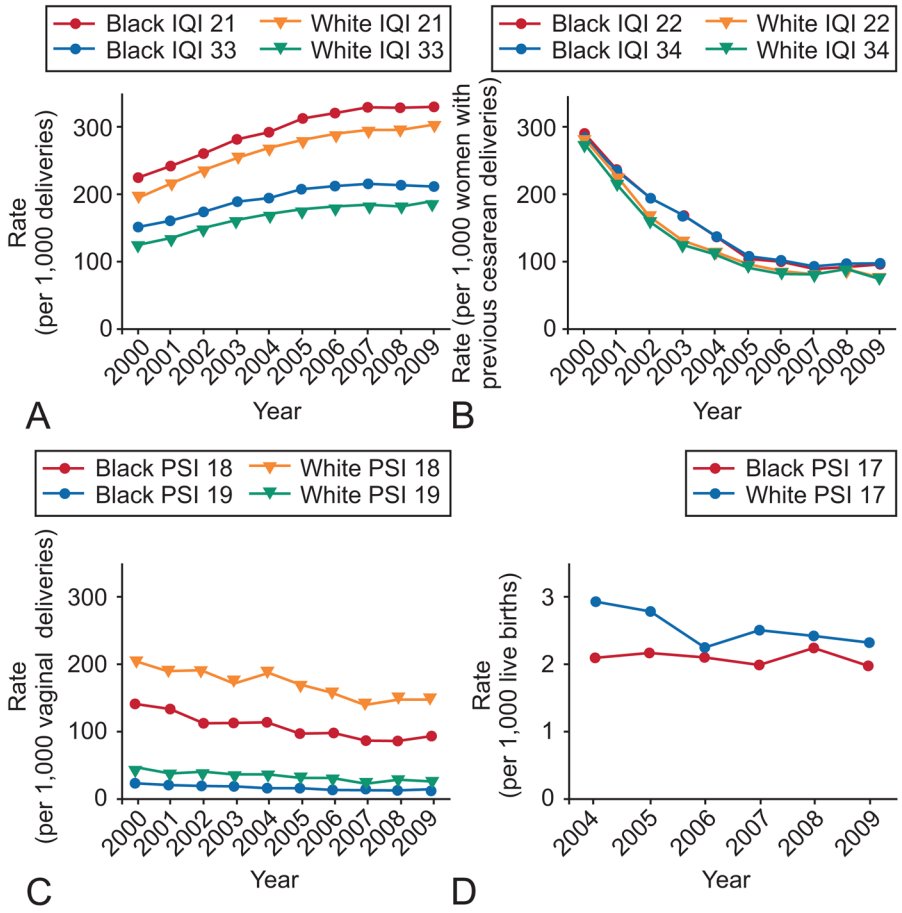


**Figure 1.**

Trends in obstetric quality indicators for black and white patients. A: trends in cesarean delivery (inpatient quality indicators [IQI] 21) and primary cesarean delivery (IQI 33) by race. B: trends in uncomplicated (IQI 22) and all (IQI 34) vaginal deliveries after cesarean by race. C: trends in obstetric trauma after vaginal deliveries with (patient safety indicators [PSI] 18) and without instruments (PSI 19) by race. D: trends in birth trauma – injury to neonate (PSI 17) by race.

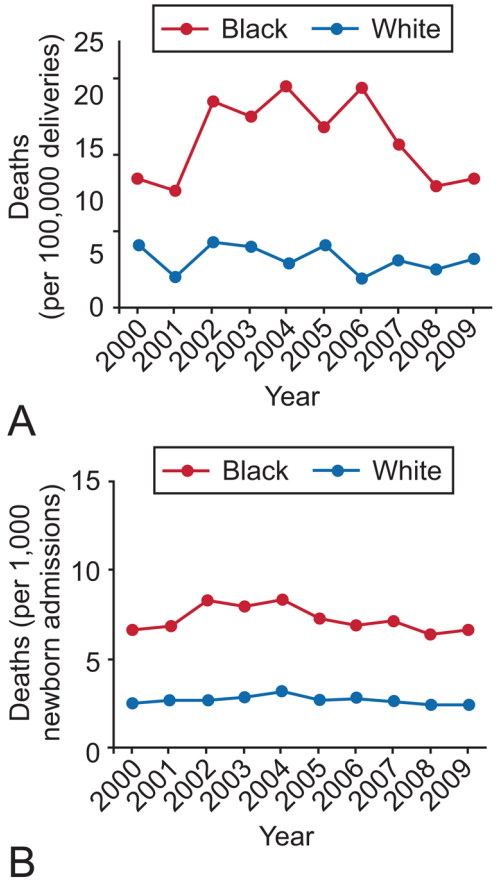


**Figure 2.**
Trends in mortality for black and white patients. A: trends in maternal mortality by race. B: trends in neonatal mortality by race.

**Table 1**

Trends in Obstetric Inpatient Quality and Patient Safety Indicators between 2000 and 2009 For Black and White Women

| Obstetric-Related Quality Indicator | Denominator | 2000 | | 2009 | | Change 2009 vs 2000 | | |
|---|---|---|---|---|---|---|---|---|
| | | Whites per 1000 | Blacks per 1000 | Whites per 1000 | Blacks per 1000 | Whites % | Blacks % | *P** |
| Inpatient quality indicators† | | | | | | | | |
| Cesarean delivery | all deliveries | 197.5 | 225.1 | 303.0 | 330.8 | + 53 | + 47 | 0.181 |
| Primary cesarean delivery | all deliveries | 125.8 | 150.8 | 186.5 | 211.8 | + 48 | + 40 | 0.686 |
| Vaginal birth after cesarean, uncomplicated | previous cesarean | 284.4 | 286.6 | 73.6 | 94.5 | − 74 | − 67 | 0.001 |
| Vaginal birth after cesarean, all | previous cesarean | 271.1 | 281.3 | 71.4 | 97.0 | − 74 | −66 | 0.001 |
| Patient safety indicators† | | | | | | | | |
| Birth trauma – injury to neonate‡ | all deliveries | 2.9 | 2.1 | 2.3 | 2.0 | − 21 | − 6 | 0.099 |
| Obstetric trauma (third or fourth degree laceration) | vaginal deliveries with instrument | 201.9 | 140.4 | 145.7 | 90.9 | − 28 | − 35 | 0.407 |
| Obstetric trauma (third or fourth degree laceration) | vaginal deliveries without instrument | 43.7 | 23.5 | 24.3 | 12.3 | − 44 | − 43 | 0.001 |

*For the time trend comparison for white women compared with black women.

†All quality indicators risk adjusted by age, comorbidity, and disease-related group as specified by Agency for Healthcare Research and Quality.

‡Comparison between 2004 and 2009 (due to changes in *International Classification of Diseases, Ninth Revision* coding in 2003).

**Table 2**

Trends in Obstetric Inpatient Quality and Patient Safety Indicators between 2000 and 2009 by Geographic Region For Black and White Women

| Quality Indicator* | Region | 2000 | | 2009 | | Change 2009 vs 2000 | | |
|---|---|---|---|---|---|---|---|---|
| | | Whites per 1000 | Blacks per 1000 | Whites per 1000 | Blacks per 1000 | Whites % | Blacks % | *P* |
| Primary cesarean delivery (IQI 33) | Northeast | 136.5 | 167.7 | 187.1 | 212.8 | 37.0 | 26.9 | 0.892 |
| | Midwest | 111.3 | 111.7 | 170.9 | 185.2 | 53.5 | 65.7 | 0.896 |
| | South | 138.2 | 152.7 | 206.9 | 219.7 | 49.7 | 43.9 | 0.940 |
| | West | 107.1 | 139.8 | 167.4 | 204.6 | 56.4 | 46.4 | 0.458 |
| Vaginal birth after cesarean delivery, all (IQI 34) | Northeast | 267.3 | 277.1 | 80.7 | 132.3 | −69.8 | −52.3 | 0.837 |
| | Midwest | 291.5 | 370.8 | 66.9 | 115.9 | −77.0 | −68.7 | 0.555 |
| | South | 229.8 | 270.5 | 57.2 | 86.3 | −75.1 | −68.1 | 0.498 |
| | West | 337.6 | 273.7 | 96.9 | 87.6 | −71.3 | −68.0 | 0.367 |
| Obstetric trauma (lacerations without instrument) (PSI 19) | Northeast | 46.4 | 25.9 | 25.1 | 14.3 | −45.8 | −44.8 | 0.005 |
| | Midwest | 47.1 | 20.1 | 24.4 | 8.3 | −48.2 | −58.5 | 0.001 |
| | South | 42.6 | 23.3 | 25.2 | 12.9 | −40.9 | −44.9 | 0.002 |
| | West | 38.2 | 22.1 | 21.8 | 11.5 | −42.8 | −48.1 | 0.051 |
| Birth trauma – injury to neonate† (PSI 17) | Northeast | 2.1 | 3.6 | 2.6 | 1.9 | 28.4 | −48.1 | 0.309 |
| | Midwest | 1.3 | 2.2 | 2.0 | 1.4 | 49.8 | −37.6 | 0.526 |
| | South | 2.1 | 2.9 | 2.5 | 2.2 | 23.2 | −21.8 | 0.311 |
| | West | 3.3 | 2.7 | 1.8 | 1.2 | −45.1 | −53.8 | 0.545 |
| Neonatal in-hospital mortality | Northeast | 2.3 | 7.8 | 2.3 | 6.7 | −0.4 | −13.9 | 0.256 |
| | Midwest | 2.1 | 7.5 | 1.9 | 6.1 | −9.4 | −18.8 | 0.098 |
| | South | 3.0 | 5.9 | 2.0 | 7.1 | −30.8 | 20.3 | 0.839 |
| | West | 2.5 | 6.7 | 2.4 | 4.4 | −3.6 | −35.0 | 0.120 |

Maternal in-hospital mortality (cannot be reported according to Nationwide Inpatient Sample guidelines because of low numbers)

IQI, inpatient quality indicators; PSI, patient safety indicators.

*All quality indicators risk adjusted by age, comorbidity, and disease-related group as specified by Agency for Healthcare Research and Quality.

†Comparison between 2004 and 2009 (due to changes in *International Classification of Diseases, Ninth Revision* coding in 2003).

**Table 3**

Sensitivity Analysis For Inpatient Quality Indicators and Patient Safety Indicators: Overall and For Black and White Women.

| Quality Indicator | Year 2000, All Deliveries | Year 2000, Reported Race* | Year 2000, Hospitals With at Least 10 Deliveries | Year 2000, Hospitals With at Least 10 Deliveries and Less than 20% Missing Race | Year 2009, All Deliveries | Year 2009, Reported Race* | Year 2009, Hospitals With at Least 10 Deliveries | Year 2009, Hospitals With at Least 10 Deliveries and Less than 20% Missing Race |
|---|---|---|---|---|---|---|---|---|
| Cesarean delivery per 1000 deliveries | 196 | 197 | 196 | 197 | 301 | 307 | 303 | 306 |
| Vaginal birth after cesarean delivery, uncomplicated per 1000 women with previous cesarean delivery | 293 | 291 | 293 | 292 | 86 | 82 | 86 | 81 |
| Primary cesarean delivery per 1000 deliveries | 126 | 126 | 126 | 126 | 184 | 186 | 184 | 186 |
| Vaginal birth after cesarean delivery, all per1000 women with previous cesarean delivery | 281 | 279 | 281 | 280 | 85 | 81 | 85 | 81 |
| Obstetric trauma, vaginal delivery with instrument per 1000 deliveries with instrument | 197 | 192 | 197 | 191 | 144 | 139 | 143 | 139 |
| Obstetric trauma, vaginal delivery without instrument per 1000 deliveries without instrument | 39 | 39 | 39 | 39 | 22 | 22 | 22 | 22 |
| Birth trauma – injury to neonate per 1000 live births† | 2.69 | 2.55 | 2.68 | 2.55 | 2.19 | 2.13 | 2.19 | 2.10 |

Indicators are compared for all deliveries, for deliveries in hospitals with at least 10 deliveries, and for deliveries in hospitals with at least 10 deliveries and less than 20% missing race.

*Excludes cases where race could not be determined.

†Comparison of 2004 with 2009 data (due to changes in *International Classification of Diseases, Ninth Revision* coding in 2003).