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Racial and Ethnic Disparities in Mode of Anesthesia for Cesarean Delivery

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Abstract

Background—Racial and ethnic disparities have been identified in the provision of neuraxial labor analgesia. These disparities may exist in other key aspects of obstetric anesthesia care. We sought to determine if racial/ethnic disparities exist in mode of anesthesia for cesarean delivery (CD).

Methods—Women who underwent CD between 1999 and 2002 at 19 different obstetric centers in the United States were identified from the Maternal-Fetal Medicine Units Network Cesarean Registry. Race/ethnicity was categorized as: Caucasian, African-American, Hispanic, Non-Hispanic Others (NHOs). Mode of anesthesia was classified as neuraxial anesthesia (spinal, epidural or combined spinal-epidural anesthesia) or general anesthesia. To account for obstetric and nonobstetric covariates that may have influenced mode of anesthesia, multiple logistic regression analyses were performed using sequential sets of covariates.

Results—The study cohort comprised 50,974 women who underwent CD. Rates of general anesthesia among racial/ethnic groups were: 5.2% for Caucasians, 11.3% for African Americans, 5.8% for Hispanics and 6.6% for NHOs. After adjustment for obstetric and nonobstetric covariates, African Americans had the highest odds of receiving general anesthesia compared to Caucasians (adjusted odds ratio (aOR) = 1.7; 95% CI: 1.5 – 1.8; $P < 0.001$). The odds of receiving general anesthesia were also higher among Hispanics (aOR = 1.1; 95% CI: 1.0 – 1.3; $P = 0.02$) and NHOs (aOR = 1.2; 95% CI: 1.0 – 1.4; $P = 0.03$) compared to Caucasians, respectively. In our sensitivity analysis, we reconstructed the models after excluding women who underwent neuraxial anesthesia prior to general anesthesia. The adjusted odds of receiving general anesthesia were similar to those in the main analysis: African-Americans (aOR=1.7; 95% CI=1.5 – 1.9; $P < 0.001$; Hispanics (aOR=1.2; 95% CI=1.1 – 1.4; $P = 0.006$); and NHOs (aOR=1.2; 95% CI=1.0 – 1.5; $P = 0.05$).

Conclusion—Based on data from the Cesarean Registry, African-American women had the highest odds of undergoing general anesthesia for CD compared to Caucasian women. It is uncertain whether this disparity exists in current obstetric practice.

Introduction

Neuraxial anesthesia is the preferred anesthetic modality for cesarean delivery (CD).^{1–3} Widespread adoption of neuraxial anesthetic techniques into contemporary obstetric anesthetic practice has resulted in major improvements for maternal safety. Maternal mortality is lower among women who receive neuraxial anesthesia (3.8 deaths per million) compared to general anesthesia (6.5 deaths per million) in the United States.⁴ Furthermore, rates of anesthetic-related maternal morbidity have decreased as the rate of neuraxial anesthesia for CD has increased.^{5,6} Complications from general anesthesia, such as aspiration and airway management disasters, can be avoided by using a neuraxial technique.⁴ Other maternal-fetal benefits of neuraxial anesthesia include lower rates of surgical site infection and postpartum hemorrhage,^{7,8} superior quality post-CD analgesia,⁹ improved ambulation and an earlier return of bowel function.^{10,11} Neuraxial anesthesia is also associated with less neonatal morbidity and post-neonatal developmental delay compared with general anesthesia.^{12–16}

Despite this strong evidence in favor of neuraxial anesthesia, the whether mode of anesthesia (general vs. neuraxial) for CD differs according to race/ethnicity. In a previous study of deliveries occurring in New York State, the odds of general anesthesia were 1.5 fold higher for African-Americans compared to Caucasians,¹⁷ however risk estimates for women in other racial/ethnic groups were not described. With national rates of CD for African-Americans and Hispanic women currently at record highs (35.8% and 32.2% respectively),¹⁸ identifying and addressing anesthesia-related disparities may improve maternal outcomes and the overall quality of obstetric anesthesia care.

The primary aim of this secondary analysis of data from an observational study was to investigate whether racial/ethnic disparities exist for mode of anesthesia (general vs. neuraxial) among women undergoing CD, and to examine whether these associations are influenced by demographic and maternal factors, obstetric morbidities and indications for CD.

Methods

Our study received permission to waive consent from the Stanford University IRB as the Cesarean Registry contains de-identified data. The study cohort was identified using a dataset (the Cesarean Registry) sourced from a previous multicenter study by the National Institute of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network.¹⁹ Details of this study were previously reported.¹⁹ Between 1999 and 2000, data were collected in women who underwent delivery by primary CD, repeat CD or vaginal delivery after CD and who delivered infants 20 weeks' gestation or 500 g at 19 academic centers in the United States. For the final two years of the study (between 2001 and 2002), only women undergoing repeat CD or vaginal birth after CD who delivered infants 20 weeks' gestation or 500 g were enrolled. Data regarding patient and hospital were de-identified by the MFMU. All data, including data on patients' predominant race and ethnicity, were abstracted from medical records by trained research nurses and submitted to a biostatistical coordinating center. The center housed a centralized data management system and regular audits were performed of the entire database and specific subsets to assess data quality.

For our study, we identified women who had undergone CD, hence excluding successful vaginal births after CD. In the Cesarean Registry there were six classifications for the predominant patients' race/ethnicity: African-American ; Caucasian; Hispanic; Asian; Native American or Alaskan; and Unknown. The cohort comprised relatively limited numbers of Asians (n=884) and Native American or Alaskans (n=98). Within these groups, low numbers of Asians (n=46) and Native Americans or Alaskans (n=8) underwent general anesthesia. Due to concern about the adequacy of patient numbers in these subgroups for our primary and sensitivity analyses, we reclassified race/ethnicity categories into the following groups: African-American, Caucasian, Hispanic, and Non-Hispanic Others (hereafter referred to as Others). Based on previously published data²⁰ and our clinical experience, emergency CD is one of the most common reasons for considering general anesthesia. Using criteria for emergency CD from a prior publication using the Cesarean Registry data,²¹ we identified conditions that may warrant urgent or emergency CD (hereafter referred to as

emergency CD), which included: umbilical cord prolapse, non-reassuring fetal tracing, placental abruption, placenta previa with hemorrhage. For our primary outcome, we classified mode of anesthesia for CD into two types: neuraxial anesthesia and general anesthesia. Women who received spinal, epidural or spinal with epidural anesthesia were classified as receiving neuraxial anesthesia. For women who had codes for both neuraxial and general anesthesia, we classified women as receiving general anesthesia. Rates of general anesthesia and neuraxial anesthesia in our study cohort, calculated as percentages, were determined by race/ethnicity.

Statistical Analysis

The relationships between race/ethnicity and mode of anesthesia were investigated using univariate and multivariate analyses. Proportions were compared using the chi-square test. For the univariate and multivariate analyses, we performed logistic regression analyses to assess the associations between race/ethnicity with mode of anesthesia for CD. To assess the influence of other factors on the associations between race/ethnicity and mode anesthesia, we created a series of models by sequentially adding groups of predictors to each model. This approach has been previously used in other studies investigating race/ethnicity disparities in obstetric outcomes.^{22,23} Independent variables included in each model are described as follows: Model 1 = only race/ethnicity; Model 2 = covariates in Model 1 + maternal age, insurance class; Model 3 = covariates in Model 2 + chronic hypertension, gestational age at delivery, singleton/multiple pregnancy, number of prior cesarean deliveries, pregnancy-associated hypertensive disease, labor or attempted induction of labor; Model 4 = covariates in Model 3 + emergency indications for CD. With each series of covariates, we performed a likelihood ratio test to compare each “full” model with the model with fewer variables (“reduced model”) that immediately preceded it. We calculated the Akaike Information Criteria for each model which provides an indication of model goodness-of-fit. We tested for multicollinearity between independent variables by calculating the variance inflation factors. Collinearity was determined to be insignificant as variance inflation scores ranged from 1.03 to 1.85 with a mean variance inflation score=1.22. Model discrimination was determined by calculating the c-statistic for the final model for each logistic regression sequence.

In order to determine whether the point estimates were influenced by women who received neuraxial block prior to general anesthesia, we performed sensitivity analyses for the following cohorts: women who did not receive a neuraxial block prior to general anesthesia; women who underwent primary CD; women who underwent repeat CD; and women who underwent CD without prior labor or induction. We also performed additional sensitivity analyses to investigate potential interactions between race/ethnicity and maternal age, body mass index (BMI) and the presence/absence of an indication for emergency CD. We included the main effect and a cross-product term in the full model (Model 4) and compared nested models with and without each cross-product term using a likelihood ratio test. Data analyses were performed using STATA version 12 (Statacorp, College Station, TX).

Results

In the Cesarean Registry, 57,182 women underwent CD. We excluded 92 women who had missing anesthetic data and 6,116 women with missing data for at least one of the covariates. A flow diagram of patients included in the final cohort is presented in Figure 1. Our final study cohort comprised 50,974 women; 3,629 (7.1%) women underwent general anesthesia and 47,343 (92.9%) women underwent neuraxial anesthesia. The major indications for CD by racial/ethnic group are presented in the Appendix.

Within the final cohort, 21,113 (41.4%) were Caucasians, 14,338 (28.1%) were African-Americans, 12,990 (25.5%) were Hispanics and 2,533 (5%) were Others. The unadjusted rate of general anesthesia was highest for African-Americans (11.3%) compared to other ethnicities and races: Caucasians = 5.2%, Hispanics = 5.8%, and Others = 6.6%. Baseline and obstetric characteristics of the study cohort are presented in Table 1. We observed statistically significant differences in all demographic, obstetric and perioperative characteristics among racial and ethnic groups. Among the women who received general anesthesia, 1,187 women received a neuraxial block (epidural and/or spinal anesthesia) prior to general anesthesia and 2,442 women received no neuraxial block prior to general anesthesia.

Using Caucasians as the reference group, the unadjusted odds of general anesthesia was increased for African-Americans (odds ratio (OR) = 2.3), Hispanics (OR=1.1) and Others (OR=1.3) (Model 1; Table 2). With sequential addition of each series of covariates to each model, the odds for African-American race was moderately reduced (adjusted odds ratio (aOR) = 1.7 [Model 4]) after accounting for mediating factors, whereas, the odds were only marginally altered for Hispanics (aOR = 1.1 [Model 4]) and Others (aOR = 1.2 [Model 4]). For African-Americans, most of the decrease in the odds for general anesthesia occurred with adjustment of demographic factors [Model 2]. The likelihood ratio test and AIC improved with sequential addition of covariates to each model indicating improved goodness-of-fit. The c-statistic for the final model was 0.80, which suggests moderate model discrimination. We also compared the full model (Model 4) with models that included a cross-product term between race/ethnicity and maternal age, BMI, and emergency CD respectively. We found no evidence of a significant improvement in model fit by including a cross-product term between race/ethnicity*maternal age ($\chi^2 = 5.3$; $P=0.5$) or race/ethnicity*BMI ($\chi^2 = 7.6$; $P=0.8$) in the full models. In contrast, we did observe evidence of improved model fit after adding a cross-product term between race/ethnicity*emergency CD ($\chi^2 = 95.3$; $P<0.001$). We examined whether the racial disparity for mode of anesthesia persisted when the results were stratified by the presence or absence of an indication for emergency CD. Among women with an emergency indication, only African-Americans (aOR=1.5; 95% CI=1.3–1.7) and Hispanics (aOR=1.6; 95% CI=1.3–1.9) were at increased odds of receiving general anesthesia in the full model. For women without an emergency indication, only African-Americans (aOR=1.8; 95% CI=1.6–2.0) and Others (aOR=1.3; 95% CI=1.0–1.7) were at significantly increased odds of receiving general anesthesia.

In our sensitivity analysis, we reconstructed the models after excluding women who underwent neuraxial anesthesia prior to general anesthesia. The odds ratios calculated from

the logistic regression analyses are presented in Table 3. The point estimates for mode of anesthesia according to race/ethnicity were similar to those observed in our primary analysis. In the final model, all non-Caucasian ethnicities and races had significantly increased odds of receiving general anesthesia compared to Caucasians, with African-Americans having the highest adjusted odds of general anesthesia. For African-Americans, with sequential addition of each series of covariates, the odds of general anesthesia remained high (aOR = 2.2 [Model 1] to 1.7 [Model 4]). In contrast, the adjusted odds remained relatively unchanged for rHispanics and Others with addition of each series of covariates. The c-statistic from the final model in our sensitivity analysis was 0.84 which indicated good model discrimination.

We performed additional sensitivity analyses to separately examine the estimates in the following subpopulations: primary CD, repeat CD, and women who underwent CD without prior labor or induction. Among women who underwent primary CD, only African American (aOR = 1.6; 95% CI = 1.4–1.8) and Hispanic (aOR = 1.5; 95% CI = 1.3–1.7) women were at significantly increased odds of general anesthesia in the full model. Among women who underwent repeat CD, only African Americans (aOR = 1.8; 95% CI = 1.5–2.1) had significantly greater odds for general anesthesia in the full model. Among women who did not experience labor or induction of labor before CD, the association for general anesthesia was increased for African American women (aOR = 1.9; 95% CI = 1.6–2.2) and Others (aOR = 1.4; 95% CI = 1.1–1.9) in the full model.

Discussion

Using clinical data from over 50,000 women who delivered by CD at 19 obstetric centers in the United States, our results suggest that there were racial/ethnic disparities in the use of general vs. neuraxial anesthesia for women undergoing CD. After adjustment, African American women had a 1.7 fold increased odds of receiving general anesthesia compared to Caucasian women. Due to the inherent nature of our observational study design, the potential etiologies for this disparity are unclear. Furthermore, we analyzed data from a cohort undergoing CD between 1999 and 2002, therefore our findings may not be applicable in current obstetric anesthesia practice.

The findings of our main analysis and sensitivity analyses indicate that African-American women were at increased odds of receiving general anesthesia for CD compared to Caucasian women. Although demographic and obstetric factors mediated the likelihood of receiving general anesthesia, African-American women were at increased odds of receiving general anesthesia in all logistic models. In our sensitivity analyses, we investigated whether this disparity was present in specific cesarean subpopulations: primary CD, repeat CD or CD without prior labor or induction of labor, and in a population that excluded women who received neuraxial anesthesia before general anesthesia. Within each cesarean subpopulation, African-American women had increased odds of receiving general anesthesia compared to Caucasian women. In contrast, the odds of general anesthesia, although significant, were only modestly increased among Hispanics (aOR = 1.1) and Others (aOR=1.2) in our analyses. It is possible that the mediating effects of other unmeasured factors may have further attenuated the observed associations for Hispanics and

Others. Our findings are in keeping with those of Obst et al. who observed evidence of racial/ethnic disparities for mode of anesthesia using a database of deliveries in New York State in 1992.¹⁷ In their study, African-American women were more likely than Caucasian women to undergo general anesthesia for CD (aOR=1.53).¹⁷ However, the authors did not account for demographic and clinical factors in their analyses, and these findings predate our findings.

Our findings may have important public health and clinical relevance. Between 1998 and 2005, the rate of maternal mortality among African-Americans (37.5 per 100,000 live births) was approximately 4-fold higher compared to the rate among Caucasians (13.4 deaths per 100,000 live births).²⁴ African-American women have also been shown to be high risk for inpatient maternal mortality and events linked to perinatal morbidity, such as CD for fetal distress.^{25–27} Although the pregnancy-related mortality ratio from anesthesia complications has decreased from 4.3 per million live births between 1979–1981 to 1.0 per million live births between 2000–2002,⁴ anesthesia-related maternal death is more common among African-Americans (46.4%) compared to women from other ethnic and racial groups (Caucasians = 42.9%; Others = 10.7%).⁴ Future population-wide studies are needed to determine national rates of general anesthesia for CD and to investigate associations between general anesthesia for urgent or emergent CD and anesthesia-related maternal morbidity.

Due to our observational study design, we are only able to determine associations and not causality. Therefore, the underlying reasons why African-American women were at increased odds of general anesthesia are unclear and likely complex. In 2003, the Institute of Medicine published a detailed report examining racial and ethnic disparities in US healthcare.²⁸ In their report, healthcare disparities are described as ‘rooted in historic and contemporary inequities’ and include variations in healthcare financing and in the institutional and organizational characteristics of health-care systems; clinical interaction between care providers and patients; and influences of the attitudes, beliefs and perceptions of care providers and patients. Although we can only speculate about possible etiologic factors for the disparities in our study, possible patient-level and healthcare-related factors include cultural barriers between minority patients and their providers, mistrust, misunderstanding, limited interaction with healthcare systems, limited health literacy, and a lack of knowledge about healthcare services and anesthesia options related to labor and delivery.^{28–32} Limited data suggest that minority patients are more likely than Caucasian patients to refuse treatment, however studies reporting these differences are small and patient refusal is unlikely to fully explain all healthcare disparities.²⁸ Provider-level biases may also be important etiologic factors. Three suggested mechanisms may explain perceived provider discriminatory behavior: bias (or prejudice) against minorities; clinical uncertainty during patient-provider interactions; and provider beliefs or stereotypes about the behavior or health of patients belonging to minority groups.^{28,33} In the setting of CD, it is possible that medical decisions regarding mode of anesthesia may reflect subjective variability and physician preference. Furthermore, there is evidence that time pressure may increase the likelihood of applying stereotypes to decision making,³³ such as a situation in which mode of anesthesia is chosen for a patient requiring urgent CD.

Our study has a number of important limitations. We could not account for key hospital-level factors in our analyses because hospital identifiers were not included in the Cesarean Registry. Furthermore, we could not determine whether rates of general anesthesia varied within or between institutions in our analysis. Hypothetically, if complete data were available, a hierarchical model would be preferred for nested data structures,³⁴ specifically, patients being nested according to the anesthesia care provider, who is in turn nested by hospital, with the hospital nested by type or geographical location. Furthermore, due to the nonlinearity of logistic regression, odds ratios are highly sensitive to the statistical model that represents an independent variable and the logit function for an outcome of interest. This statistical issue has been highlighted previously in an *Anesthesia & Analgesia* statistical grand round by Dexter et al.³⁵ Although we lacked hospital-specific data on rates of anesthesia, the overall rate of general anesthesia in our cohort (7.9%) was within the range reported from other high-volume obstetric centers with >1,500 births per year in 2001 (3% for elective CD; 15% for emergency CD).³ Another limitation is the age of our dataset. As the data were collected between 1999 and 2002, we cannot state that our findings are applicable to current obstetric anesthesia practice. However, there is a surprising lack of population-wide data on rates of neuraxial and general anesthesia for CD, therefore it is uncertain if, and to what degree, rates of general and neuraxial anesthesia have changed since 2002.

Missing data were also a concern. Approximately 10% of our original study cohort was excluded from our analysis due to missing data. Despite our study cohort comprising >50,000 women, the exclusion of patients with missing data may have introduced bias. Within the study cohort, low numbers of Asians (n=8) and Native Americans or Alaskans (n=8) who underwent general anesthesia; therefore, risk estimates for these subgroups could not be computed. We collapsed women who were Asian, Native American or Alaskans, or other race into one group, therefore we appreciate that the heterogeneity of women within this group limits inference of the risk estimate for Others. The accuracy of race/ethnicity documentation in the medical records could not be determined. Underreporting and variability can occur in the documentation of race/ethnicity data in medical records, data registries and other administrative datasets.^{36,37} Therefore misclassification bias is a potential concern when these data sources are used for secondary analyses.

Unmeasured anesthetic factors may also have biased our risk estimates. Epidural “top-up” is recommended for women with pre-existing labor epidural analgesia for providing surgical anesthesia for intrapartum CD.³⁸ However, disparities in rates of labor epidural analgesia use³⁰ may have resulted in different rates of epidural top-up for CD among racial/ethnic groups. Unfortunately, we were unable to determine if epidural catheters were originally sited for labor analgesia or CD anesthesia. In addition, we were not able to deduce whether anesthetic-related complications, such as failed epidural top-up, failed spinal anesthesia or unanticipated perioperative breakthrough pain, were primary indications for general anesthesia. Despite these limitations, the risk estimates for general anesthesia among women who did not receive any neuraxial block prior to general anesthesia were similar to those observed in our primary analysis. These results suggest that the anesthesia-related complications did not influence the risk estimates across racial/ethnic groups. For women

classified as having an emergent CD, the clinical determinants that influence the degree of urgency could not be ascertained, especially for women with a non-reassuring fetal trace. In light of controversies related to interpretation of intrapartum fetal heart tracings,³⁹ we appreciate that a non-reassuring heart rate may cover a broad spectrum of fetal trace abnormalities. Nonetheless, in a prior examination of Cesarean Registry, the most common indication of emergency CD was a non-reassuring fetal trace, with 62% of women with a non-reassuring trace incurring a decision-to-delivery period of less than 30 minutes,²¹ implying a degree of urgency to deliver. In our study, African-Americans had the highest rates of non-reassuring fetal trace as the main indication for CD compared to other races/ethnicities. This is consistent with prior research suggesting that African-Americans are at higher odds of CD for a non-reassuring trace compared to Caucasians.²⁵ Further work is needed to determine whether these disparities are due to biological factors that may influence fetal tolerance of labor or whether provider biases may influence management of labor and interpretation of fetal traces and the subsequent decision to perform urgent operative delivery under general anesthesia.

Using clinical data from the MFMU Cesarean Registry, our findings suggest that racial/ethnic disparities may have existed for African American women regarding mode of anesthesia for CD at the turn of the millennium. Population-wide prospective studies are needed to validate these findings in current obstetric anesthesia practice, and to identify etiologic factors to explain why rates of general anesthesia may vary according to patients' race/ethnicity.

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Appendix A. Major Indications for Cesarean Delivery according to Race / Ethnicity

	Caucasian (n=21,113)	African-American (n=14,338)	Hispanic (n=12,990)	Others (n=2,533)
Cephalo-pelvic disproportion	1,344 (6.37%)	501 (3.49%)	422 (3.25%)	146 (5.76%)
Failure to progress	2,373 (11.24%)	2,389 (16.66%)	2,023 (15.57%)	385 (15.2%)
Cord Prolapse	154 (0.73%)	139 (0.97%)	69 (0.53%)	17 (0.67%)
Non-reassuring trace	2,153 (10.2%)	2,818 (19.65%)	1,088 (8.38%)	310 (12.24%)
Malpresentation – no prior ECV	2,546 (12.06%)	1,224 (8.54%)	993 (7.64%)	242 (9.55%)

	Caucasian (n=21,113)	African-American (n=14,338)	Hispanic (n=12,990)	Others (n=2,533)
Malpresentation – prior unsuccessful ECV	384 (1.82%)	127 (0.89%)	124 (0.95%)	32 (1.26%)
Multiple gestation	400 (1.89%)	132 (0.92%)	93 (0.72%)	35 (1.38%)
Suspected macrosomia	342 (1.62%)	184 (1.28%)	144 (1.11%)	43 (1.7%)
Placental abruption	244 (1.16%)	149 (1.04%)	54 (0.42%)	18 (0.71%)
Placenta previa with hemorrhage	158 (0.75%)	106 (0.74%)	64 (0.49%)	33 (1.3%)
Placenta previa without hemorrhage	153 (0.72%)	96 (0.67%)	57 (0.44%)	17 (0.67%)
Preeclampsia or hypertension	672 (3.18%)	512 (3.57%)	339 (2.61%)	83 (3.28%)
Prior myomectomy	95 (0.45%)	108 (0.75%)	36 (0.28%)	30 (1.18%)
Herpes	148 (0.7%)	183 (1.28%)	37 (0.28%)	11 (0.43%)
Prior classical, vertical, T-shape or J-shaped incision	288 (1.36%)	368 (2.57%)	175 (1.35%)	20 (0.79%)
Prior cesarean – unknown prior hysterotomy incision	59 (0.28%)	121 (0.84%)	1,277 (9.83%)	58 (2.29%)
Elective repeat	8,538 (40.44%)	4,447 (31.02%)	5,458 (42.02%)	929 (36.68%)
Other	515 (2.44%)	265 (1.85%)	118 (0.91%)	44 (1.74%)
Non-reassuring antepartum fetal testing	340 (1.61%)	219 (1.53%)	317 (2.44%)	44 (1.74%)
Failed induction	207 (0.98%)	250 (1.74%)	102 (0.79%)	36 (1.42%)

ECV = external cephalic version

Data presented as n (%)

Figure 1. Flow Diagram

The Cesarean Registry of the National Institute of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network comprises data collected between 1999 and 2002. Data were collected in women who underwent delivery by primary CD, repeat CD or vaginal delivery after CD and who delivered infants ≥ 20 weeks' gestation or ≥ 500 g at 19 academic centers in the United States from 1999–2000. For the final two years of the study (between 2001 and 2002), only women undergoing repeat CD or vaginal birth after CD who delivered infants ≥ 20 weeks' gestation or ≥ 500 g were enrolled.

Table 1

Maternal Demographic and Obstetric Characteristics

	Race / Ethnicity				P value
	Caucasian N=21,113	African-American N=14,338	Hispanic N=12,990	Other N=2,533	
Age (yr):					<0.001
<20	867 (4.1%)	2,021 (14.1%)	897 (6.9%)	85 (3.3%)	
20–34	15,212 (72.1%)	10,324 (72%)	10,380 (79.9%)	1,773 (70%)	
>34	5,034 (23.8%)	1,993 (13.9%)	1,713 (13.2%)	675 (26.7%)	
Insurance Class:					<0.001
Government-Assisted	4,301 (20.4%)	9,098 (63.5%)	7,228 (55.6%)	895 (35.3%)	
Private Insurance	16,103 (76.3%)	4,151 (28.9%)	1,311 (10.1%)	1,335 (52.7%)	
Self-Pay or Other	709 (3.3%)	1,089 (7.6%)	4,451 (34.3%)	303 (12%)	
BMI at delivery (kg/m ²)					<0.001
24.9	2,199 (10.4%)	1,124 (7.8%)	899 (6.9%)	304 (12%)	
25–29.9	6,882 (32.6%)	3,029 (21.1%)	3,881 (29.9%)	964 (38.1%)	
30–34.9	6,034 (28.6%)	3,822 (26.7%)	4,617 (35.5%)	715 (28.2%)	
35–39.9	3,282 (15.5%)	2,859 (19.9%)	2,288 (17.6%)	331 (13.1%)	
40	2,716 (12.9%)	3,504 (24.5%)	1,305 (10.1%)	219 (8.6%)	
Chronic Hypertension	547 (2.6%)	665 (4.6%)	146 (1.1%)	94 (3.7%)	<0.001
Gestational Age at delivery (weeks):					<0.001
<37	4,738 (22.4%)	3,140 (21.9%)	1,586 (12.2%)	466 (18.4%)	
37–41	15,279 (72.4%)	9,858 (68.8%)	10,037 (77.3%)	1,897 (74.9%)	
>41	1,096 (5.2%)	1,340 (9.3%)	1,367 (10.5%)	170 (6.7%)	
Type of pregnancy:					<0.001
Multiple Pregnancy	1,175 (5.6%)	614 (4.3%)	314 (2.4%)	93 (3.7%)	
Singleton Pregnancy	19,938 (94.4%)	13,724 (95.7%)	12,676 (97.6%)	2,440 (96.3%)	
Number of prior CD:					<0.001

	Race / Ethnicity				P value
	Caucasian N=21,113	African-American N=14,338	Hispanic N=12,990	Other N=2,533	
None	9,031 (42.8%)	6,576 (45.9%)	4,061 (31.3%)	1,082 (42.7%)	
1 prior CD	8,773 (41.5%)	5,385 (37.5%)	6,018 (46.3%)	1,069 (42.2%)	
2 or more prior CD	3,309 (15.7%)	2,377 (16.6%)	2,911 (22.4%)	382 (15.1%)	
Pregnancy associated hypertension:					<0.001
None	18,565 (87.9%)	12,078 (84.3%)	11,539 (88.8%)	2,245 (88.6%)	
Gestational hypertension	788 (3.7%)	496 (3.5%)	372 (2.9%)	83 (3.3%)	
Preeclampsia	1,519 (7.2%)	1,637 (11.4%)	1,027 (7.9%)	187 (7.4%)	
Eclampsia or HELLP syndrome	241 (1.1%)	127 (0.9%)	52 (0.4%)	18 (0.7%)	
Labor or attempted induction	8,863 (42%)	8,107 (56.5%)	5,603 (43.1%)	1,251 (49.4%)	<0.001
Emergency CD *	2,709 (12.8%)	3,212 (22.4%)	1,275 (9.8%)	378 (14.9%)	<0.001

Data presented as n (%).

BMI, body mass index; CD, cesarean delivery; HELLP, hemolysis, elevated liver enzymes, low platelet count

* Emergency Cesarean delivery is defined by at least one of the following conditions or events: placental abruption, cord prolapse, placenta previa with antenatal bleeding, or a non-reassuring fetal tracing.

Table 2
Associations between Race/Ethnicity and Mode of Anesthesia (General Compared to Neuraxial) for Cesarean Delivery

	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Caucasian	Reference		Reference		Reference		Reference	
African-American	2.3 (2.2–2.5)	<0.001	1.7 (1.6–1.9)	<0.001	1.9 (1.7–2.1)	<0.001	1.7 (1.5–1.8)	<0.001
Hispanic	1.1 (1.0–1.2)	0.01	0.8 (0.7–0.9)	<0.001	1.1 (1.0–1.2)	0.14	1.1 (1.0–1.3)	0.02
Other	1.3 (1.1–1.5)	0.003	1.1 (0.9–1.3)	0.2	1.2 (1.0–1.4)	0.03	1.2 (1.0–1.4)	0.03
Log likelihood	–12.837		–12.714		–11.731		–10.925.3	
LRT			246.3	<0.001	1965.2	<0.001	1,613.4	<0.001
AIC	25,683.5		25,445.1		23,507.9		21,896.6	

AIC = Akaike Information Criteria; CI = Confidence Intervals; LRT = Likelihood Ratio Test; OR = Odds Ratio

^aModel 1: only race/ethnicity.

^bModel 2: adjusted for maternal age and insurance class.

^cModel 3: adjusted for maternal age, insurance class, body mass index at time of delivery, chronic hypertension, gestational age at delivery, singleton/multiple pregnancy, number of prior cesarean deliveries, pregnancy-associated hypertensive disease, labor or attempted induction.

^dModel 4: adjusted for maternal age, insurance class, body mass index at time of delivery, chronic hypertension, gestational age at delivery, singleton/multiple pregnancy, number of prior cesarean deliveries, pregnancy-associated hypertensive disease, labor or attempted induction, and emergency indication for cesarean delivery.

Associations between Race/Ethnicity and Mode of Anesthesia in Women with no Prior Neuraxial Block who Received General Anesthesia Compared to Neuraxial Anesthesia

Table 3

	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Caucasian	Reference		Reference		Reference		Reference	
African-American	2.2 (2.0–2.4)	<0.001	1.6 (1.4–1.8)	<0.001	1.9 (1.7–2.2)	<0.001	1.7 (1.5–1.9)	<0.001
Hispanic	1.1 (1.0–1.2)	0.06	0.7 (0.6–0.8)	<0.001	1.1 (1.0–1.3)	0.05	1.2 (1.1–1.4)	0.006
Other	1.3 (1.0–1.6)	0.01	1.1 (0.9–1.3)	0.6	1.2 (1.0–1.5)	0.04	1.2 (1.0–1.5)	0.05
Log likelihood	–9,595		–9,743		–8,418.4		–7,606.1	
LRT			189	<0.001	2,164.5	<0.001	1,624.6	<0.001
AIC	19,198.4		19,017.4		16,880.9		15,258.3	

AIC = Akaike Information Criteria; CI = Confidence Interval; LRT = Likelihood Ratio Test; OR = Odds Ratio

^aModel 1: only race and ethnicity.

^bModel 2: adjusted for maternal age and insurance class

^cModel 3: adjusted for maternal age, insurance class, body mass index at time of delivery, chronic hypertension, gestational age at delivery, singleton/multiple pregnancy, number of prior cesarean deliveries, pregnancy-associated hypertensive disease, labor or attempted induction.

^dModel 4: adjusted for maternal age, insurance class, body mass index at time of delivery, chronic hypertension, gestational age at delivery, singleton/multiple pregnancy, number of prior cesarean deliveries, pregnancy-associated hypertensive disease, labor or attempted induction, and emergency indication for cesarean delivery.