

## Maternal Morbidity for Vaginal and Cesarean Deliveries, According to Previous Cesarean History: New Data From the Birth Certificate, 2013

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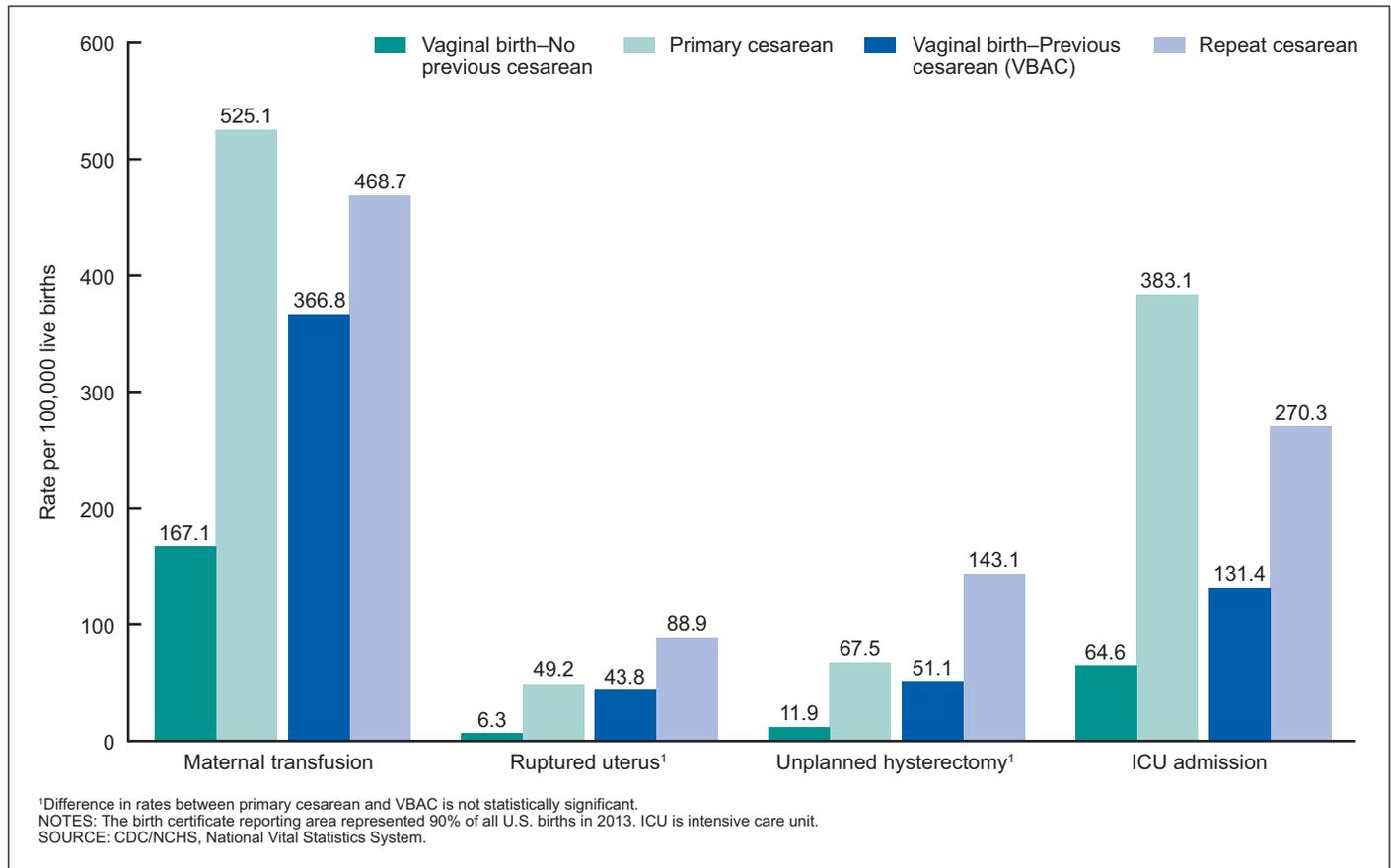


Figure 1. Maternal morbidity, by method of delivery and previous cesarean history: 41-state and District of Columbia reporting area, 2013

## Abstract

**Objectives**—This report presents recent findings for 2013 on four maternal morbidities associated with labor and delivery—maternal transfusion, ruptured uterus, unplanned hysterectomy, and intensive care unit (ICU) admission—that are collected on birth certificates for a 41-state and District of Columbia reporting area, which represents 90% of all births in the United States.

**Methods**—Rates of maternal morbidity (per 100,000 live births) by maternal age and race and ethnicity are presented by current method of delivery (vaginal or cesarean) and previous cesarean history. Total rates are also presented by current method of delivery, previous cesarean history, and whether a trial of labor was attempted.

**Results**—Rates of maternal morbidity were higher for cesarean than vaginal deliveries—rates of transfusion (525.1 per 100,000) and ICU admission (383.1) were highest for primary cesarean deliveries, while rates of ruptured uterus (88.9) and unplanned hysterectomy (143.1) were highest for repeat cesarean deliveries. Higher rates of maternal morbidity for cesarean compared with vaginal deliveries were found for nearly all maternal age groups and for women of all races and ethnicities. Women with no previous cesarean delivery who had vaginal deliveries had lower rates for all maternal morbidities compared with those who had cesarean deliveries. Women with a previous cesarean delivery who labored and had vaginal birth generally had lower rates for most of the morbidities, but failed trials of labor were generally associated with higher morbidity than scheduled repeat cesarean deliveries, especially for ruptured uterus, which was seven times higher (495.4 per 100,000 compared with 65.6).

**Keywords:** transfusion • ruptured uterus • ICU admission • trial of labor

## Introduction

Maternal morbidity was defined recently by the World Health Organization as “any health condition attributed to and/or aggravated by pregnancy and childbirth that has a negative impact on the woman’s wellbeing” (1). These morbidities can have short- and long-term health implications for the mother and the newborn and can lengthen hospital stays and increase health care costs (2). Recent research has shown that severe maternal morbidity is increasing in California, partly due to worsening trends in underlying maternal health—increased obesity, diabetes, and hypertension, both before and during pregnancy (3). Other clinical factors that have been associated with the rise in maternal morbidity are the increased use of cesarean delivery and induction and augmentation of labor (4,5). A demographic contributor to rising maternal morbidity has been the increasing proportion of births to older women, who tend to have more health issues and more labor interventions than younger women (6,7). Racial and ethnic disparities persist in maternal morbidity, with non-Hispanic black women in particular having higher rates, even after other factors are taken into account (8).

Another predictor of maternal morbidity is previous cesarean history—research has generally shown that for women with a previous birth, those with a history of previous cesarean delivery are at an increased risk of maternal morbidity (9–11). This increased morbidity persisted even when other relevant demographic and health risk factors were taken into account (9). In particular, issues involving the placenta

(placenta previa and accreta, and placental abruption) are more common in women with previous cesarean deliveries (10). Additionally, the risk of many serious maternal morbidities has been shown to increase progressively as the number of previous cesarean deliveries increased (12).

Given the lower morbidity for vaginal compared with cesarean deliveries, attempting a trial of labor is recommended for most women with no previous cesarean as well as for low-risk women with a previous cesarean delivery (13). However, although successful attempts at a trial of labor after cesarean (i.e., leading to a vaginal birth after cesarean [VBAC]) result in lower morbidity than planned repeat procedures, failed trials of labor result in increased morbidity (14). For example, although rare, rates of ruptured uterus are higher among women attempting a trial of labor after a previous cesarean than among women with elective repeat procedures (15). The attempt to avoid such morbidities may have contributed to the declining percentage of women with previous cesarean deliveries attempting a trial of labor over the last 2 decades (16).

Data on maternal morbidity are available for the first time for births registered using the 2003 revision of the U.S. Standard Certificate of Live Birth. Items capturing maternal morbidity were added to the birth certificate to establish a national surveillance system to monitor these morbidities. Maternal morbidity data are available for 41 states that adopted the 2003 revised birth certificates as of January 1, 2013, representing 90% of all births in the United States in 2013; complete national data from all of the states are expected to be available for data year 2015.

This report focuses on the incidence of four maternal morbidities reported on the birth certificate: maternal transfusion, ruptured uterus, unplanned hysterectomy, and ICU admission, all of which are usually associated with severe complications of labor or delivery. The rates are compared between vaginal and cesarean deliveries by whether the mother had a previous cesarean delivery and by whether a trial of labor was attempted. This stratified analysis is possible with birth certificate data because they are based on large and almost complete counts of birth records.

## Methods

Data used in this analysis are from the birth certificate and based on 100% of births registered in the 41 states and the District of Columbia (D.C.) that had implemented the 2003 revision of the birth certificate as of January 1, 2013. The 41 states are: Alaska, California, Colorado, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York (including New York City), North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

The births in the 41-state and D.C. reporting area represent 90% of all births in the United States in 2013 but are not generalizable to the entire United States in 2013. Some differences between the reporting area and the United States are notable, particularly in the race and Hispanic origin distributions. Births to Hispanic women and non-Hispanic black women are slightly overrepresented (23.2% in the reporting area compared with 23.1% in the nation for Hispanic women;

15.1% compared with 15.0% for non-Hispanic black women), while births to American Indian or Alaska Native women (AIAN) and Asian or Pacific Islander (API) women are slightly underrepresented (0.9% compared with 1.0% for AIAN women; 6.3% compared with 6.5% for API women); see Table D of the “User Guide to the 2013 Natality Public Use File” (17). While these differences are small, they are statistically significant. By comparison, almost no statistically significant differences were observed between the reporting area and the United States in maternal age, marital status, and infant characteristics. Although not based on births from all 50 states, these birth certificate data provide a large number of births to examine rare events such as maternal morbidity by method of delivery and history of cesarean delivery.

The 2003 revision of the U.S. Standard Certificate of Live Birth added the item of maternal morbidity. The instructions for this item are to check all that apply of the following morbidities: maternal transfusion, third- or fourth-degree perineal laceration, ruptured uterus, unplanned hysterectomy, admission to intensive care unit (ICU), unplanned operating room procedure following delivery, or none of the above. The source of this information is recommended to be in the medical record (18).

Two of the six listed morbidities were not included in this report. Third- or fourth-degree perineal lacerations was not included because this condition almost always occurs in vaginal births (99%), and an analysis by method of delivery is not appropriate. Unplanned operating room procedure was not included because the definition is considered ambiguous. The four morbidities in this report are usually associated with severe maternal morbidity—its causes (i.e., ruptured uterus) as well as its treatments (maternal transfusion, unplanned hysterectomy, and ICU admission). Transfusions are most often administered to treat severe anemia and hemorrhaging (19). Unplanned hysterectomies are most often performed to treat hemorrhaging (4). Some of the most common reasons for ICU admission are pregnancy-related hypertensive disease, hemorrhaging, cardiac disease, and infections (20). Records for states in the reporting area with missing information on maternal morbidity numbered 22,064 (of 3,548,525 births), or 0.6%.

Information on whether a woman had a previous cesarean and the number of previous cesareans was obtained from the “Risk factors in this pregnancy” item on the birth certificate. Missing records for this item numbered 18,956 (of 3,548,525 births), or 0.5%. Information on method of delivery was obtained from the “Method of delivery” item on the birth certificate. The three categories of vaginal births—vaginal/spontaneous, vaginal/forceps, and vaginal/vacuum—were combined for a total vaginal births category. While not explicitly recorded on the birth certificate, by their very nature, all vaginal births are assumed to have had a successful trial of labor. If a cesarean birth was indicated, then the question, “If cesarean, was a trial of labor attempted,” was used to obtain information on trial of labor for these births. Records with missing information for trial of labor numbered 34,094 (of 1,165,708 births in cesarean deliveries), or 2.9% of cesarean deliveries.

The terms “trial of labor” and “labor” are used interchangeably in this report. In addition, the terms “cesarean deliveries without a trial of labor” and “scheduled cesarean deliveries” are used interchangeably.

Race and Hispanic origin are reported independently on the birth certificate. This report includes data for “single-race, non-Hispanic white,” “single-race, non-Hispanic black,” “single-race, non-Hispanic Asian,” and Hispanic births. Detailed information on Native Hawaiian

or Other Pacific Islander, AIAN, and multiple-race births is not shown because of the small numbers of births for these groups in this reporting area. Detailed results for Hispanic subgroups are also not shown.

Rates and percentages in this report are computed by subtracting the “not stated” values from the total live births to obtain the denominators. All maternal morbidity rates in this report are per 100,000 live births. Rates in this report are computed only when the number of cases of a specified morbidity (the numerator) is greater than or equal to 20, but some of the rates in this report are based on cases numbering between 20 and 99. The random variability of these small numbers is usually greater in terms of percentage than for larger numbers of events. All differences between groups discussed in this report were tested for statistical significance, but caution should be used when evaluating rates based on fewer than 100 events. The statistical tests used are based on the Poisson distribution when the number of events is fewer than 100, and the normal distribution when the number of events is 100 or greater. See “User Guide to the 2010 Natality Public Use File” (21) for more detail on the significance testing and examples of computations.

## Results

### Overall findings

- Maternal transfusion was the most common of the four morbidities (280.4 per 100,000), followed by ICU admission (154.8), unplanned hysterectomy (40.7), and ruptured uterus (26.1) (Table 1).
- Women having vaginal deliveries with no previous cesarean delivery had the lowest rates for all four morbidities (Figure 1).
- Women with primary cesarean deliveries had the highest rates of transfusion (525.1) and ICU admission (383.1), while mothers with repeat cesarean deliveries had the highest rates of ruptured uterus (88.9) and unplanned hysterectomy (143.1).
- Women with VBAC deliveries had lower rates of all four maternal morbidities compared with women with repeat cesarean deliveries, and lower rates of transfusion and ICU admissions compared with primary cesarean deliveries.

### Maternal age

Variation in maternal morbidity by maternal age is partly associated with differences by age in rates of cesarean delivery and previous cesarean history (Table A.) For example, the total cesarean rate for women aged 35–54 (43.0 per 100 births) is nearly twice that of women under age 20 (21.8), while the primary cesarean rate is about 50% higher (29.4 compared with 19.9). About 9 of 10 women with a previous cesarean have repeat procedures for all age groups, but the percentage is slightly higher for women aged 35–54 than for younger women. A larger proportion of older mothers have also had a previous cesarean. Table 1 contains rates of maternal morbidity by maternal age for all births, as well as rates by method of delivery and previous cesarean history.

- Total rates of transfusion (316.3) and ICU admission (156.4) by maternal age were higher for teenaged mothers than for mothers

**Table A. Total, primary, and repeat cesarean rates and previous cesarean history, by maternal age and race and ethnicity: 41-state and District of Columbia reporting area, 2013**

Maternal age and race and ethnicity	Number	Total cesarean rate <sup>1</sup>	Primary cesarean rate <sup>2</sup>	Repeat cesarean rate <sup>3</sup>	Previous cesarean history			
					Total	None	One	Two or more
Per 100 births								
All births <sup>4</sup>	3,548,525	32.6	22.8	89.4	100.0	85.4	10.3	4.4
Maternal age (years):								
Under 20	248,842	21.8	19.9	89.5	100.0	97.3	2.5	0.2
20–34	2,758,010	31.5	21.9	89.3	100.0	85.8	10.1	4.2
35–54	541,673	43.0	29.4	89.9	100.0	77.7	14.9	7.4
Maternal race and ethnicity:								
Non-Hispanic white	1,880,350	31.8	22.6	89.1	100.0	86.3	10.0	3.7
Non-Hispanic black	511,132	35.9	25.7	89.0	100.0	84.0	10.7	5.3
Non-Hispanic Asian	206,651	33.9	24.6	89.4	100.0	85.6	12.0	2.4
Hispanic	818,006	32.3	21.1	90.4	100.0	83.9	10.4	5.7

<sup>1</sup>Number of births by cesarean delivery per 100 total births.

<sup>2</sup>Number of births by cesarean delivery per 100 births to women with no previous cesarean delivery.

<sup>3</sup>Number of births by cesarean delivery per 100 births to women with a previous cesarean delivery.

<sup>4</sup>Includes births with race and ethnicity not stated.

NOTES: Race and Hispanic origin are reported separately on the birth certificate. Race categories are consistent with 1997 Office of Management and Budget standards; see Methods. Data by race are non-Hispanic and exclude mothers reporting multiple races. Reporting area includes Alaska, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

aged 20–34 (262.4 and 135.5, respectively), and highest for mothers aged 35–54 (355.5 and 252.8, respectively) (Table 1).

- Total rates of ruptured uterus and unplanned hysterectomy generally increased with maternal age, with a greater increase for unplanned hysterectomy—the rate for women aged 35–54 (103.8) was more than 10 times the rate for women under age 20 (10.1).

### Women under age 20

- The rate of transfusion was almost three times higher for births in primary cesarean deliveries (645.4 per 100,000) than for vaginal births with no previous cesarean (226.9).
- The rate of ICU admission was seven times higher for women having primary cesarean deliveries (496.6) than for women having vaginal births with no previous cesarean (68.5).
- Cases of ruptured uterus and unplanned hysterectomy for women under age 20 were too few in number to examine differences by method of delivery and previous cesarean history.

### Women aged 20–34 and 35–54

- Maternal transfusions were more common for mothers with primary and repeat cesarean deliveries and VBAC deliveries than for mothers with vaginal births with no previous cesarean.
- Among the method-of-delivery groups for which data were available, rates of ruptured uterus were highest for repeat cesareans (90.6 for women aged 20–34 and 83.1 for women aged 35–54), and lowest for vaginal births with no previous cesarean (5.7 for women aged 20–34 and 11.2 for women aged 35–54).
- Women with vaginal births with no previous cesarean had lower rates of unplanned hysterectomy than women who had primary or repeat cesarean births. Rates of unplanned hysterectomy were higher for repeat cesarean deliveries than for primary cesarean deliveries.

- Women with vaginal deliveries with no previous cesarean had the lowest ICU admission rates (58.9 for women aged 20–34 and 97.3 for women aged 35–54). Women with primary cesarean deliveries had higher rates of ICU admission than women with repeat cesarean deliveries (344.3 compared with 231.3, respectively, for women aged 20–34; 502.2 compared with 397.1 for women aged 35–54).

### Race and ethnicity

Variation in maternal morbidity by maternal race and ethnicity is partly associated with differences by race and ethnicity in rates of cesarean delivery and previous cesarean history (Table A). For example, non-Hispanic white women had the lowest total cesarean rate (31.8 per 100 births) and the highest percentage of women with no previous cesarean (86.3). Hispanic women had the lowest primary cesarean rate (21.1), but the highest proportion of women with two or more previous cesarean deliveries (5.7%). Table 2 contains rates of maternal morbidity by maternal race and ethnicity for all births as well as rates by method of delivery and previous cesarean history. Due to insufficient cases in some instances for births in VBAC deliveries and to non-Hispanic Asian women, rates were not computed for some of the morbidities by race and ethnicity.

- Non-Hispanic black women had the highest rates of transfusion (332.3) and ICU admission (239.5) among all racial and ethnic groups.
- Non-Hispanic black (39.2) and non-Hispanic Asian (32.1) women had the highest rates of ruptured uterus.
- For categories with sufficient cases to compute rates, maternal morbidity was higher for women who had cesarean deliveries than their counterparts who had vaginal deliveries with no previous cesarean for all of the racial and ethnic groups.
- In most instances, rates of ruptured uterus and unplanned hysterectomy were higher for repeat cesarean deliveries than for

primary cesarean deliveries for the racial and ethnic groups. The exceptions were ruptured uterus for Hispanic women (44.4 for primary compared with 51.2 for repeat cesarean, not significantly different) and unplanned hysterectomy for non-Hispanic Asian women (110.9 for primary compared with 124.5 for repeat cesarean, not significantly different).

- Rates of ICU admission were higher for primary cesarean deliveries than for repeat cesarean deliveries for all racial and ethnic groups.

## Trial of labor and method of delivery

Another important consideration in examining rates of maternal morbidity by previous cesarean history is whether a woman attempted a trial of labor with her current delivery. Rates of trial of labor and trial-of-labor success rates differ markedly by previous cesarean history (Table B and Figure 2). Almost 9 of 10 women with no history of a previous cesarean attempt a trial of labor (87%), and the vast majority are successful (89%). In contrast, only 1 in 5 women who had one previous cesarean attempt a trial of labor after cesarean (20%), although 70% of these are successful. Less than 1 in 10 women with a history of two or more previous cesarean deliveries attempted a trial of labor (7%), with about one-half of these resulting in successful vaginal deliveries (51%).

## Women with no previous cesarean delivery

Table 3 and Figure 3 present maternal morbidity rates for women with no previous cesarean delivery by whether a trial of labor was attempted and whether the labor resulted in a vaginal delivery.

- Women who attempted a trial of labor and had a successful vaginal delivery had lower rates for all of the morbidities compared with women who had cesarean deliveries, either with or without labor.
- Women with cesarean deliveries who did not labor had higher rates of ICU admission (420.6 per 100,000) than women who had

failed trials of labor (318.4), but lower rates of maternal transfusion (486.9 compared with 600.9, respectively).

- The rates of ruptured uterus and unplanned hysterectomy were not statistically different by whether a trial of labor was attempted for women who had cesarean deliveries with no history of a previous cesarean.

## Women with a previous cesarean

Table 4 and Figure 4 present maternal morbidity rates for women with a previous cesarean delivery by whether they attempted a trial of labor and whether this labor ultimately resulted in a VBAC delivery.

- Women who attempted a trial of labor after cesarean and had a successful VBAC delivery had lower rates of transfusion, unplanned hysterectomy, and ICU admission than did women with cesarean deliveries without labor. Rates of ruptured uterus were not significantly different between successful VBAC births (43.8 per 100,000) and cesarean births (65.6) without a trial of labor.
- Women with successful trials of labor resulting in VBAC deliveries had lower rates for all of the morbidities compared with women who had failed trials of labor resulting in repeat cesarean deliveries.
- Women who had failed trials of labor resulting in repeat cesarean deliveries had higher rates for three of the morbidities compared with women with repeat cesareans without labor (transfusion, ruptured uterus, and ICU admission). The greatest difference in rates was for ruptured uterus—the rate for women with failed trials of labor (495.4 per 100,000) was more than seven times higher than for women with repeat cesarean deliveries who did not labor (65.6).

## Discussion

This report presents recent data from the birth certificate on maternal morbidity associated with labor and delivery. The data used in this analysis from the 41-state and D.C. reporting area in 2013 represent 90% of all U.S. births, and complete national data on maternal morbidity are expected with the 2015 data year. The estimates of maternal morbidity from this study may not be nationally representative, because births to Hispanic and non-Hispanic black women are slightly overrepresented. Findings from the birth certificate data are generally consistent with previous research, although some new findings for which previous research is not available are also presented.

## Findings from the birth certificate compared with other studies

The findings in this study that women with cesarean deliveries have more morbidity than women with vaginal deliveries is consistent with many other studies (2–5,9,12). History of a previous cesarean has been generally associated with increased morbidity (9–11) and was found in this study for ruptured uterus and unplanned hysterectomy, which had higher rates for repeat compared with primary cesarean deliveries. Given this pattern, the higher rates of transfusion and ICU admission for primary cesareans compared with repeat cesareans was somewhat unexpected. However, a multicenter U.S.

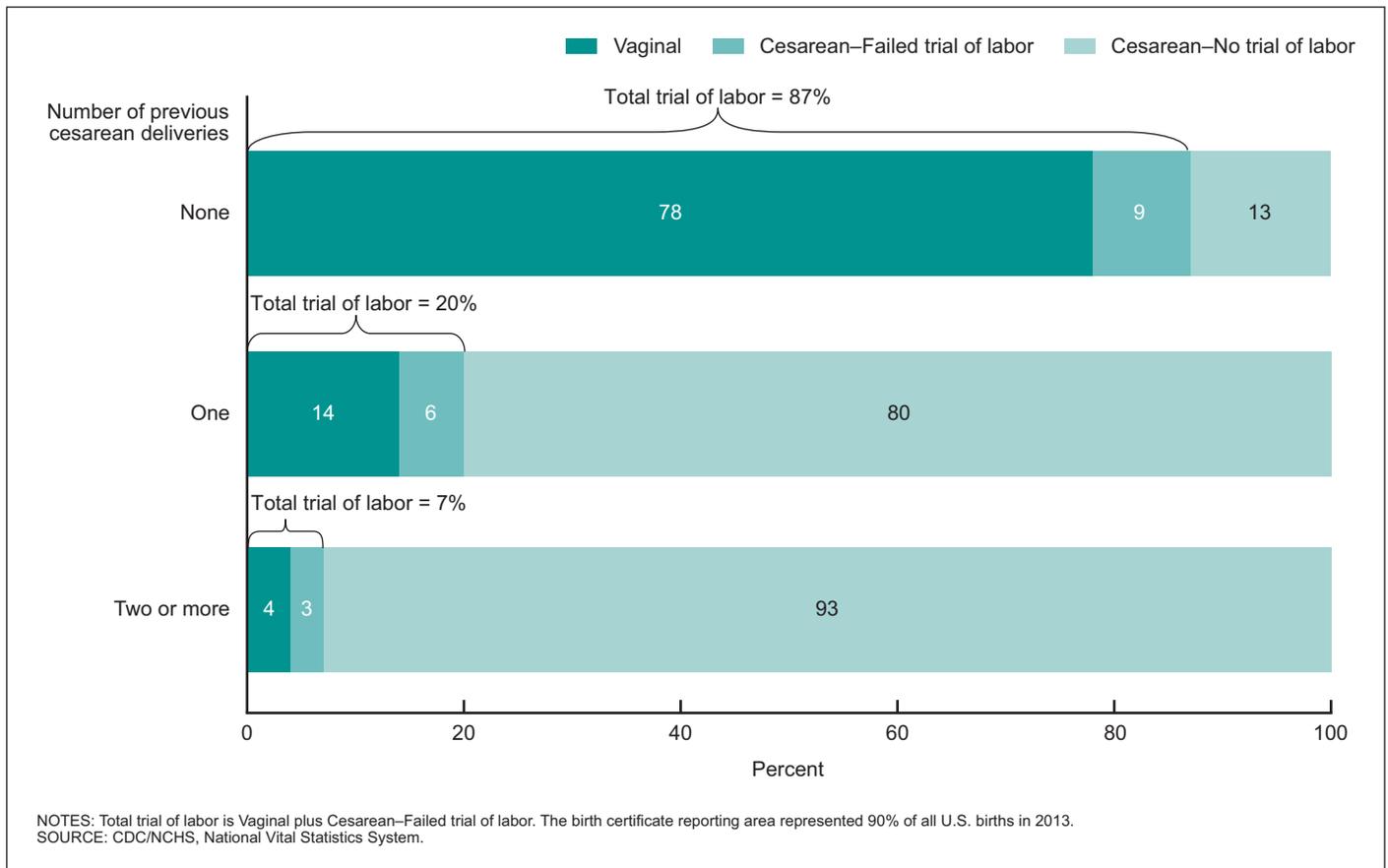
**Table B. Method of delivery and trial of labor, by previous cesarean history: 41-state and District of Columbia reporting area, 2013**

Trial of labor and method of delivery	Total	Previous cesarean history		
		None	One	Two or more
All births . . . . .	100.0	100.0	100.0	100.0
Successful trial of labor—vaginal deliveries (includes VBAC <sup>1</sup> ) . . . . .	67.8	77.6	13.8	3.5
Failed trial of labor—cesarean delivery . . . . .	8.5	9.1	5.8	3.3
No trial of labor—cesarean delivery . . . . .	23.7	13.3	80.4	93.2
Success rate when trial of labor is attempted <sup>2</sup> . . . . .	88.8	89.5	70.4	51.4

<sup>1</sup>Vaginal birth after cesarean.

<sup>2</sup>Percentage of vaginal births when a trial of labor is attempted.

NOTE: Reporting area includes Alaska, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.



**Figure 2. Trial of labor and method of delivery, by number of previous cesarean deliveries: 41-state and District of Columbia reporting area, 2013**

study that focused specifically on transfusions for women undergoing cesarean delivery also found an increased incidence in primary compared with repeat cesarean deliveries (19). The findings for ICU admission are new, with no other large U.S. studies available that examine this specifically by method of delivery and previous cesarean history.

Older mothers and non-Hispanic black mothers have higher rates of maternal morbidity, but this reflects, to some extent, their higher cesarean rates. However, these groups generally have higher morbidity, even when other relevant factors are considered (9). Although rates could not be computed for some groups due to insufficient cases, the elevated morbidity for cesarean compared with vaginal deliveries was generally found in all age groups and for all racial and ethnic groups.

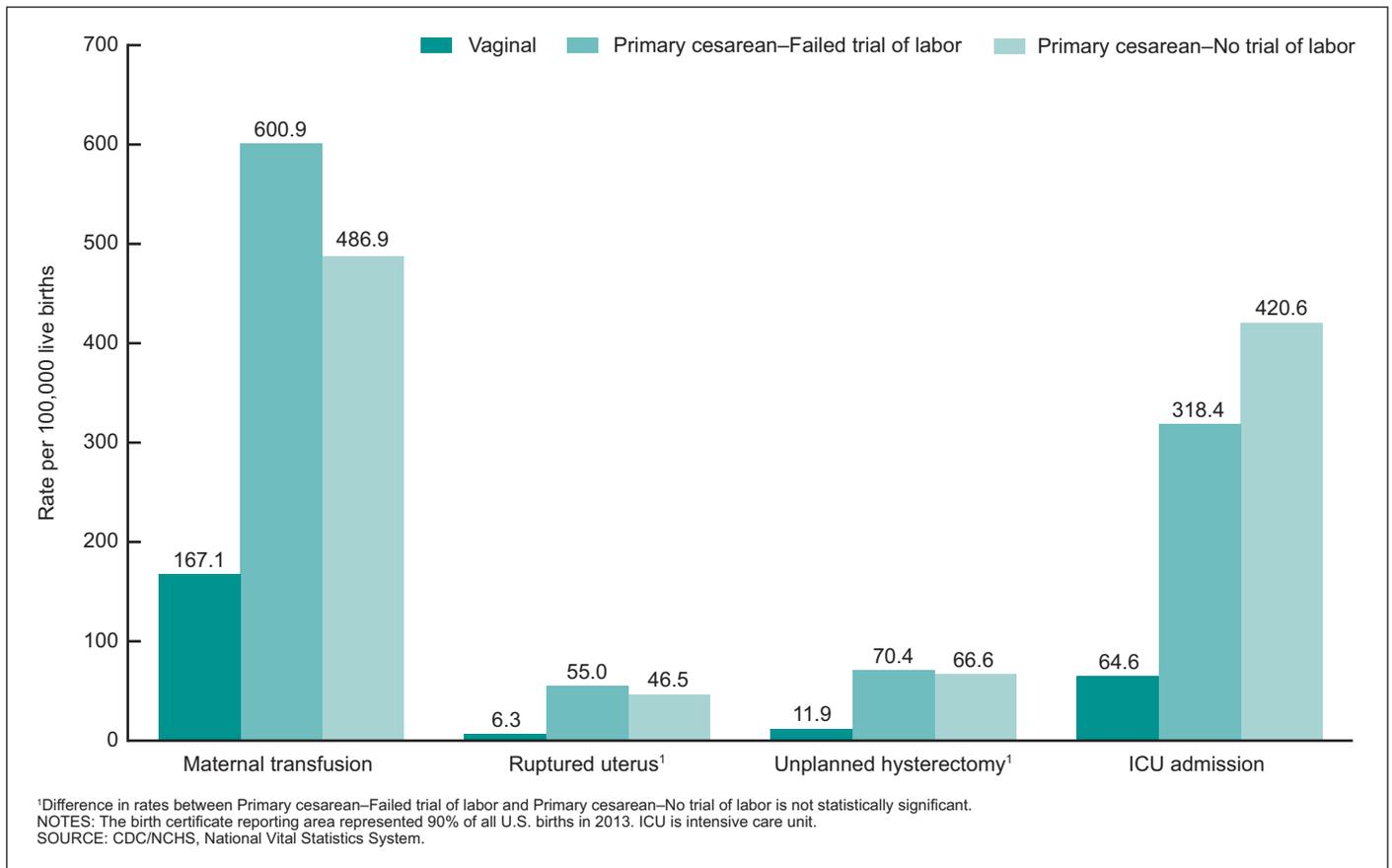
For women with no history of previous cesarean, morbidity was always lower for vaginal births compared with women with births by cesarean deliveries, either with or without labor. Results were mixed for primary cesarean deliveries by whether a trial of labor was attempted—failed trials of labor were associated with elevated morbidity for transfusions relative to cesarean deliveries without labor, but associated with lower rates of ICU admission. Because most women with no previous cesarean attempt labor (almost 9 of 10), those with scheduled cesarean deliveries are more likely to have underlying health conditions or problematic pregnancies—more preeclampsia, plural gestations, malpresentations, and suspected macrosomic fetuses (weighing more than 4,000 grams)—while a very small percentage

have elective procedures (22,23). Admission to the ICU has been shown to be associated with both underlying maternal health (chiefly hypertensive and cardiac issues) as well as issues associated with labor and delivery (hemorrhaging and infection) (20).

For women with a previous cesarean delivery, successful VBAC deliveries were generally associated with lower morbidity than scheduled repeat procedures (with the exception of ruptured uterus, which was not significantly different). However, failed trials of labor were associated with increased rates for three of the morbidities compared with scheduled repeat procedures, which is consistent with many other studies (24–27) and especially true for ruptured uterus. Attempting a trial of labor with the current delivery after a previous cesarean delivery is a consistent predictor of ruptured uterus (15,27,28), although this morbidity is still very rare.

### Data quality of health information from birth certificates

Medical and health information have been traditionally underreported on the birth certificate (29,30). The National Center for Health Statistics (NCHS) fielded a recent validity study based on data from the 2003 revision that did not include maternal morbidity due to the rarity of some of the items (31). Other relevant medical items (method of delivery, number of previous cesarean deliveries, and trial of labor) were included in the NCHS validity study conducted in two states. The primary measurement of data quality for checkbox items in the



**Figure 3. Maternal morbidity for women with no previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013**

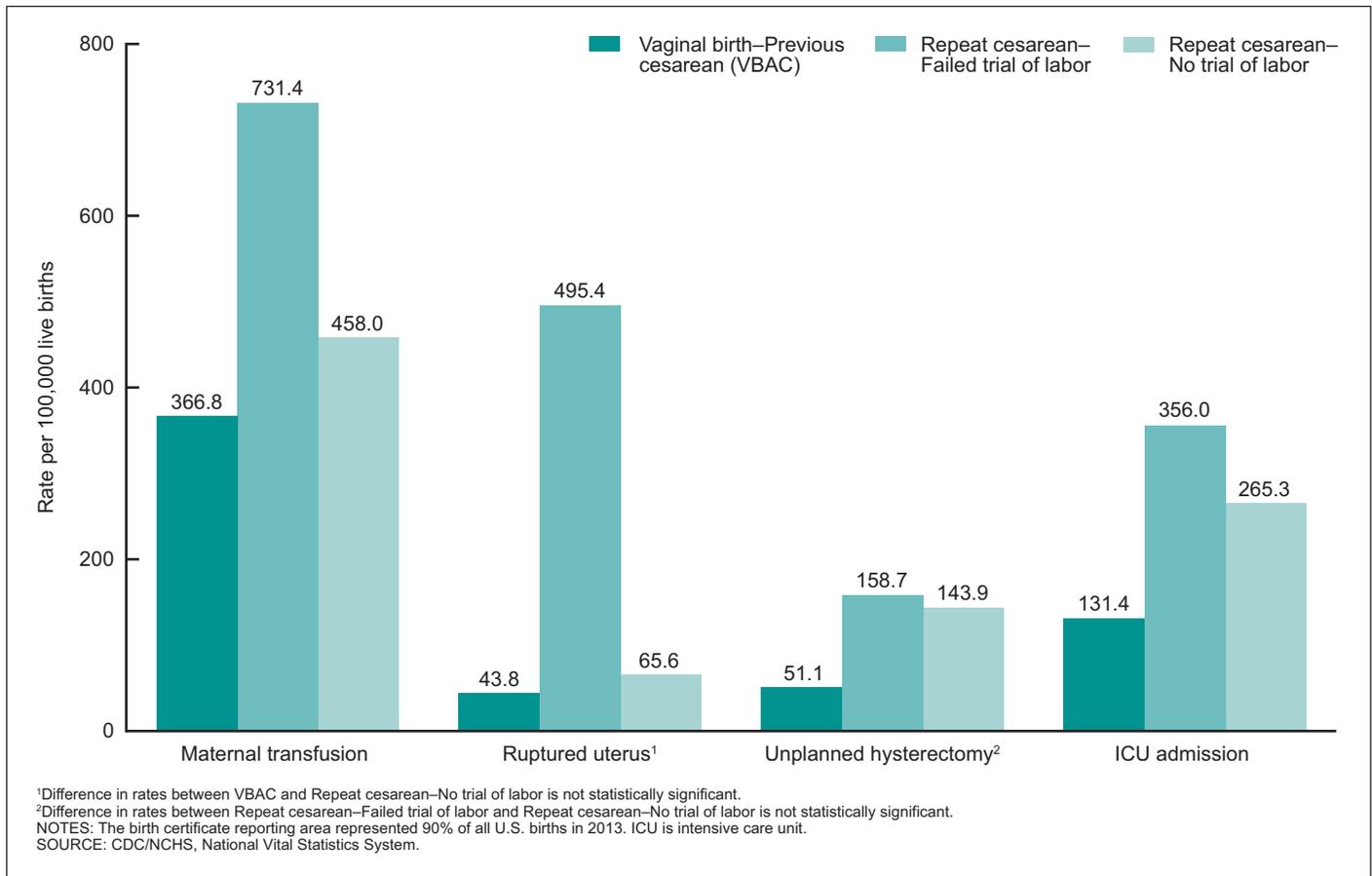
quality report was sensitivity, or the “true positive” rate. This is measured as the percentage of birth records for which a specific item was reported when it was indicated on the medical record. For method of delivery, this study found high sensitivity, above 90%, for vaginal and cesarean deliveries in both states. For the items “mother had a previous cesarean delivery” and “trial of labor,” one state had “substantial” sensitivity, between 75.0% and 89.9%, and the other state had “moderate” sensitivity, between 60.0% and 74.9%. The number of previous cesarean deliveries is not a checkbox item, but a continuous variable. The exact agreement between the birth certificate and the medical record (the primary quality measure) was above 90% in both states.

As an aggregate comparison, two of the maternal morbidities in this report, maternal transfusions and unplanned hysterectomy, are also included to some extent on the Center for Disease Control and Prevention’s (CDC’s) list of severe maternal morbidity indicators (32). These data are collected from a nationally representative survey based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD–9–CM) codes from hospital discharge records in the United States. Their estimate of maternal transfusions for the latest data year, 2010–2011, was 117 per 10,000 deliveries (or 1,170 per 100,000) compared with about 280 per 100,000 for birth certificate data in 2013. Their estimate of hysterectomy was 9 per 10,000 deliveries (or 90 per 100,000), compared with about 41 per 100,000 for birth certificate data. Note that the definitions and method of ascertainment of these morbidities

differ between the two data sources, which could, in part, explain these discrepancies. For example, the CDC indicator for hysterectomy does not differentiate the procedure according to whether it was planned or unplanned, whereas the item on the birth certificate is specific about its being “unplanned.” However, given that these hysterectomies are performed at the time of delivery, the majority are emergent and unplanned (33). Despite the limitations, this comparison of the severe maternal mortality indicators and the birth certificate data suggests underreporting of these morbidities on the birth certificate. The differentials in morbidity among groups featured in this report are generally consistent with the literature, but the overall levels are most likely underestimated.

No large-scale, recent studies exist to use as comparisons for ruptured uterus and ICU admission, and previous estimates of ruptured uterus vary widely (34). Problems in identifying ruptured uterus with ICD–9–CM codes have been documented and may extend to birth certificate data as well (35). In particular, ICD–9–CM codes do not distinguish between a ruptured uterus and a less serious condition, uterine dehiscence. A study that compares birth certificate entries with the medical record would be necessary to ascertain whether this issue also exists for birth certificate data.

Maternal morbidities are rare but important maternal health issues, and they are difficult to examine with most sample survey data. Studies that assess the validity of the birth certificate data are needed. It is hoped that these findings will inform researchers and clinicians as well as suggest avenues of further research using these new data.



**Figure 4. Maternal morbidity for women with a previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013**

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## List of Detailed Tables

1. Maternal morbidity, by previous cesarean history, method of delivery, and age of mother; 41-state and District of Columbia reporting area, 2013 . . . . . 10
2. Maternal morbidity, by previous cesarean history, method of delivery, and race and Hispanic origin of mother: 41-state and District of Columbia reporting area, 2013 . . . . . 11
3. Maternal morbidity for women with no previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013 . . . . . 12
4. Maternal morbidity for women with a previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013 . . . . . 13

**Table 1. Maternal morbidity, by previous cesarean history, method of delivery, and age of mother: 41-state and District of Columbia reporting area, 2013**

[Rates are number of live births with specified morbidity per 100,000 live births in specified group]

Age (years) and maternal morbidity	All births	Previous cesarean history and method of delivery			
		Without previous cesarean delivery		With previous cesarean delivery	
		Vaginal	Primary cesarean	VBAC <sup>1</sup>	Repeat cesarean
All ages <sup>2</sup>		Number of births			
Total number . . . . .	3,548,525	2,322,320	686,194	54,933	464,380
Not stated <sup>3</sup> . . . . .	22,064	3,863	1,558	140	1,154
Condition reported:		Rate			
Maternal transfusion . . . . .	9,888	3,875	3,595	201	2,171
Ruptured uterus . . . . .	922	146	337	24	412
Unplanned hysterectomy . . . . .	1,437	277	462	28	663
Admission to intensive care unit. . . . .	5,460	1,497	2,623	72	1,252
Condition reported:		Rate			
Maternal transfusion . . . . .	280.4	167.1	525.1	366.8	468.7
Ruptured uterus . . . . .	26.1	6.3	49.2	43.8	88.9
Unplanned hysterectomy . . . . .	40.7	11.9	67.5	51.1	143.1
Admission to intensive care unit. . . . .	154.8	64.6	383.1	131.4	270.3
Under age 20		Number of births			
Total number . . . . .	248,842	192,901	47,823	712	6,043
Not stated <sup>3</sup> . . . . .	1,327	289	100	1	10
Condition reported:		Rate			
Maternal transfusion . . . . .	316.3	226.9	645.4	*	480.7
Ruptured uterus . . . . .	11.7	*	*	*	*
Unplanned hysterectomy . . . . .	10.1	*	*	*	*
Admission to intensive care unit. . . . .	156.4	68.5	496.6	*	*
Aged 20–34		Number of births			
Total number . . . . .	2,758,010	1,834,940	515,536	42,021	349,709
Not stated <sup>3</sup> . . . . .	16,566	2,965	1,086	98	813
Condition reported:		Rate			
Maternal transfusion . . . . .	262.4	157.8	489.3	333.9	462.0
Ruptured uterus . . . . .	24.5	5.7	45.3	*	90.6
Unplanned hysterectomy . . . . .	31.2	9.4	50.5	50.1	114.4
Admission to intensive care unit. . . . .	135.5	58.9	344.3	109.7	231.3
Aged 35–54		Number of births			
Total number . . . . .	541,673	294,479	122,835	12,200	108,628
Not stated <sup>3</sup> . . . . .	4,171	609	372	41	331
Condition reported:		Rate			
Maternal transfusion . . . . .	355.5	186.1	628.8	468.8	489.4
Ruptured uterus . . . . .	41.1	11.2	73.5	*	83.1
Unplanned hysterectomy . . . . .	103.8	31.6	158.4	*	239.2
Admission to intensive care unit. . . . .	252.8	97.3	502.2	213.8	397.1

\* Figure does not meet standards of reliability or precision; based on fewer than 20 births in the numerator.

<sup>1</sup>Vaginal birth after cesarean; 98% of vaginal births were to women with no previous cesarean, while 2% were VBAC. For some groups, maternal morbidity cases were too few (less than 20) for VBAC to show rates by age category.

<sup>2</sup>Includes births with previous cesarean history, method of delivery, or maternal morbidity not stated.

<sup>3</sup>No response reported for maternal morbidity item; includes births to residents of states using the 2003 U.S. Standard Certificate of Live Birth but occurring in states using the 1989 U.S. Standard Certificate of Live Birth (0.3%).

NOTE: Reporting area includes Alaska, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

**Table 2. Maternal morbidity, by previous cesarean history, method of delivery, and race and Hispanic origin of mother: 41-state and District of Columbia reporting area, 2013**

[Rates are number of live births with specified morbidity per 100,000 live births in specified group]

Race and Hispanic origin and maternal morbidity	All births	Previous cesarean history and method of delivery			
		Without previous cesarean delivery		With previous cesarean delivery	
		Vaginal	Primary cesarean	VBAC <sup>1</sup>	Repeat cesarean
All races <sup>2</sup>		Number of births			
Total number . . . . .	3,548,525	2,322,320	686,194	54,933	464,380
Not stated <sup>3</sup> . . . . .	22,064	3,863	1,558	140	1,154
Condition reported:		Rate			
Maternal transfusion . . . . .	9,888	3,875	3,595	201	2,171
Ruptured uterus . . . . .	922	146	337	24	412
Unplanned hysterectomy . . . . .	1,437	277	462	28	663
Admission to intensive care unit. . . . .	5,460	1,497	2,623	72	1,252
Condition reported:		Rate			
Maternal transfusion . . . . .	280.4	167.1	525.1	366.8	468.7
Ruptured uterus . . . . .	26.1	6.3	49.2	43.8	88.9
Unplanned hysterectomy . . . . .	40.7	11.9	67.5	51.1	143.1
Admission to intensive care unit. . . . .	154.8	64.6	383.1	131.4	270.3
Non-Hispanic white		Number of births			
Total number . . . . .	1,880,350	1,250,426	365,751	28,174	230,594
Not stated <sup>3</sup> . . . . .	5,590	1,826	730	50	514
Condition reported:		Rate			
Maternal transfusion . . . . .	276.7	172.5	532.0	334.2	421.6
Ruptured uterus . . . . .	24.3	4.7	44.9	*	95.6
Unplanned hysterectomy . . . . .	38.9	11.8	65.2	*	140.8
Admission to intensive care unit. . . . .	120.1	47.7	309.8	88.9	215.1
Non-Hispanic black		Number of births			
Total number . . . . .	511,132	316,972	109,553	8,995	72,924
Not stated <sup>3</sup> . . . . .	3,474	1,042	474	59	368
Condition reported:		Rate			
Maternal transfusion . . . . .	332.3	156.4	584.9	402.9	704.3
Ruptured uterus . . . . .	39.2	10.1	67.8	*	118.5
Unplanned hysterectomy . . . . .	46.1	13.0	59.6	*	165.4
Admission to intensive care unit. . . . .	239.5	80.7	572.1	*	436.9
Non-Hispanic Asian		Number of births			
Total number . . . . .	206,651	133,109	43,385	3,164	26,584
Not stated <sup>3</sup> . . . . .	743	312	117	10	69
Condition reported:		Rate			
Maternal transfusion . . . . .	251.6	155.1	487.7	*	335.7
Ruptured uterus . . . . .	32.1	*	50.8	*	113.1
Unplanned hysterectomy . . . . .	47.6	*	110.9	*	124.5
Admission to intensive care unit. . . . .	150.6	67.8	367.5	*	211.2
Hispanic		Number of births			
Total number . . . . .	818,006	539,552	144,342	12,676	119,360
Not stated <sup>3</sup> . . . . .	2,234	478	185	20	160
Condition reported:		Rate			
Maternal transfusion . . . . .	247.1	150.8	453.0	331.9	419.5
Ruptured uterus . . . . .	20.3	6.9	44.4	*	51.2
Unplanned hysterectomy . . . . .	40.1	11.3	65.2	*	139.3
Admission to intensive care unit. . . . .	182.0	92.8	428.0	173.8	286.9

\* Figure does not meet standards of reliability or precision; based on fewer than 20 births in the numerator.

<sup>1</sup>Vaginal birth after cesarean; 98% of vaginal births were to women with no previous cesarean, while 2% were VBAC. For some groups, maternal morbidity cases were too few (less than 20) for VBAC to show rates by racial and ethnic categories.<sup>2</sup>Includes births with previous cesarean history, method of delivery, maternal morbidity, or race and ethnicity not stated.<sup>3</sup>No response reported for maternal morbidity item; includes births to residents of states using the 2003 U.S. Standard Certificate of Live Birth but occurring in states using the 1989 U.S. Standard Certificate of Live Birth (0.3%).

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**Table 3. Maternal morbidity for women with no previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013**

[Rates are number of live births with specified morbidity per 100,000 live births in specified group]

Maternal morbidity	Trial of labor		
	Attempted		None
	Successful, vaginal	Failed, primary cesarean	Primary cesarean
Total <sup>1</sup> . . . . .	2,322,320	273,120	398,736
Not stated <sup>2</sup> . . . . .	3,863	528	705
Condition reported:			
Maternal transfusion . . . . .	167.1	600.9	486.9
Ruptured uterus . . . . .	6.3	55.0	46.5
Unplanned hysterectomy . . . . .	11.9	70.4	66.6
Admission to intensive care unit . . . . .	64.6	318.4	420.6

<sup>1</sup>Includes births with maternal morbidity not stated.<sup>2</sup>No response reported for maternal morbidity item; includes births to residents of states using the 2003 U.S. Standard Certificate of Live Birth but occurring in states using the 1989 U.S. Standard Certificate of Live Birth (0.3%).

NOTE: Reporting area includes Alaska, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

**Table 4. Maternal morbidity for women with a previous cesarean delivery, by method of delivery and trial of labor: 41-state and District of Columbia reporting area, 2013**

[Rates are number of live births with specified morbidity per 100,000 live births in specified group]

Maternal morbidity	Trial of labor		
	Attempted		None
	Successful, VBAC <sup>1</sup>	Failed, repeat cesarean	Repeat cesarean
Total <sup>2</sup> . . . . .	54,933	25,926	432,547
Not stated <sup>3</sup> . . . . .	140	86	928
Condition reported:			
Maternal transfusion . . . . .	366.8	731.4	458.0
Ruptured uterus . . . . .	43.8	495.4	65.6
Unplanned hysterectomy . . . . .	51.1	158.7	143.9
Admission to intensive care unit . . . . .	131.4	356.0	265.3

<sup>1</sup>Vaginal birth after cesarean.<sup>2</sup>Includes births with maternal morbidity not stated.<sup>3</sup>No response reported for maternal morbidity item; includes births to residents of states using the 2003 U.S. Standard Certificate of Live Birth but occurring in states using the 1989 U.S. Standard Certificate of Live Birth (0.3%).

NOTE: Reporting area includes Alaska, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

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**Contents**

Abstract . . . . .	2
Introduction . . . . .	2
Methods . . . . .	2
Results . . . . .	3
Overall findings . . . . .	3
Maternal age . . . . .	3
Race and ethnicity . . . . .	4
Trial of labor and method of delivery . . . . .	5
Discussion . . . . .	5
Findings from the birth certificate compared with other studies . . . . .	5
Data quality of health information from birth certificates . . . . .	6
References . . . . .	8
List of Detailed Tables . . . . .	9

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